UNIVERSITY OF NAIROBI

COLLEGE OF ARCHITECTURE AND ENGINEERING

SCHOOL OF ENGINEERING

# CHARACTERIZATION OF THE MICROSTRUCTURE OF ORDINARY PORTLAND CEMENT PASTE USING AUTOGENOUS SHRINKAGE AND HEAT OF HYDRATION PARAMETERS

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**A Thesis Submitted in Fulfillment for the Degree of Master of Science in Civil Engineering (Structures) in the Department of Civil and Construction Engineering in the University of Nairobi**

**JUNE 2016**

# DECLARATION/APPROVAL

**Declaration:**

This thesis is my original work and has not been presented for a degree in any other university

……………………………………...............................................................................

Name of student

………………………………………

Date

**Approval:**

This thesis has been submitted for examination with my approval as university supervisor.

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Name and title of supervisor

………………………………………

Date

# DEDICATION

This Thesis is dedicated to God, for His greater Glory. Moreover, to my late dad and late mum, for their efforts in molding me into who I am today.

# ACKNOWLEDGEMENT

I wish to thank the many individuals who assisted me in the completion of this Thesis. In particular, my special thanks to my supervisor, Dr. Siphila Mumenya, for providing support, encouragements, and suggestions during this thesis preparation. Her knowledge and dedication have made this work possible.

## ABSTRACT

The main objective of this study was to characterize the microstructure of Ordinary Portland Cement paste using autogenous shrinkage and heat of hydration parameters. The relevance of the research was the need to advance the knowledge on understanding the underlying mechanism of autogenous shrinkage and heat of hydration parameters and their influence on the evolution of cement paste microstructure. This will allow Engineers to develop performance based specifications to mitigate pre mature cracking due to autogenous shrinkage and heat of hydration.

Though there are many types of cements manufactured and available in Kenya, this thesis focused on Ordinary Portland Cement paste. To limit scope and hence achieve a comprehensive research, the research was limited to cement paste and concrete mixes of water/cement (w/c) ratios of 0.35 and 0.45. Type K temperature probes and Extech Differential Temperature Data Logger were used to measure the heat of hydration of Ordinary Portland Cement paste. Strain gauge and MadgeTech Bridge/Strain data loggers were used to measure autogenous shrinkage-induced strain of hydrating Ordinary Portland Cement paste. A stereo microscope was used to evaluate the microstructure evolution of a hydrating Ordinary Portland Cement paste (as a function of pores formation and cracking).

The research findings were that samples with lower w/c ratios recorded higher autogenous shrinkage, bigger pores and increased risk of cracking than the rest of the samples. It was also found that curing in saturated conditions ensures replacement and availability of more water for hydration of Ordinary Portland Cement paste. This reduces autogenous shrinkage. Availability of water for curing reduces the temperature due to cooling aided by the presence of water.

It was recommended that further research is done to relate the development of pore structure with autogenous shrinkage. The effect of aggregates on autogenous shrinkage should be further studied. Evidence that autogenous shrinkage causes problems in concrete practice in this region should be sought.

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# ABBREVIATIONS

C: Calcium Oxide (CaO)

S: Silicon Dioxide ($SiO_2$)

H: Water ($H_2O$)

A: Aluminum Oxide ($Al_2O_3$)

F: Iron Oxide ($Fe_2O_3$)

$\overline{S}$ : Sulfur Trioxide ($SO_3$)

SEM: Scanning Electron Microscopy

$C_3S$: Tricalcium Silicate

$C_2S$: Dicalcium Silicate

$C_3A$: Tricalcium Aluminate

$C_4AF$: Tetracalcium Aluminoferrite

C-S-H: Calcium Silicate Hydrate

CH: Calcium Hydroxide

w/c: Water to Cement Ratio

# 1. INTRODUCTION

## 1.1. Background

### 1.1.1. Introduction and Study Justification

The main objective of this study was to characterize the microstructure of Ordinary Portland Cement paste using autogenous shrinkage and heat of hydration parameters.

The cement paste of a modern, high-performance concrete typically shows low porosity and a discontinuous capillary pore structure. This is often obtained by keeping a low water to cement ratio (w/c) and by adding silica fume. While modern concretes can possess some advantageous properties compared with traditional concrete in terms of good workability, high strength from early ages, low permeability, and improved durability, they may also exhibit unwanted behaviour such as autogenous strain (Pietro *et al*., 2008).

The motivation of this research was the need to advance knowledge on understanding the underlying mechanism of autogenous shrinkage and production of heat during hydration and their influence in evolution of Ordinary Portland Cement paste microstructure. It is hoped that the study will provide a solution to prevailing concrete production problems in Kenya and allow engineers to develop performance-based specifications to mitigate pre-mature shrinkage cracking. An in depth understanding of the effect of reducing water to cement ratio should act as an eye-opener to contractors and concrete users to be more specific and careful about concrete mixing ratios especially in Kenya where the issue of concrete production is taken casually and anyone is expected to do it even though some have little understanding of the underlying mechanism of cement hydration. It is also hoped that the results of this research will enable the Authorities relevant for registration of contractors to be more stringent about the qualifications of the Contractors they register to ensure they understand that the issue of water to cement ration is sensitive despite the availability of admixtures that help solve workability issues.

### 1.1.2. Hydration and Shrinkage of Portland Cement

Portland cement is produced by heating a mixture of limestone and clay, or other materials of similar bulk composition and sufficient reactivity, to a temperature of about 1450°C, at which partial fusion occurs and nodules of clinker are formed. The clinker is then mixed with a few percentages of gypsum and finely ground. There are different types of Portland Cement depending on their composition and manufacturing technology.

#### 1.1.2.1. Types and Composition of Portland Cements

Various types of Portland Cements have been developed to meet different physical and chemical requirements for specific construction conditions. These cement types are produced by adjusting the chemical composition and the fineness of cement.

According to **KS EAS 18-1: 2001** (previously Kenya Bureau of Standards — KS 1725:Part1: 2001, equivalent to EN 196), the 27 products in the family of common cements, covered by EAS 18-1 and their notation are given in Table 1 of KS EAS 18-1: 2001 . They are grouped into five main cement types as follows:

- CEM I Portland cement;
- CEM II Portland-composite cement;
- CEM III Blastfurnace cement;
- CEM IV Pozzolanic cement;
- CEM V Composite cement.

The composition of each of the 27 products in the family of common cements shall be in accordance with Table 1 of KS EAS 18-1: 2001.

**Table 1.1: The 27 Product in the Family of Common Cements**

| Main Types | Notation of the 27 products (types of common cement) | | Composition [percentage by mass a)] | | | | | | | | | | Minor additional |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main constituents | | | | | | | | | | |
| | | | Clinker | Blast-Furnace | Silica fume | Pozzolana | | Fly ash | | Burnt Shale | Lime stone | | |
| | | | | | | natural | natural calcined | Siliceous | Calcareous | | | | |
| | | | K | S | D b) | p | q | V | W | T | L | LL | |
| CEM I | Portland cement | CEM I | 95-100 | – | – | – | – | – | – | – | – | | 0 to 5 |
| CEM II | Portland–slag cement | CEM II/A-S | 80–94 | 6 to 20 | – | – | – | – | – | – | – | – | 0to 5 |
| | | CEM II/B-S | 65–79 | 21 to 35 | | – | – | – | – | – | – | – | 0 to 5 |
| | Portland silica fume cement | CEM I/A-D | 90 to 94 | – | 6 to 10 | – | – | – | – | – | – | – | 0 to 5 |
| | Portland– | CEM II/A-P | 80 to 94 | – | – | 6 to 20 | – | – | – | – | – | – | 0 to 5 |

| Main Types | Notation of the 27 products (types of common cement) | | Composition [percentage by mass [a]] | | | | | | | | | | Minor additional |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main constituents | | | | | | | | | | |
| | | | Clinker | Blast-Furnace | Silica fume | Pozzolana | | Fly ash | | Burnt Shale | Lime stone | | |
| | | | | | | natural | natural calcined | Siliceous | Calcareous | | | | |
| | | | K | S | D[b] | p | q | V | W | T | L | LL | |
| | Pozzolana cement | CEM II/B-P | 65 to 79 | – | – | 21 to 35 | – | – | – | – | – | – | 0 to 5 |
| | | CEM II/A-Q | 80 t0 94 | – | – | | 6 to 20 | – | – | – | – | – | 0 to 5 |
| | | CEM II / B-Q | 65 to 79 | – | – | – | 21 to 35 | – | – | – | – | – | 0 to 5 |
| | Portland –fly ash cement | CEM II / A-V | 80–94 | – | – | – | – | 6 to 20 | – | – | – | – | 0 to 5 |
| | | CEMII / B-V | 65 to 79 | – | – | – | – | 21 to 35 | – | – | – | – | 0 to 5 |

| Main Types | Notation of the 27 products (types of common cement) | | Composition [percentage by mass [a)]] | | | | | | | | | | Minor additional |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main constituents | | | | | | | | | | |
| | | | Clinker | Blast-Furnace | Silica fume | Pozzolana | | Fly ash | | Burnt Shale | Lime stone | | |
| | | | | | | natural | natural calcined | Siliceous | Calcareous | | | | |
| | | | K | S | D[b)] | p | q | V | W | T | L | LL | |
| | | CEM II/A-W | 80–94 | – | – | – | – | – | 6 to 20 | – | – | – | 0 to 5 |
| | | CEMII/B-W | 65 to 79 | – | – | – | – | – | 21 to 35 | – | – | – | 0 to 5 |
| | Portland–burnt shale cement | CEM II/A-T | 80–94 | – | – | – | – | – | – | 6 to 20 | – | – | |
| | | CEM II/ B-T | 65 to 79 | – | – | – | – | – | – | 21 to 35 | – | – | 0 to 5 |
| | Portland–limestone | CEM II/ A-L | 80 to 94 | – | – | – | – | – | — | – | 6 to 20 | – | 0 to 5 |

| Main Types | Notation of the 27 products (types of common cement) | | Composition [percentage by mass [a)]] | | | | | | | | | | Minor additional |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main constituents | | | | | | | | | | |
| | | | Clinker | Blast-Furnace | Silica fume | Pozzolana | | Fly ash | | Burnt Shale | Lime stone | | |
| | | | | | | natural | natural calcined | Siliceous | Calcareous | | | | |
| | | | K | S | D[b)] | p | q | V | W | T | L | LL | |
| | cement | CEM II/A-L | 65 to 79 | – | – | – | – | – | – | – | 21 to 35 | – | 0 to 5 |
| | | CEM II/A-LL | 80 to 94 | – | – | – | – | – | – | – | – | 6 to 20 | 0 to 5 |
| | | CEM II/ B-LL | 65 to 79 | – | – | – | – | – | – | – | – | 21 to 35 | 0 to 5 |
| | Portland composite cement[c)] | CEM II/ A-M | 80–94 | <-------- 6 to 20 --------> | | | | | | | | | 0 to 5 |
| | | CEM II/ B-M | 65 to 79 | <-------- 21 to 35 --------> | | | | | | | | | 0 to 5 |

| Main Types | Notation of the 27 products (types of common cement) | | Composition [percentage by mass [a)]] | | | | | | | | | | Minor additional |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main constituents | | | | | | | | | | |
| | | | Clinker | Blast-Furnace | Silica fume | Pozzolana | | Fly ash | | Burnt Shale | Lime stone | | |
| | | | | | | natural | natural calcined | Siliceous | Calcareous | | | | |
| | | | K | S | D[b)] | p | q | V | W | T | L | LL | |
| | | | | | | | | | | | | | |
| CEM III | Blast–furnace cement | CEM III/A | 35 to 64 | 36 to 65 | – | – | – | – | – | – | – | – | 0 to 5 |
| | | CEM III/B | 20 to 34 | 66 to 80 | – | – | – | – | – | – | – | – | 0 to 5 |
| | | CEM III/C | 5 to 19 | 81 to 95 | – | – | – | – | – | – | – | – | 0 to 5 |
| CEM IV | Pozzolanic cement [c)] | CEM IV/A | 65 to 89 | – | <----------- 11 to 35 ----------> | | | | | – | | | 0 to 5 |

| Main Types | Notation of the 27 products (types of common cement) | | Composition [percentage by mass [a)]] | | | | | | | | | | Minor additional |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main constituents | | | | | | | | | | |
| | | | Clinker | Blast-Furnace | Silica fume | Pozzolana | | Fly ash | | Burnt Shale | Lime stone | | |
| | | | | | | natural | natural calcined | Siliceous | Calcareous | | | | |
| | | | K | S | D[b)] | p | q | V | W | T | L | LL | |
| | | CEM IV/B | 45 to 64 | – | <-------- 36 to 55 -------> | | | | | – | | | 0 to 5 |
| CEN V | Composite cement [c)] | CEM V/ A | 40 to 64 | 18 to 30 | | <---- 18 to 30 ---> | | | – | – | | | 0 to 5 |
| | | CEM V/B | 20 to 38 | 31 to 50 | | <---- 31 to 50 ---> | | | – | – | | | 0 to 5 |

| Main Types | Notation of the 27 products (types of common cement) | Composition [percentage by mass [a]] | | | | | | | | | | Minor additional |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Main constituents | | | | | | | | | | |
| | | Clinker | Blast-Furnace | Silica fume | Pozzolana | | Fly ash | | Burnt Shale | Lime stone | | |
| | | | | | natural | natural calcined | Siliceous | Calcareous | | | | |
| | | K | S | D[b] | p | q | V | W | T | L | LL | |

a) The values in the table refer to the sum of the main and minor additional constituents

b) The proportion of silica fume is limited to 10 %.

c )In Portland–composite cements CEM II/A–M and CEM II/B–M, in Pozzolanic cements CEM IV/A and CEM IV/B and in composite cements CEM V/A and CEM V/B the main constituents other than clinker shall be declared by designation of the cement ( for example see Clause 8).

**KS EAS 18-1: 2001** states that Portland cement clinker is made by sintering a precisely specified mixture of raw materials (raw meal, paste or slurry) containing elements, usually expressed as oxides, CaO, $SiO_2$, $AL_2O_3$ $Fe_2O_3$ and small quantities of other materials. The raw meal, paste or slurry is finely divided, intimately mixed and therefore homogeneous. Portland cement clinker is a hydraulic material which shall consist of at least two-thirds by mass of calcium silicates ($3CaO.SiO_2$ and $2CaO .SiO_2$ the remainder consisting of aluminium and iron containing clinker phases and other compounds. The ratio by mass $(CaO)/(SiO_2)$ shall be not less than 2.0. The content of magnesium oxide (MgO) shall not exceed 5.0 % by mass.

Typical composition of Portland Cement is given in Table 1.2.

**Table 1.2: Typical composition of Portland Cement (Mindess 2003)**

| Chemical Name | Chemical formula | Shorthand Notation | Weight percent |
|---|---|---|---|
| Tricalcium silicate(alite) | $3CaO.SiO_2$ | $C_3S$ | 55 |
| Dicalcium silicate (belite) | $2CaO.SiO_2$ | $C_2S$ | 18 |
| Tricalcium aluminate | $3CaO.Al_2O_3$ | $C_3A$ | 10 |
| Tetracalcium aluminoferrite | $4CaO.Al_2O_3.Fe_2O_3$ | $C_4AF$ | 8 |
| Calcium sulfate didydrate (Gypsum) | $CaSO_4.2H_2O$ | $C\overline{S}H_2$ | 6 |

### 1.1.2.2. Hydration of Portland Cement

The reaction of Portland cement and water is defined as hydration; and the new solids formed through such hydration are called hydration products. The hydration of Portland cement consists of a series of exothermic reactions and is too complex to be described by simple chemical equations as is elaborated later in the literature review chapter.

When Portland Cement is mixed with water, hydration products are formed. Calcium silicates consist of tricalcium silicate and dicalcium silicate. The two calcium silicates induce very similar hydration reactions. Equations 1.1 and 1.2 describe the hydration reaction of calcium silicates.

The principal hydration product is calcium silicate hydrate (C-S-H) and calcium hydroxide. C-S-H gel plays the role of a binder of the cement paste and eventually has an effect on the strength and durability of concrete.

$C_2S$ and $C_3S$ produce a C-S-H gel of about 82 percent and 61 percent, respectively. The ultimate strength and durability of high $C_2S$ cement would be higher than for one with a high proportion of $C_3S$.

$2C_3S + 11H \rightarrow C_3S_2H_8$ (C-S-H) + 3CH (calcium hydroxide) Equation (1.1)

$2C_2S + 9H \rightarrow C_3S_2H_8$ (C-S-H) + CH (calcium hydroxide) Equation (1.2)

Tricalcium aluminate ($C_3A$) reacts immediately with water. The rapid hydration of $C_3A$ can be slowed down by the addition of gypsum. Therefore, the final hydration products vary with the gypsum content. The hydration products of $C_3A$ are commonly formed into ettringite in the first stage and monosulfoaluminate later (Equation 1.3). The precipitation of ettringite contributes to stiffening, setting, and early strength development. After the depletion of sulfate, ettringite becomes unstable and is gradually converted into monosulfoaluminate (Equation 1.4). If a new source of sulfate is added, monosulfoaluminate can convert back to ettringite again. Tricalcium aluminate ($C_3A$) contributes little to the strength of cement paste.

$C_3A + 3C\bar{S}H_2 + 26H \rightarrow C_6A\bar{S}_3H_{32}$ (ettringite) Equation(1.3)

$C_3A + C_6A\bar{S}_3H_{32} + 4H \rightarrow 3C_4A\bar{S}H_{12}$ (monosulfoaluminate) Equation(1.4)

The hydration of tetracalcium aluminoferrite ($C_4AF$) is similar to hydration products of $C_3A$. The hydration reactions are slower and involve less heat. Two possible hydrates can form depending on the availability of gypsum (Equations

1.5 and 1.6).

$$C_4AF + 3C\bar{S}H_2 + 21H \rightarrow C_6(A,F)\bar{S}_3H_{32} + (F,A)H_3 \quad \text{Equation(1.5)}$$

$$C_4AF + C6(A,F)\bar{S}3H_{32} + 7H \rightarrow 3C_4(A,F)\bar{S}H_{12} + (F,A)H_3 \quad \text{Equation(1.6)}$$

#### 1.1.2.3. Shrinkage of Cement Paste

The volume of the hydration products is smaller than the combined volume of the reacted cement and water. This reduction in volume is partly due to chemical shrinkage of cement paste and autogenous shrinkage. This is the bulk shrinkage of cement paste in a closed isothermal system (i.e. without moisture exchange).

Another kind of shrinkage, which is usually referred to as the drying shrinkage, is caused by the loss of water during hydration due to evaporation when cement paste is exposed to the open air. There also exist other kinds of deformation, such as the thermal deformation due to temperature change; the carbonation shrinkage due to the reaction between CH in the cement paste with water and $CO_2$ in the air; and the deformation due to external loads. Many investigations have been conducted on the shrinkage of cementitious materials via experiments and theoretical analysis. Thorough reviews of the autogenous deformation and its measurements can be found in Justnes et al. (1994) and Jensen and Hansen (1996, 2001). A discussion of drying shrinkage is given in Hansen (1987).

An essential relationship exists between heat of hydration and autogenous shrinkage as it pertains to cement hydration. Some researchers have reported that the magnitude and the development rate of autogenous shrinkage of the cement paste, mortar and concrete were affected by the history and magnitude of the inner temperature at early ages (Bjmperature et al. 1997; Horita et al. 2001; Loukili et al. 2000 and Shima et al. 2006).

## 1.2. Problem Statement

Autogenous shrinkage is the major shrinkage component of concretes that contain much less water than would be required for complete hydration. The relative surplus of cement leads to an internal drying, irrespective of whether the concrete dries out to the ambient air or not. This process of so called self-desiccation is associated with autogenous shrinkage which, if restrained, can lead to cracks, potentially impairing in many respects of durability of the concrete. (Mechtcherine and Breitenbücher, 2010).

It was for this reason that samples with water to cement (w/c) ratios lower than the ones normally chosen for workability reasons were used (i.e. w/c ratios of 0.35 and 0.45 were used in this research). It is also worthwhile to note that low w/c ratio mixes are increasingly preferred for their higher strength and durability properties. Concrete infrastructures undergo complex chemical and physical changes due to cement hydration and exposure to the environments. These changes affect the desired service life or durability of the concrete.

There are many factors affecting the durability of cementitious materials and the importance of these factors varies with circumstances. Shrinkage is one of the major causes of cracking in bridge decks, pavements, indoor floors and other structures (Wei, 2008). Concrete develops volumetric changes due to thermal and moisture related deformations, which can be detrimental when substantial stresses occur in restrained structural elements, particularly at early ages when the concrete has a low tensile strength.

The particular aspects of degradation related to shrinkage cracking include; chemical and microbiological degradation of concrete, corrosion of reinforcing and prestressing steels, sulfate attack, alkali-silica reaction, and deterioration associated with certain aggregates(e.g. those containing reactive silica and dolomitic rocks) that leads to spalling of concrete structures.

The increasing focus on shrinkage-cracking-related durability problem requires a better understanding of the material properties to be able to adjust the concrete to the level of attack it must resist. Common concrete is intrinsically porous the degree of which depends on the grade. In addition to affecting the mechanical properties such as strength, modulus, and toughness of concrete, the porous microstructure is the main source of shrinkage (Wei, 2008).

Cement hydration leads to the formation of the vapor-filled porosity upon the percolation of the solid phase. The paste phase undergoes internal pore drying known as self-desiccation due to the consumption of moisture from pore structures for further hydration. Unlike drying that may occur from the outside of the specimen inward, self-desiccation occurs uniformly throughout the concrete microstructure and results in autogenous shrinkage which is the major source of cracking if external (adjunct structures) or internal (aggregate or anhydrous cement particles) restraints exist.

Though the phenomenon of autogenous shrinkage and its influence on structure behavior have long been recognized, the mechanism behind is not fully understood yet and no standard test method was accepted by the scientific community. Numerous researchers have investigated and contributed to a better understanding of the underlying process of autogenous shrinkage and found that the factors which influence this phenomenon include:

- The chemical compositions and physical properties of cement
- Water/cement ratio (w/c)
- Chemical and physical properties of Supplementary Cementitious Materials (SCM)
- Exposure temperature

Quantifying the autogenous shrinkage of cementitious systems, especially given the increasing and widespread utilization of high-performance concrete containing supplementary cementitious materials, becomes important in order to understand and control premature cracking in concrete structures. However, lack of data on this property which is attributed to testing challenges has hampered the development of sound prediction models for autogenous shrinkage.

## 1.3. Objectives of Research

The overall objective of this research was to characterize the microstructure of Ordinary Portland Cement paste as a function of autogenous shrinkage and heat of hydration. The research focused on achieving the following specific objectives:

1. The effect of water to cement ratio on the evolution of the microstructure of hydrating Ordinary Portland cement paste using autogenous shrinkage parameter
2. The effect of curing conditions on the evolution of the microstructure of hydrating Ordinary Portland cement paste using autogenous shrinkage parameter
3. The effect of water to cement ratio on the evolution of the microstructure of hydrating Ordinary Portland cement paste using heat of hydration parameter
4. The effect of curing conditions on the evolution of the microstructure of hydrating Ordinary Portland cement paste using heat of hydration parameter

This paper focused on the following techniques to characterize the hydration and microstructure of Ordinary Portland Cement paste and concrete of w/c ratios of 0.35 and 0.45:

1. Use of type K temperature probes and Extech Differential Temperature Data logger to measure the heat of hydration of Ordinary Portland Cement paste.
2. Use of a strain gauge and MadgeTech Bridge/Strain Data logger to measure autogenous shrinkage strain of hydrating Ordinary Portland Cement paste.
3. Use of a stereo microscope to evaluate the microstructure evolution of a hydrating Ordinary Portland Cement paste (as a function of pores formation and cracking).

To efficiently realize the objectives, the experimental investigation was limited to the following variables:

1. Although many types of cements are manufactured in Kenya, this research was only limited to CEM I (Ordinary Portland cement). Although all the

27 cement types do not behave the same, lack of enough equipments limited the number of samples that could be done as even the strain gauges were imported and were not re-usable. As such, carrying out the tests on all the 27 cement types would not only have been expensive but it would have taken a very long time than is allowed for at the MSc. level.

2. Water/cement ratios of 0.35 and 0.45 since autogenous shrinkage is predominantly present in mixes with low w/c ratios.
3. Saturated and unsaturated curing conditions as a function of age.
4. Each specimen was tested from ages zero to 10 days.

# 2. LITERATURE REVIEW

## 2.1. Introduction

In this chapter, cement hydration, microstructure formation, and the existing mechanism of autogenous shrinkage were reviewed.

## 2.2. Portland Cement Production

Cement, is a mixture of compounds made by burning limestone and clay together at very high temperatures ranging from 1400 to 1600˚C. Although there are other cements for special purposes, this study will focus solely on Ordinary Portland Cement. The production of Portland cement begins with the quarrying of limestone (CaCO3). Huge crushers break the blasted limestone into small pieces. The crushed limestone is then mixed with clay (or shale), sand, and iron ore and ground together to form a homogeneous powder. This powder is microscopically heterogeneous (http://matse1.matse.illinois.edu/concrete/prin.html). The mixture is heated in kilns that are long rotating steel cylinders on an incline. The kilns may be up to 6 meters in diameter and 180 meters in length.

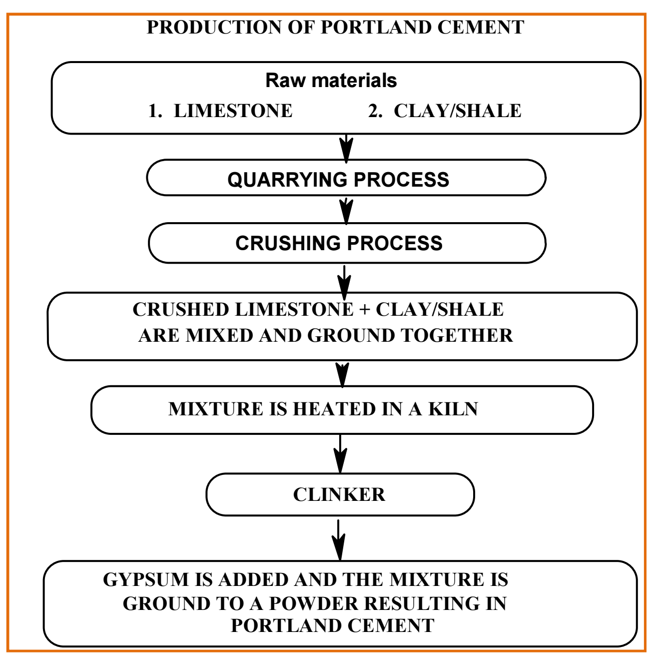


**Figure 2.1: Flow diagram of Portland Cement production (Http://matse1.matse.illinois.edu/concrete/prin.html)**

The mixture of raw materials enters at the high end of the cylinder and slowly moves along the length of the kiln due to the constant rotation and inclination. At the low end of the kiln, a fuel is injected and burned, thus providing the heat necessary to make the materials react. It can take up to 2 hours for the mixture to pass through the kiln, depending upon the length of the cylinder (Http://matse1.matse.illinois.edu/concrete/prin.html).

As the mixture moves down the cylinder, it progresses through four stages of transformation. Initially, any free water in the powder is lost by evaporation. Next, decomposition occurs from the loss of bound water and carbon dioxide. This is called calcination. The third stage is called clinkering. During this stage, the calcium silicates are formed. The final stage is the cooling stage. The marble-sized pieces produced by the kiln are referred to as clinker. The clinker is cooled, ground, and mixed with a small amount of gypsum (which regulates setting) to produce the general-purpose Portland cement (Http://matse1.matse.illinois.edu/concrete/prin.html).

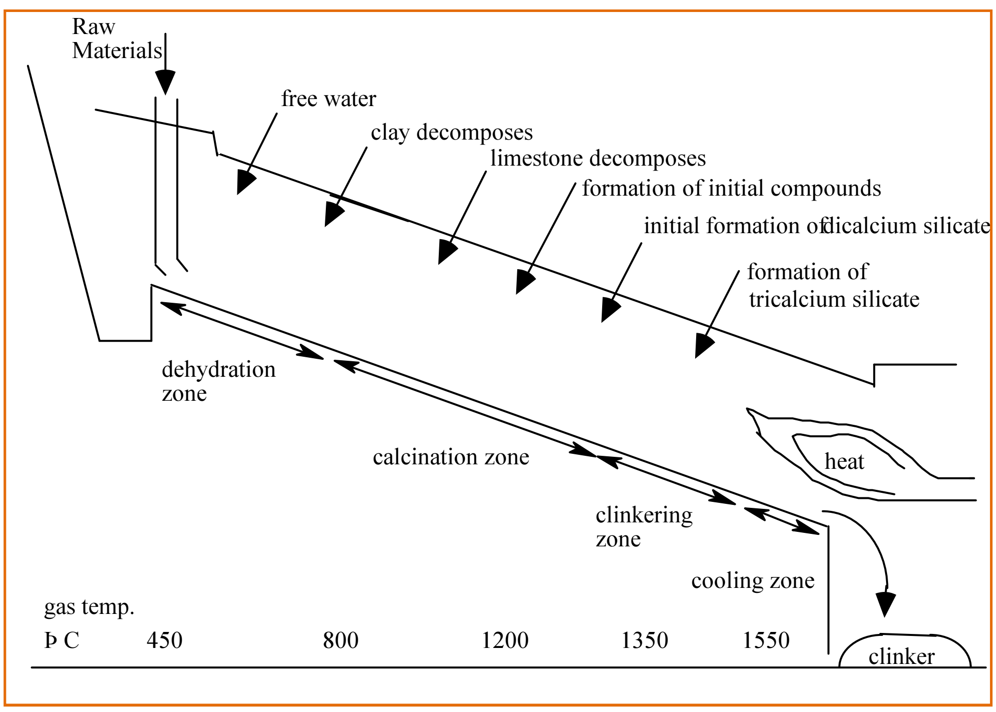


Figure 2.2: Schematic diagram of rotary kiln.

## 2.3. Concrete Practice in Kenya and East Africa Region as a Whole

According to **Raúl H. Figueroa Fernández (2014)** in his research paper titled ' **Strategies to reduce the risk of building collapse in developing countries** ' , in developing countries, poor quality construction has led to spontaneous building collapse and, during earthquakes, to major disasters. While reliable building codes are widely used in design, builders in developing countries often fail to meet acceptable standards. Structural defects are frequently identified too late, often after catastrophic collapse. In Kenya, more than eighty people have been killed, an over 290 injured, by collapsed buildings, since 2006. However, Kenya is not an exception. Throughout the world, in particular in countries with developing economies and growing populations, thousands of dangerously weak buildings will be built, and millions of people will be exposed to unnecessarily higher risks for generations (Figueroa Fernandez R.H. 2014).

The data suggest that the quality control mechanisms for structural concrete currently used in Kenya are not as effective as they should be. Architects and engineers routinely certify buildings as safe for occupation based, in part, on inaccurate or false laboratory reports. These findings highlight an example of lax quality control in the construction industry that could be pervasive in East Africa, as in developing countries elsewhere. Thousands of dangerously weak buildings will be built, and unless better control systems are implemented, millions of people will likely be exposed to unnecessarily higher risks for generations. National governments and international organizations interested in safer and more sustainable cities should give high priority to improving construction quality control processes and regulation. Policymakers in government, nongovernmental organizations, and professional organizations must catalyze institutional change in the construction industry as a matter of urgency. Their efforts will be most effective if attention is given to the promotion and enforcement of prudent quality control protocols that encourage engineers and inspectors to assume less and verify more (Figueroa Fernandez R.H. 2014).

## 2.4. Hydration Process

### 2.4.1. Introduction

The composition of a typical Portland cement is listed by weight percentage in Table 2.1 (Http://matse1.matse.illinois.edu/concrete/prin.html).

**Table 2.1: Composition of Portland cement with chemical composition and weight percent.**

| Cement Compound | Weight Percentage | Chemical Formula |
|---|---|---|
| Tricalcium silicate | 50 % | $Ca_3SiO_5$(or $3CaO \cdot SiO_2$) |
| Dicalcium silicate | 25 % | $Ca_2SiO_4$(or $2CaO \cdot SiO_2$) |
| Tricalcium aluminate | 10 % | $Ca_3Al_2O_6$(or $3CaO \cdot Al_2O_3$) |
| Tetracalcium aluminoferrite | 10 % | $Ca_4Al_2Fe_2O_{10}$(or $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$) |
| Gypsum | 5 % | $CaSO_4 \cdot 2H_2O$ |

### 2.4.2. Hydration Reactions

When water is added to cement, each of the compounds (as listed in Table 2.1) undergoes hydration and contributes to the final concrete product. Only the calcium silicates contribute to strength. Tricalcium silicate is responsible for most of the early strength (first 7 days). Dicalcium silicate, which reacts more slowly, contributes only to the strength at later stages (Http://matse1.matse.illinois.edu/concrete/prin.html). The hydration process described here takes place at room temperature and is spontaneous (i.e., does not require a catalyst).

The following are the basic reactions presenting an approximation of hydration of the constitutive clinker phases taking the addition of gypsum into account (Mounanga *et al*., 2004);

$2C_3S+10.6H \rightarrow C_{3.4}S_2H_8+2.6CH$ Equation (2.1)

$2C_2S+8.6H \rightarrow C_{3.4}S_2H_8+0.6CH$ Equation (2.2)

$C_3A+3C\bar{S}H_2+26H \rightarrow C_6A\bar{S}_3H_{32}$ Equation (2.3)

$2C_3A+C_6A\bar{S}_3H_{32}+4H \rightarrow 3C_4A\bar{S}H_{12}$ Equation (2.4)

$C_3A+6H \rightarrow C_3AH_6$ Equation (2.5)

$C_4AF+3C\bar{S}H_2+30H \rightarrow C_6A\bar{S}_3H_{32}+CH+FH_3$ Equation (2.6)

$2C_4AF+C_6A\bar{S}_3H_{32}+12H \rightarrow 3C_4A\bar{S}H_{12}+2CH+2FH_3$ Equation (2.7)

$C_4AF+10H \rightarrow C_3AH_6+CH+FH_3$ Equation (2.8)

The principal hydration product is the calcium silicate hydrate, which is usually in gel form and of a composition that varies over a wide range. Therefore, the formula $C_{3.4}S_2H_8$ is only approximate, and the designation C–S–H is more frequently used instead. Other major hydration products include calcium hydroxide (CH) and calcium sulfoaluminate hydrate that mainly consists of ettringite ($C_6A\bar{S}_3H_{32}$) and monosulfoaluminate ($C_4A\bar{S}H_{12}$), all of which are in crystal forms (Feng, 2006).

### 2.4.2.1. Hydration of Tricalcium silicate

The reaction for the hydration of tricalcium silicate is given by:

Tricalcium silicate + Water→Calcium silicate hydrate+Calcium hydroxide + heat

$2Ca_3SiO_5+7H_2O \rightarrow 3CaO \cdot 2SiO_2 \cdot 4H_2O+3\ Ca(OH)_2+173.6kJ$ Equation (2.9)

Upon the addition of water, tricalcium silicate rapidly reacts to release calcium ions, hydroxide ions, and a large amount of heat. The pH quickly rises to over 12 because of the release of alkaline hydroxide ($OH^-$) ions. This initial hydrolysis slows down quickly after it starts resulting in a decrease in heat evolved (Http://matse1.matse.illinois.edu/concrete/prin.html).

The reaction slowly continues producing calcium and hydroxide ions until the system becomes saturated. Once this occurs, the calcium hydroxide starts to crystallize. Simultaneously, calcium silicate hydrate begins to form. Ions precipitate out of solution accelerating the reaction of tricalcium silicate to calcium and hydroxide ions (Le Chatlier's principle). The evolution of heat is then dramatically increased. The formation of the calcium hydroxide and calcium silicate hydrate crystals provide "seeds" upon which more calcium silicate hydrate can form. The calcium silicate hydrate crystals grow thicker making it more difficult for water molecules to reach the unhydrated tricalcium silicate. The speed of the reaction is now controlled by the rate at which water molecules diffuse through the calcium silicate hydrate coating. This coating thickens over time causing the production of calcium silicate hydrate to become slower (Http://matse1.matse.illinois.edu/concrete/prin.html).

Figure 2.3 illustrates the different stages of hydration and the formation of pores as calcium silicate hydrate is formed. In part (a) of the figure, hydration has not yet occurred and the pores (empty spaces between grains) are filled with water. Part (b) represents the beginning of hydration. In part (c), hydration is seen to continue. Although empty spaces still exist, they are filled with water and calcium hydroxide. Part (d) shows nearly hardened cement paste. Note a greater proportion of space is filled with calcium silicate hydrate. The portion that is not filled with the hardened hydrate is primarily calcium hydroxide solution. Hydration will continue as long as water is present and unhydrated compounds in the cement paste (Http://matse1.matse.illinois.edu/concrete/prin.html).

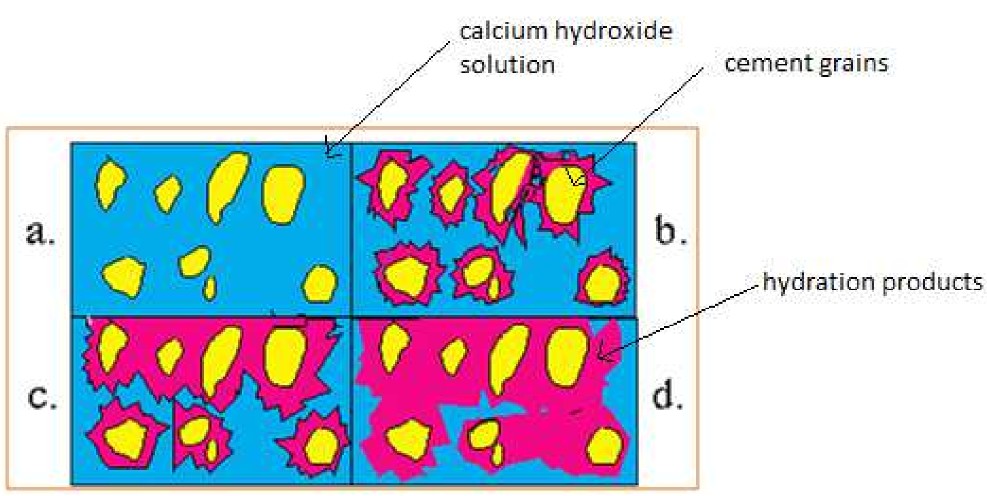


**Figure 2.3: Schematic illustration of the pores in calcium silicate through different stages of hydration.**

#### 2.4.2.2. Hydration of Dicalcium Silicate

Dicalcium silicate affects the strength of concrete through its hydration. Dicalcium silicate reacts with water in a similar manner compared to tricalcium silicate, but much more slowly. Dicalcium silicate is much less reactive. The heat released is less than that by the hydration of tricalcium silicate. The products from the hydration of dicalcium silicate are the same as those for tricalcium silicate (Http://matse1.matse.illinois.edu/concrete/prin.html).

Dicalcium silicate + Water--->Calcium silicate hydrate + Calcium hydroxide +heat

$2Ca_2SiO_4 + 5H_2O \text{--->} 3CaO \cdot 2SiO_2 \cdot 4H_2O + Ca(OH)_2 + 58.6\ kJ$ Equation (2.10)

Equation 2.10 differs from Equation 2.9 shown earlier in that the heat of hydration is approximately one third in the hydration of Dicalcium Silicate. The heat released is less than that by the hydration of tricalcium silicate because the dicalcium silicate is much less reactive

#### 2.4.2.3. Hydration of Tricalcium Aluminate and Tetracalcium Aluminoferrite

The other major components of portland cement, tricalcium aluminate and tetracalcium aluminoferrite also react with water. Their hydration chemistry is more complicated because it involves reactions with the gypsum as well which is not the case with Tri-calcium and Dicalcium Silicates reactions.

### 2.4.3. Stages in Cement Hydration

Although the hydration of each cement compound has been treated independently here, this is not completely accurate considering that the rate of hydration of a compound may be affected by varying the concentration of another. In general, the rates of hydration during the first few days ranked from fastest to slowest are:

- tricalcium aluminate > tricalcium silicate > tetracalcium aluminoferrite > dicalcium silicate

Over time, the cement hydration process due to the above minerals produces a unique heat release signature. A typical hydration process is shown in Figure 2.4 and the reaction sequence is briefly described in Table 2.2.

**Table 2.2: Typical hydration process of cement (Mindess, 2003)**

| | Reaction Stage | Kinetics Reaction | Chemical processes |
|---|---|---|---|
| 1 | Initial hydrolysis | Chemical control; rapid | Dissolution of ions |
| 2 | Induction period | Nucleation control; slow | Continued dissolution of ions |
| 3 | Acceleration | Chemical control; rapid | Initial formation of hydration products |
| 4 | Deceleration | Chemical and diffusion control; slow | Continued formation of hydration products |
| 5 | Steady state | Diffusion control; slow | Slow formation of hydration products |

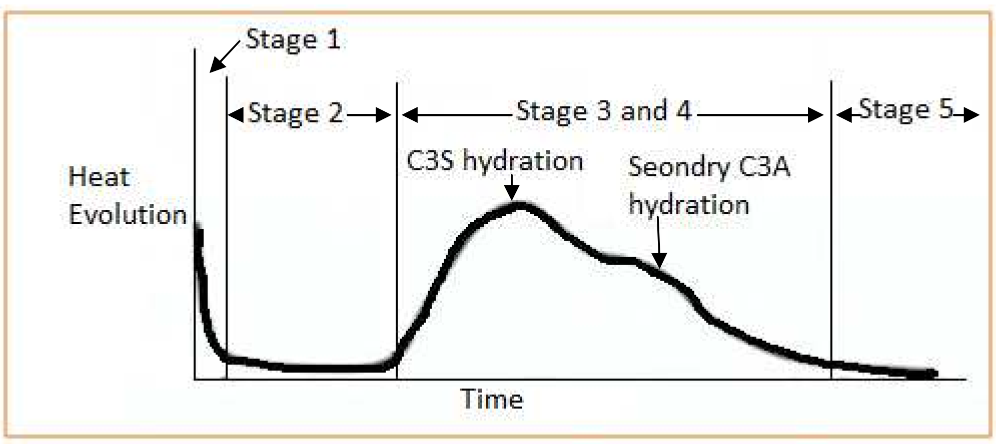


**Figure 2.4: Rate of heat evolution during hydration of portland cement (Adapted from PCA, 2006)**

The data from heat of hydration studies can be used for characterizing the setting and hardening behavior of cements, and for predicting the temperature rise (Mehta, 2006).

1. In Stage I (the dissolution stage), the reaction occurs right after contact with water because ions dissolved in water react with $C_3A$ and gypsum. The formation of ettringite produced after initial hydration reactions sharply reduces the rate of the reaction in the latter part of Stage I. This stage has little effect on concrete strength. The system then enters a dormant period (Stage II).
2. In Stage II (the induction [dormant] period), the concentration of ions in the solution gradually increases along with the solution of solid phase. Cement paste remains in the plastic state. This stage does not develop concrete strength. However, it is important for workability and transportation of concrete because this stage allows concrete to be transported and molded into the desired shape.
3. In Stage III (the acceleration stage), the alite ($C_3S$) and belite ($C_2S$) in the cement start to hydrate and release heat. In this stage concrete setting begins and heat generation is rapidly accelerated. The silicate reaches a high rate of hydration at the end of the Stage III. Concrete strength is developed in this stage in which final setting was finished and early hardening has begun. Therefore, the acceleration stage is a very important characteristic in concrete.
4. In stage IV (the deceleration stage), the rate of heat generation again decreases and shifts to a diffusion-controlled process. In this phase, the thickness of hydrated particles increases and the surface area of the unhydrated parts decreases. The layer of cement hydrates acts as a diffusion area to govern the permeability of the water and dissolved ions. Ettringite is converted to monosulfate phase which is sometimes noted as the heat contribution of $C_3A$ hydration.
5. In stage V (the steady stage), the thicker layer of hydrates around the cement particles reduces the rate of hydration remarkably. It is difficult in this stage for hydrates to be precipitated because the space originally filled by water is covered with hydrated cement. The hydration is completely controlled by the diffusion process.

Complete hydration of cement is generally assumed to require a water/cement ratio of about 0.4 and a minimum w/c ratio of 0.42 (Mindess et al. 2003). The heat evolution rate starts to decrease as the w/c ratio decreases after a certain time (Byfors 1980).

According to Integrated Materials and Construction Practices for Concrete Pavement Manual (FHWA HIF-07-004) October 2007, there are five main stages of cement hydration as follows:

**Stage 1: Mixing (Hydrolysis)**

Within minutes of mixing cement and water, the aluminates start to dissolve and react, with the following results:

- Aluminate reacts with water and sulfate, forming a gel-like material (C-A-S-H). This is an exothermic reaction.
- The C-A-S-H gel builds up around the grains, limiting water's access to the grains and thus controlling the rate of aluminate reaction. This occurs after an initial peak of rapid hydration and heat generation.

**Stage 2: Dormancy**

For about two to four hours after mixing, there is a dormant period, during which the following reactions take place:

- The C-A-S-H gel controls the aluminate reactions. Little heat is generated, and little physical change occurs in the concrete which is in a plastic state.
- During dormancy, as silicates (alite [$C_3S$] and belite [$C_2S$]) slowly dissolve, calcium ions and hydroxyl (OH) ions accumulate in solution.

**Stage 3: Hardening**

This stage is dominated by alite ($C_3S$) hydration and the resulting formation of C-S-H and CH crystals:

- When the solution becomes super-saturated with calcium ions (from dissolving alite [$C_3S$] primarily), fiber-like C-S-H and crystalline CH start to form. This is an exothermic reaction. Meshing of C-S-H with other solids causes the mixture to stiffen and set.

- The increasing heat and stiffening of the cement paste mark the beginning of hydration acceleration, which lasts several hours. Initial set occurs early during this stage.
- Acceleration is characterized by a rapid rate of hydration, significant heat generation, continued hardening, and strength development.
- The rates of reaction are faster for finer cementitious materials and for systems with higher alkali contents. Slower reacting systems will react longer and will generally provide a better microstructure in the long term.
- During acceleration, aluminate and sulfate continue to react, and needle-like ettringite (C-A-S-H) crystals form.
- Final set(concrete is hard enough to support loads), occurs before heat energy peaks (before alite [$C_3S$] reactions begin to slow).
- After final set, tensile stresses start to develop due to temperature and drying effects, the mixture's increasing stiffness. For a slab, friction with the pavement base starts here.

**Stage 4: Cooling**

After final set, the rate of alite ($C_3S$) reactions begins to slow, and the amount of heat generated firstly starts to peak and thereafter begins to drop. This occurs because the buildup of C-S-H and CH interferes with contact between remaining water and undissolved cement grains.

During this stage, several processes are taking place simultaneously:

- The concrete gains strength, as the amount of C-S-H (and CH) increases. However, the concrete is still porous and should carry only light loads.
- Tensile stresses may be building faster than tensile strength. At some point, the stress exceeds the strength, causing cracking. Unless joints are sawed to control the crack locations, random cracking will occur.
- Sometime after the temperature peaks, sulfate, which has continued reacting with aluminate (see stages 1 and 2) gets depleted. Any remaining

aluminate will react with ettringite to form monosulfate, which may be associated with a brief increase in heat. (Monosulfate does not significantly affect concrete properties.)

**Stage 5: Densification**

This stage is critical for continued development of concrete strength and reduction of concrete permeability. When concrete has low permeability, water and dissolved salts cannot readily penetrate and it is less susceptible to freeze-thaw damage. The concrete must be kept moist as long as possible because:

- As long as alite ($C_3S$) remains and there is water in the concrete, the alite will continue to hydrate. As the volume of hydration products grows, concrete porosity (and permeability) decreases, and the concrete gains strength. Eventually, the products—particularly C-S-H—will combine into a solid mass.
- Belite ($C_2S$), which reacts more slowly than alite ($C_3S$), also produces C-S-H. After several days, in the presence of water, most of the alite has reacted and the rate of belite hydration begins to be noticeable. It is important to maintain sufficient moisture long enough for belite reactions to occur.
- Hydration products will continue to develop, permeability will continue to decrease, and strength will continue to increase slowly for days, weeks, even years, as long as cementitious material and water are present. This process is affected by factors like cement type and fineness.

Figure 2.5 illustrates the inter-relationship between the heat of hydration, time and the physical processes described in this chapter.

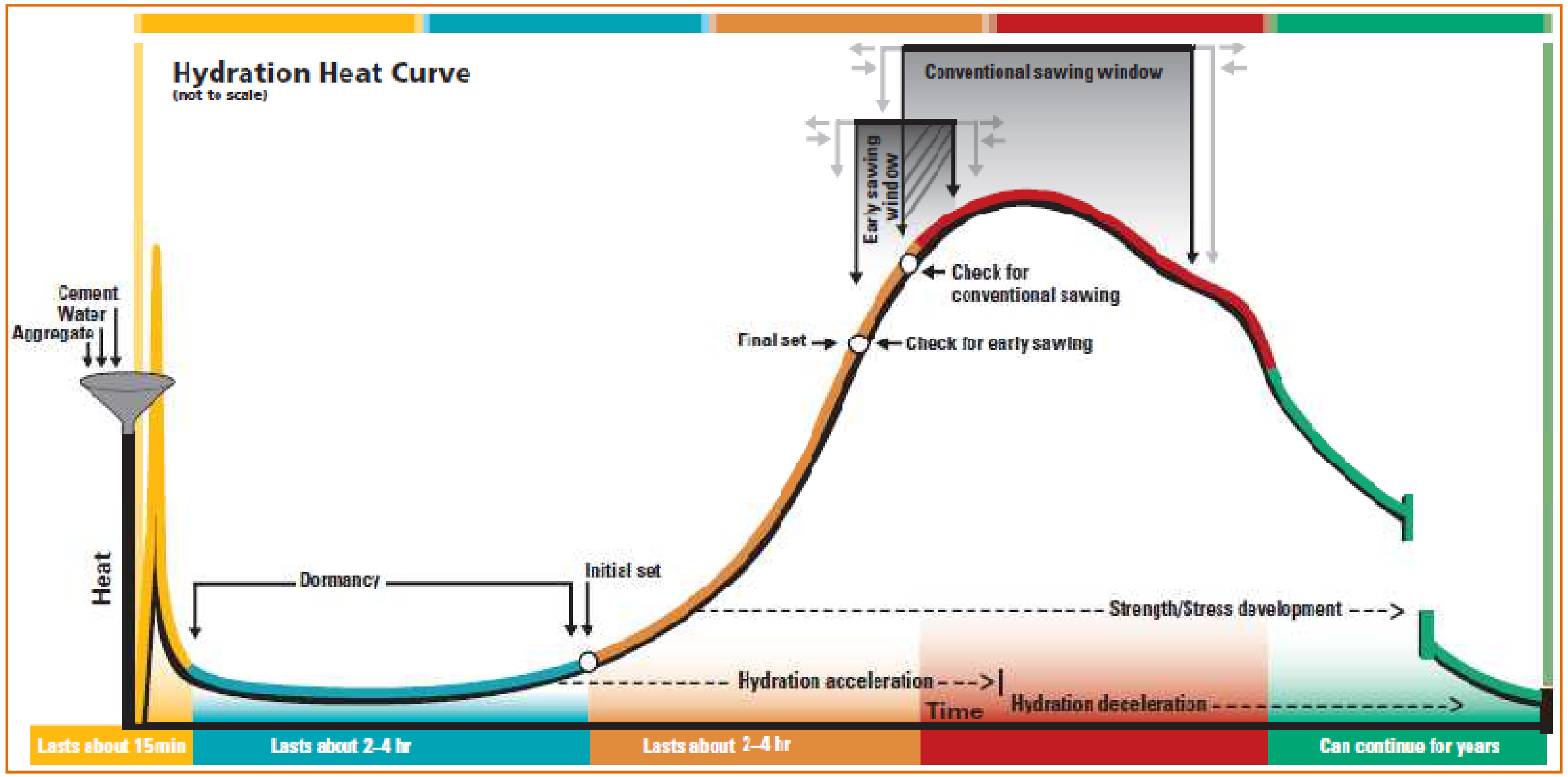


Figure 2.5: Hydration-heat curve (Adapted from Integrated Materials and Construction Practices for Concrete Pavement manual, 2007

### 2.4.4. Development of Pore Structure

With cement hydration, the solid phase (hydration products) and pore structure develop. The formation of pore structure mainly depends on degree of hydration and w/c ratios. It is generally agreed that there are mainly three types of pores (Mindess and Young, 1981): gel pores, capillary pores, and air voids, though Jennings (2004) has proposed a new classification of pore size based on the studies on mechanisms of reversible shrinkage. As part of C-S-H gel, the pores are very small with diameter of about 0.5nm to 10nm. Capillary pores are meso-macro pores between the gel pores and air voids, with diameter ranging from 10nm to 10µm. Larger than the capillary pores are the air voids.

Capillary pores are considered responsible for the water and gas transport within cement paste (Mindess and Young, 1981). They are formed during cement hydration where water in the pores is removed for providing reactant for further hydration. Thus, the capillary pores depend on the degree of hydration as well as the w/c ratios.

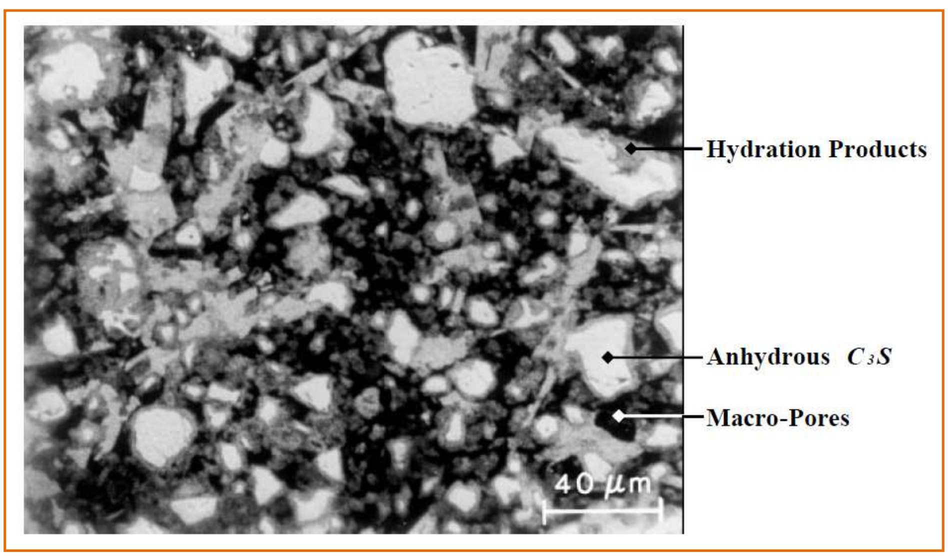


**Figure 2.6: Scanning Electron Micrograph of a *C-S-H* Paste (Tennis et al., 1997)**

Capillary pores increase with the initial w/c both in the pore volume and pore size. However, capillary pore volume and size decrease as the hydration progresses and as hydration products start filling the pores. Conversely, as more hydrated gel is formed the associated gel pore volume increases. However, the capillary pore volume decreases more rapidly than gel pore volume increases, because only a portion of the gel which fills the capillary spaces is porous. Thus, the total capillary and gel pore volume of the cement paste decreases with continuing hydration.

### 2.4.5. Heat of Hydration

Heat is evolved with cement hydration due to the breaking and making of chemical bonds during hydration. The heat generated is shown in Figure 2.7 as a function of time. In stage I, hydrolysis of the cement compounds occurs rapidly with a temperature increase of several degrees. Stage II is known as the dormancy period. The evolution of heat slows dramatically in this stage. During this period, the concrete is in a plastic state which allows the concrete to be transported and placed without any major difficulty. It is at the end of this stage that initial setting begins (Http://matse1.matse.illinois.edu/concrete/prin.html).

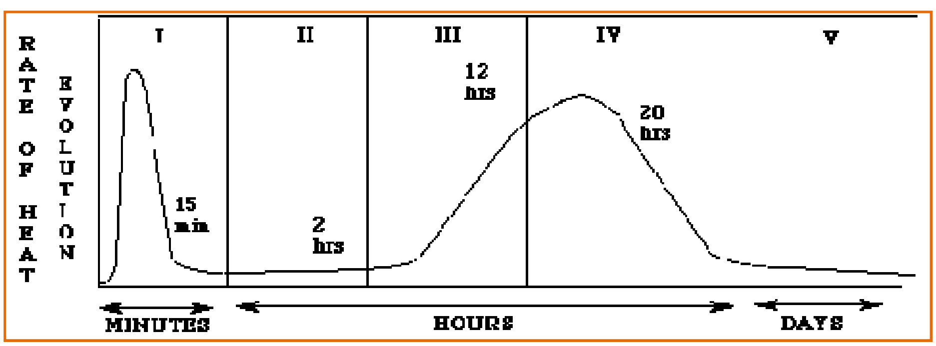


**Figure 2.7: Rate of heat evolution during the hydration of Portland cement (Http://matse1.matse.illinois.edu/concrete/prin.html)**

In stages III and IV, the concrete starts to harden and the heat evolution increases due primarily to the hydration of tricalcium silicate. Stage V is reached after 36 hours. The slow formation of hydrate products occurs and continues as long as water and unhydrated silicates are present (Http://matse1.matse.illinois.edu/concrete/prin.html). During normal concrete construction, the heat is dissipated into the soil or the air and resulting temperature changes within the structure, which are not significant. However, in some situations, particularly in mass concrete structures, such as dams, mat foundations, or any element more than about a meter thick, the heat cannot be readily released. The mass concrete may then attain high internal temperatures, especially during hot weather construction, or if high cement contents are used. These temperature rises cause expansion while the concrete is hardening. If the temperature rise is significantly high and the concrete undergoes non-uniform or rapid cooling, stresses due to thermal contraction in conjunction with structural restraint can result in cracking before or after the concrete eventually cools to the surrounding temperature. Contractors often insulate massive elements to control temperature changes (Portland Cement Association, 1997)

## 2.5. Autogenous Deformation

### 2.5.1. Definitions

Most aspects of autogenous shrinkage have been known for more than fifty years and are largely undisputed, yet there still is no exact univocal definition. Furthermore, some terminological discrepancies persist. For instance, autogenous shrinkage in some publications of French origin apparently comprises the complete chemical shrinkage (Bar 1999); Bar (2005); Mou (2006); Bou (2008). A comprehensive overview of terminology is given in Jen (2001).

The autogenous shrinkage of most concretes of normal strength is negligible as no self-desiccation takes place. The interest in autogenous shrinkage significantly rose in the 1990's when high strength concrete with relatively low water-cement ratios came into wider use. Despite appropriate curing, early age cracks were observed which could be explained only by restrained autogenous shrinkage (Bui (1980); Zie (1982); Taz (1992): Sel (1995). Subsequent to several years of research, the Japan Concrete Institute (JCI) suggested the following definition (JCI, 1996), published in English in 1999 (Taz, 1999): "Autogenous shrinkage is the macroscopic volume reduction of cementitious materials when cement hydrates after initial setting. Autogenous shrinkage does not include volume change due to loss or ingress of substances, temperature variation, application of an external force and restraint."

The following terminologies related to autogenous shrinkage are adopted from Jensen and Hansen (2001). Other definitions about autogenous shrinkage can be found in (JCI, 1999).

- **Autogenous deformation:** The bulk deformation of a closed, isothermal, cementitious material system not subjected to external forces.
- **Autogenous relative humidity change:** The change of internal relative humidity in a closed, isothermal, cementitious material system not subjected to external forces.
- **Self-desiccation:** Autogenous relative humidity change of a cementitious material system after setting, caused by chemical shrinkage.
- **Self-desiccation shrinkage:** Autogenous deformation of a cementitious material system after setting, caused by chemical shrinkage.

Note that "closed" means no exchange of water occurs between the cementitious material and the surroundings; "isothermal" requires that the temperature is kept constant. For autogenous shrinkage, changes in tension in capillary water, disjoining pressure, and surface tension of the solid gel particles are the principal mechanisms that have been suggested.

## 2.5.2. Mechanisms of Autogenous Shrinkage

***Capillary Tension***

Capillary pores are formed during cement hydration when water in the pores is removed for providing reactant for further hydration. This will cause a reduction of the relative humidity of the capillary pores, known as self-desiccation. The reduction of pore humidity is sensitive to w/c ratio. The humidity drop is very slow in a high w/c ratio system and the pore structure will probably remain filled with capillary water for a long period. However, the self-desiccation is pronounced in a low w/c ratio cement paste. For w/c=0.3, the pore humidity drops to 78% at 50% degree of hydration. Thermodynamic analysis by Jensen (1995) showed that the pore humidity could not drop below 75% from self-desiccation alone.

With the reduction of pore humidity, meniscus and surface tension of the liquid forms in capillary pores to maintain the equilibrium between the liquid and the vapor over the liquid. Thus, the capillary pressure develops, which is the vapor pressure minus water pressure. This capillary pressure will cause water in capillaries under depression (under tensile stress) and has to be balanced by compressive stress of the surrounding solid. This compressive stress will result in volume decrease in cement paste. Because this compressive stress is originally induced by the reduction of internal relative humidity, any drying process either from external drying or internal drying (self-desiccation) will cause shrinkage in cement paste. Further hydration decreases the relative humidity resulting in reduction of the curvature radius of the meniscus.

Assuming cylindrical capillary pores, the radius of meniscus curvature decreases with reduction of relative humidity until it equals to the radius of the capillary. Due to the size distribution effect of capillary pores, the evaporation will first take place in the big pores. Further hydration will cause the formation of meniscus in the small pores after the big pore have been emptied. Thus, in hydrating cement paste pores that have radius lower than that of meniscus are filled with water and pores with bigger radius are empty.

Capillary menisci are unstable below about 45% pore humidity (Soroka, 1979; Mindess, 1981), and thus the capillary tension mechanism for autogenous shrinkage should be only effective in the upper pore humidity range, which is above 45%. Since the pore humidity in capillary pores is not dropping below 75% due to self-desiccation alone (Jensen, 1995), it has justification to state that capillary tension mechanism is appropriate to explain autogenous shrinkage deformation. Figure 2.8 illustrates the forces acting during the process of shrinkage.

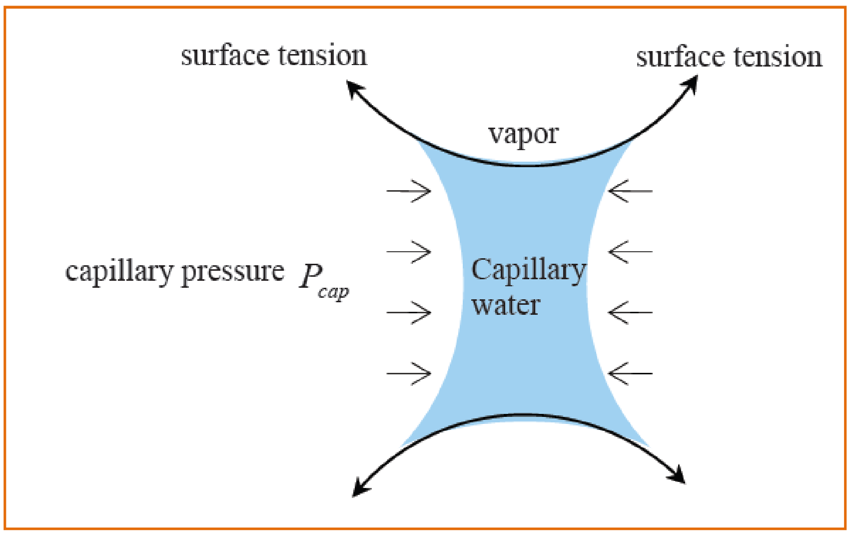


**Figure 2.8: Capillary tension as the mechanism of shrinkage**

***Solid Surface Tension***

Solids have surface tension at their interface with other materials. Changes in the surface tension of solid hydration products could result in bulk shrinkage or expansion of the cement paste. The magnitude of solid surface tension is dependent on the thickness of the adsorbed layers of water, which lowers the surface tension of the cement gel particles and results in expansion. Conversely, removal of the adsorbed water increases the solid surface tension and creates a net compression of the solid resulting in micro-scale shrinkage (Powers, 1968). Surface tension can induce huge compressive stresses of around 250 MPa in cement gel particles with large specific surface area (Soroka, 1979), and thus noticeable bulk shrinkage.

However, it was suggested that surface tension do not become significant until lower pore humidity (less than 50%) where only one or two adsorbed water layers are present ( Mindess, 1981). Thus, this mechanism does not apply to autogenous deformation since the relative humidity is generally above 75% from self-desiccation alone (Jensen, 1995). Research by Hansen (1987), on the other hand, showed that solid surface tension contributes to shrinkage at higher pore humidity as well.

***Disjoining Pressure***

The disjoining pressure between the solid particles is the result of van der Waals forces, double layer repulsion, and structural forces (Ferraris and Wittmann, 1987). The layered structures of C-S-H particles have huge surface area which attracts water molecules at interfaces. As water moves into the layers of C-S-H particles, the repulsive forces arise and the attractive van der Waals' force decreases between the solid layers, and thus results in volume changes. This swelling pressure from the absorbed water is referred to as 'disjoining pressure'. Stresses develop in the solid microstructure to balance the reduction in disjoining pressure, resulting in macro-scale shrinkage (Grasely, 2006). The disjoining pressure varies with the pore humidity. When the pore humidity drops, the disjoining pressure is reduced, causing shrinkage. However, disjoining pressure is in debate regarding at what relative humidity range this mechanism is responsible for volume changes (Mindess and Young, 1981).

### 2.5.3. Relationship between Autogenous Shrinkage and Heat of Hydration

Kim et al. (2011) investigated the early-age properties and relationships between hydration heat and autogenous shrinkage in high-strength mass concrete of different mixture proportions through analysis of the history curves of hydration heat and autogenous shrinkage. The hydration temperature and hydration heating velocity (HHV) of the concrete were found to increase with increases in specimen size and decrease when the concrete contained a retarder, fly ash (FA) and ground granulated blast-furnace slag (GGBS). Even in samples of the same mixture proportion, autogenous shrinkage was noted to become greater as the inner temperature increased. The autogenous shrinkage of high-strength mass concrete containing FA and GGBS was lower than that of ordinary Portland cement high-strength mass concrete. The autogenous shrinking velocity of concrete increased as the size of the specimen increased and decreased when the concrete contained a retarder, FA and GGBS. Finally, a close correlation was found between the hydration temperature and autogenous shrinkage at an early age: a higher HHV and a larger HHV–maturity factor led to greater autogenous shrinkage. The early-age properties and relationships between hydration heat and autogenous shrinkage in high-strength mass concrete of different mixture proportions are investigated through analysis of the history curves of hydration heat and autogenous shrinkage. The hydration temperature and hydration heating velocity (HHV) of the concrete were found to increase with increases in specimen size and decrease when the concrete contained a retarder, fly ash (FA) and ground granulated blast-furnace slag (GGBS). Even in samples of the same mixture proportion, autogenous shrinkage was noted to become greater as the inner temperature increased. The autogenous shrinkage of high-strength mass concrete containing FA and GGBS was lower than that of ordinary Portland cement high-strength mass concrete. The autogenous shrinking velocity of concrete increased as the size of the specimen increased and decreased when the concrete contained a retarder, FA and GGBS. Finally, a close correlation was found between the hydration temperature and autogenous shrinkage at an early age: a higher HHV and a larger HHV–maturity factor led to greater autogenous shrinkage (Kim et al., 2011).

### 2.5.4. Research Gap and Conceptual Framework

Cracks are the result of relatively complex processes, in particular at early age when concrete properties change rapidly. A dependable assessment of the cracking risk requires comprehensive testing and a thorough understanding of the interacting parameters. Early age cracking in cementitious systems is not a new problem; cracking due to restrained drying shrinkage and thermal contraction has previously been examined at length. However, the investigation and prediction of stresses and cracks due to autogenous shrinkage brings about new challenges. The essential issue is the onset of stresses at very early age. This greatly increases the influence of creep and relaxation. Especially at stress levels close to failure, this influence is highly non-linear and difficult to quantify, experimentally as well as mathematically (Mechtcherine and Breitenbücher, 2010).

Another challenge is the fact that temperature strongly influences the autogenous shrinkage and, presumably, the cracking risk as well. From isothermal tests for different temperatures, it appears that this influence cannot be accounted for by formulas conventionally used to describe the temperature dependency of cement hydration (Mechtcherine and Breitenbücher, 2010).

The lack of clarity in quantification of autogenous shrinkage cracks in part is a consequence of a series of methodological issues, most importantly the large number of different test methods and the difficulties in defining the onset of the autogenous shrinkage. The measurement of autogenous shrinkage, yet error-prone at constant temperatures, becomes particularly demanding at realistic temperature histories. The thermal deformations that inevitably superimpose the shrinkage strains are difficult to compensate for. At present, there is no general agreement on how to measure the autogenous shrinkage under non-isothermal conditions. In brief, the current knowledge about the influence of creep and temperature on autogenous shrinkage, restraint stress and cracking is insufficient. Obviously, the experimental methods need to be improved in order to overcome the existing deficiencies (Mechtcherine and Breitenbücher, 2010).

An experimental method was chosen in this research in an attempt to quantify the heat of hydration of cement paste as a function of pores formation and cracking. The method is described in chapter three (3) that follows.

# 3. MATERIALS AND METHODS

## 3.1. Introduction

The objectives of experimental work was to obtain data for characterizing Ordinary Portland Cement paste microstructure using heat of hydration and autogenous shrinkage parameters. In this chapter, measuring techniques, and materials used are presented. The tests included:

1. Use of type K temperature probes and Extech Differential Temperature Data logger to measure the heat of hydration of Ordinary Portland Cement paste.
2. Use of a strain gauge and MadgeTech Bridge/Strain Data logger to measure autogenous shrinkage strain of hydrating Ordinary Portland Cement paste.
3. Use of a stereo microscope to evaluate the microstructure evolution of a hydrating Ordinary Portland Cement paste (as a function of pores formation and cracking).

## 3.2. Materials, Curing Conditions and Mix Proportioning

Ordinary Portland Cement (OPC) was used for preparation of Ordinary Portland Cement paste and concrete mixtures. In concrete mixtures, the coarse aggregate was crushed limestone with a maximum aggregate size of 10mm. The fine aggregate was natural river sand which was sourced from Machakos. To ensure accurate measurements, right after casting into the rig, the external drying was prevented by sealing the specimens using an impermeable sheet. Regular concrete contains maximum aggregate size of 25.4 mm and aggregate content ranging from 60% to 80% of the total mixture. It was intended to investigate the effect of aggregate content and size on autogenous shrinkage. Concrete samples with different aggregate contents (less than the normal range of aggregate content) and with small sized aggregates (maximum aggregate size of 10mm) was used in this research.

Table 3.1: Mix proportioning for paste ($\varphi_A$=0%) and concrete

| **Sample no.** | 1(Sealed-unsaturated curing) | 2(Sealed-unsaturated curing) | 3(Sealed-unsaturated curing) | 4(Sealed-unsaturated curing) | 5(Sealed-saturated curing) | 6(Sealed-saturated curing) | 7(Sealed-saturated curing) | 8(Sealed-saturated curing) |
|---|---|---|---|---|---|---|---|---|
| Material | w/c=0.35 ($\varphi_A$ =0%) | w/c=0.45 ($\varphi_A$ =0%) | w/c=0.35 ($\varphi_A$ =40%) | w/c=0.45 (φA =40%) | w/c=0.45 (φA=40%) | w/c=0.35 ($\varphi_A$ =40%) | w/c=0.45 ($\varphi_A$ =0%) | w/c=0.35 ($\varphi_A$ =0%) |
| Cement (kg) | 1.5 | 1.305 | 0.763 | 0.660 | 0.660 | 0.763 | 1.305 | 1.5 |
| Water (kg) | 0.525 | 0.587 | 0.267 | 0.297 | 0.297 | 0.267 | 0.587 | 0.525 |
| Limestone (kg) | n. a. | n. a. | 0.268 | 0.268 | 0.268 | 0.268 | n. a. | n. a. |
| Sand ($kg/m^3$) | n. a. | n. a. | 0.763 | 0.763 | 0.763 | 0.763 | n. a. | n. a. |

n. a. = not available.

The mix proportions are shown in Table 3.1 for w/c=0.35 and 0.45 at the aggregate contents of 0% and 40% of total mix by volume. In all the concrete mixtures, the ratio of sand to coarse aggregate by volume was kept constant, however the total aggregate content varied. All the mix proportions shown in Table 3.1 were for molds of size 100x100x100mm. The effectiveness of internal curing on mitigating autogenous shrinkage and cracking was investigated as well. The following curing conditions were chosen.

1. Sealed/saturated curing using distilled water
2. Sealed/unsaturated curing

## 3.3. Measurement of Heat of Hydration and Autogenous Shrinkage

The schematic of the specimen and test method for the hydration temperature and deformation of Ordinary Portland Cement paste and concrete were as shown in Figure 3.1.

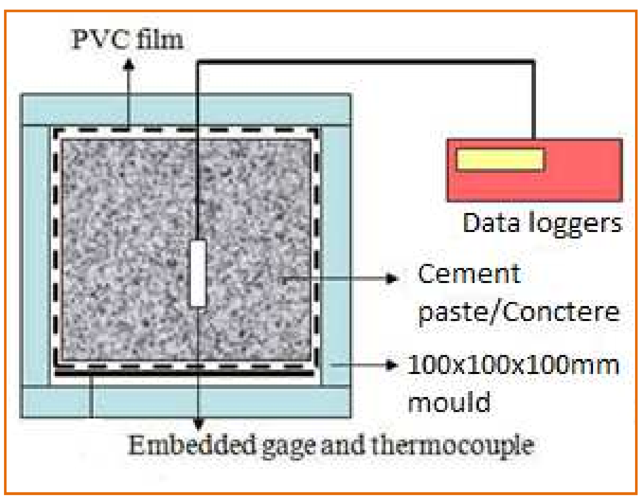


**Figure 3.1: Schematic of the Test Method for the Hydration Temperature and Deformation of Concrete**

The 100×100×100mm specimen was cast in a mold made with impervious pvc film. The inner temperature and deformation of the specimen were measured using a thermocouple and an embedded strain gauge every ten minutes after casting for 10 days per specimen. Eight specimens were tested corresponding to their w/c ratios, aggregate content and curing conditions described in the previous section 3.2. The strain gauges used had a resistance of 60±0.5 ohms (Ω) and a gauge factor of 1.68±3%. Figure 3.2 and 3.3 show the strain gauge and temperature data loggers used in this study.

**Figure 3.2: Photograph of the Strain Gauge Data Logger used in this study**

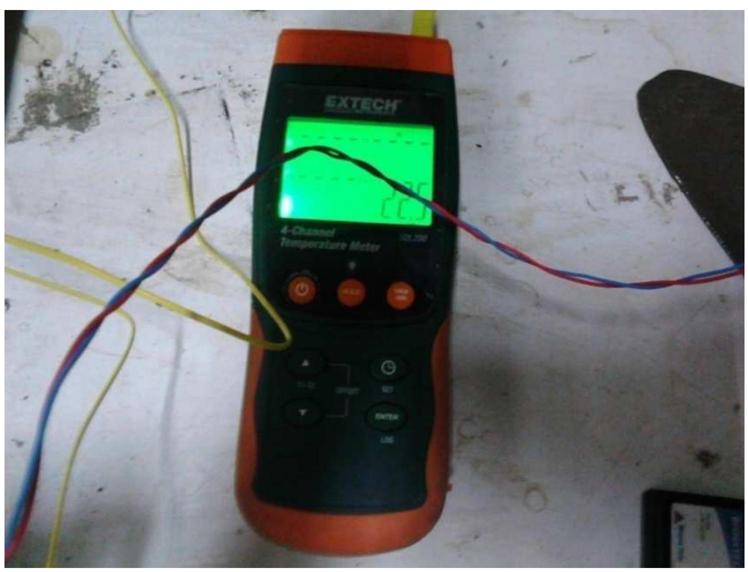


**Figure 3.3: Photograph of the Temperature Data Logger**

## 3.4. Basic Working Principles of Strain Gauge and Temperature Data Loggers

### 3.4.1. Strain Gauge

The Bridge101A Data Logger measures and records voltage, typically used in conjunction with strain gauges, load cells or other low-level DC voltage sources. This device is designed to accurately measure and record the output of the gauge to determine parameter levels such as stress, torque, strain, and pressure on a structure or item over a period.

The MadgeTech Data Logger Software offers user programmable Engineering Units which facilitates measurement of collected data to be presented in the established formats. Equipped with endless data analysis and reporting tools, the MadgeTech software simplifies device management and provides the user with a graph, tabular or summary reports with the capability of exporting data to 'MS Excel' as needed. Figure 3.4 show the strain gauge data logger.


**Figure 3.4: Strain gauge data logger**

### 3.4.2. Device Operation

The connecting and starting the data logger are summarized in form of the following six (6) steps:

STEP 1 - Once the software was installed and running, the interface cable was plugged into the data logger.

STEP 2 - The USB end of the interface cable was connected into an open USB port on the computer.

STEP 3 - After the device appeared in the Connected Devices list, the desired data logger was highlighted.

STEP 4 - For most applications, "Custom Start" is selected from the menu bar and the desired start method chosen. Thereafter, reading rate and other parameters appropriate for the data logging application were chosen and "Start" button checked. ("Quick Start" applies to the most recent custom start options, "Batch Start" is used for managing multiple loggers at once, "Real Time Start" stores the dataset as it records while connected to the logger.)

STEP 5 - It was ensured that the status of the device changed to either "Running"; "Waiting to Start" or "Waiting to Manual Start", depending upon the start method.

STEP 6 - The data logger was disconnected from the interface cable and placed in the environment to take measurements.

*Note: The device stops recording data when the end of memory is reached or the device is stopped. At this point the device cannot be restarted until it has been re-armed using a computer.*

### 3.4.3. Downloading Data from a Data Logger

The steps for downloading data are summarized as follows:

STEP 1 - The data logger was connected to the interface cable.

STEP 2 - The data logger was highlighted in the Connected Devices list. “Stop” on the menu bar was clicked.

STEP 3 - Once the data logger had been stopped, with the logger highlighted, “Download” was clicked. It prompted the naming of the report.

STEP 4 - The final step was downloading and saving all the recorded data to the PC, ready for analysis.

#### 3.4.4. Basic Principles of Working of Temperature Data Logger

The features of the Extech temperature data logger used in this research are given as follows:

- 4-Channel datalogging with 6 Thermocouple types (J, K, E, T, R,S) and 2-Channel datalogging with RTD (Pt100Ω) probes;
- Displays [T1, T2, T3, T4] or differential [T1-T2] reading;
- Offset adjustment used for zero function to make relative measurements;
- Stores 99 readings manually and 20M readings via 2G SD card;
- Records readings with real date and time stamp;
- User programmable sampling rate: 1 to 3600 seconds;
- Min/Max and Data Hold functions;
- Auto power off with disable function;
- Built-in PC interface;
- Complete with 6 AA batteries, four general purpose Type K bead wire temperature probes, SD card, and hard carrying case.

## 3.5. Stereo Microscopy

Stereo Microscopy was undertaken to evaluate the microstructure of hydrating cement. Detection and quantification of microcracks and pores in a hydrating cement paste is a difficult task. Available techniques either lack the required resolution or may produce additional cracks that are indistinguishable from the original ones. A properly developed technique allows identification of microstructure while avoiding artefacts induced by unwanted restraint, drying, or temperature variations during sample preparation.

In the present study, microstructural evolution in a hydrating Ordinary Portland Cement paste was studied by means of a simplified, 2-dimensional model.

After the desired period of hardening in desired curing conditions, the Ordinary Portland Cement paste and concrete samples were cut using a rock saw to a small size viewable under a stereo microscope. These were then polished and viewed with a stereo microscope.

Representative images were acquired for the microstructures achieved after the duration described earlier for all the w/c ratios and all the curing conditions investigated in this study. Each image was analysed to characterize the formation of micro-cracks ad pores formation due to autogenous shrinkage and heat of hydration of Ordinary Portland Cement paste.

## 3.6. Data Collection

Samples were set up and left at the Civil Engineering Concrete Laboratories at the University of Nairobi (UoN) for the desired period of time per sample. The Stereo Microscopy was done at the Microscopy Laboratory in the Mechanical Engineering Department also at UoN. Data collection was by qualified Laboratory Technicians. The following section presents some of  the photographs taken in the course of data collection for this study.

### 3.6.1.- Samples Mixing and Setting Up Photographs

Figures 3.5 and 3.6 illustrates manual mixing of materials in a laboratory environment.

**Figure 3.5: Mixing of Ordinary Portland Cement paste in laboratories (University of Nairobi) - 16th Feb 2015**

**Figure 3.6: Mixing Ordinary Portland Cement paste in laboratories (University of Nairobi) -2nd April 2015**

Figures 3.7 and 3.8 illustrates how the samples were cut using a rock saw in the laboratories for viewing in a stereo microscope.

**Figure 3.7: Cutting samples using rock saw for stereo microscopy**

**Figure 3.8 : Setting samples into the rock saw**

Figures 3.9 and 3.10 illustrate the setting up of the data loggers inserted in the samples, how the samples were sealed using an impermeable film (Figure 3.9) and how those to be cured under saturated conditions were set up (Figure 3.10).

**Figure 3.9: A complete set up with loggers in place**

**Figure 3.10: A complete set up with loggers in place for the samples to be cured under saturated conditions- 8th April 2015**

# 4. RESULTS AND DISCUSSION

## 4.1. Heat of Hydration

### 4.1.1. General

As discussed earlier in Chapters 1 and 2, Ordinary Portland Cement is composed largely of four types of minerals amongst others: alite ($C_3S$), belite ($C_2S$), aluminate ($C_3A$), and aluminoferrite ($C_4AF$). When these minerals and water are mixed, hydration products are formed. Heat is evolved with cement hydration due to breaking and development of chemical bonds during hydration. The heat generated by the cement's hydration raises the temperature of concrete.

The heat generated can be described as a function of time as shown in figures 4.1 to 4.10 of this chapter and Appendix C representing results of samples one (1) to eight (8) as described previously in Table 3.1 of Chapter 3. Heat of hydration data was taken after every 10 minutes for 9 to 10 days. Figure 4.1 shows a combined graph for samples one to six temperature rise against time during cement pastes hydration.

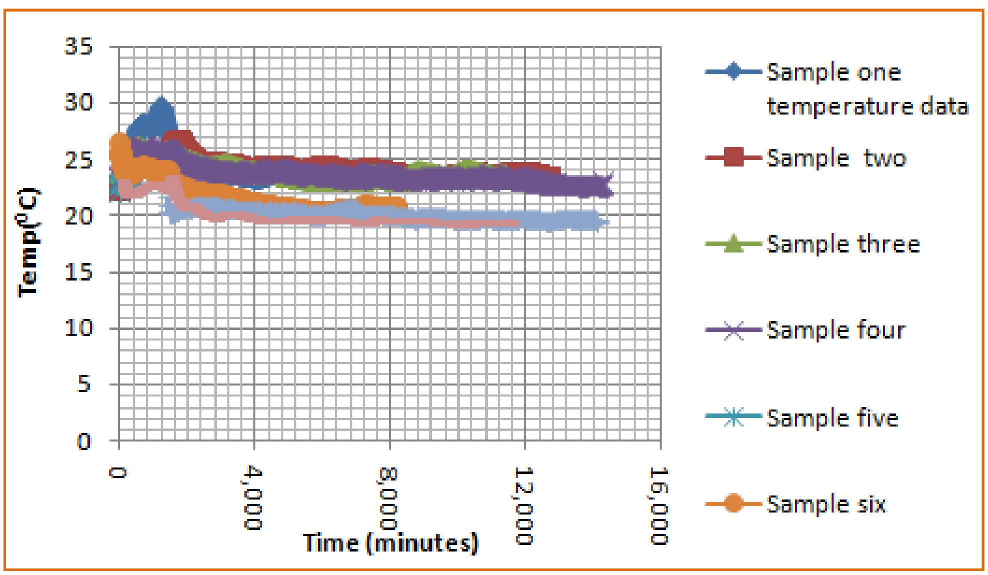


**Figure 4.1: Samples one to six temperature against date**

The results of this research as shown in Figure 4.1 are comparable to the literature. For example, Http://matse1.matse.illinois.edu/concrete/prin.html expressed heat of hydration as a function of time as illustrated in Figure 4.2.

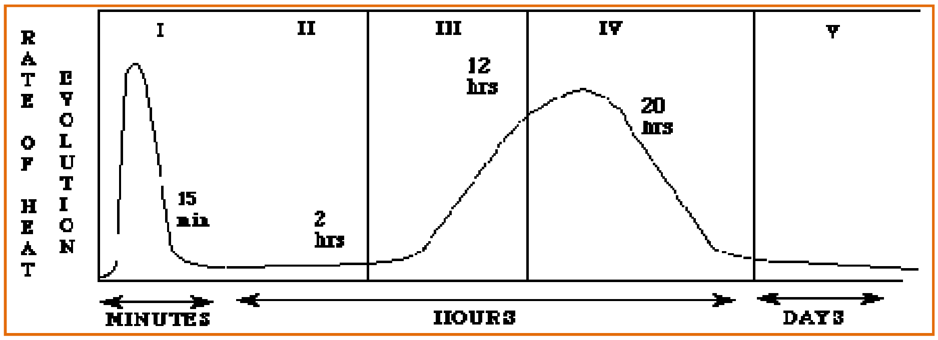


**Figure 4.2: Rate of heat evolution during the hydration of Portland cement (Http://matse1.matse.illinois.edu/concrete/prin.html)**

In stage I, hydrolysis of the cement compounds occurs rapidly with a temperature increase of several degrees. Stage II is known as the dormancy period. The evolution of heat slows dramatically in this stage. During this period, the concrete is in a plastic state which allows the concrete to be transported and placed without any major difficulty. This is particularly important for the construction trade who must transport concrete to the job site. It is at the end of this stage that initial setting begins.

In stages III and IV, the concrete starts to harden and the heat evolution increases due primarily to the hydration of tricalcium silicate. Stage V is reached after 36 hours. The slow formation of hydrate products occurs and continues as long as water and unhydrated silicates are present. (Http://matse1.matse.illinois.edu/concrete/prin.html).

Figure 4.1 which is a result of this research compares favorably with the work by Http://matse1.matse.illinois.edu/concrete/prin.html as shown in Figure 4.2. Temperature rose rapidly (Stage I) then slowed down (Dormancy Stage II). The recorded temperature rose again signifying Stages III and IV and thereafter dropped, marking Stage V.

### 4.1.2. Heat of Hydration in Sample One

Figure 4.3 shows temperature changes due to heat of hydration in sample one taken after every 10 minutes for 9 days. Sample one was only a cement and water mix with no aggregates. It had a water to cement ratio (w/c) of 0.35 cured under sealed but unsaturated conditions.

There was an increase of 19.6% in temperature within the first 12 hours of mixing, peaking at the 11$^{th}$ hour and starting to drop by 1% at the 13$^{th}$ hour. It then rose again by 5% beyond which the temperature dropped by 20% to stabilize at room temperature.

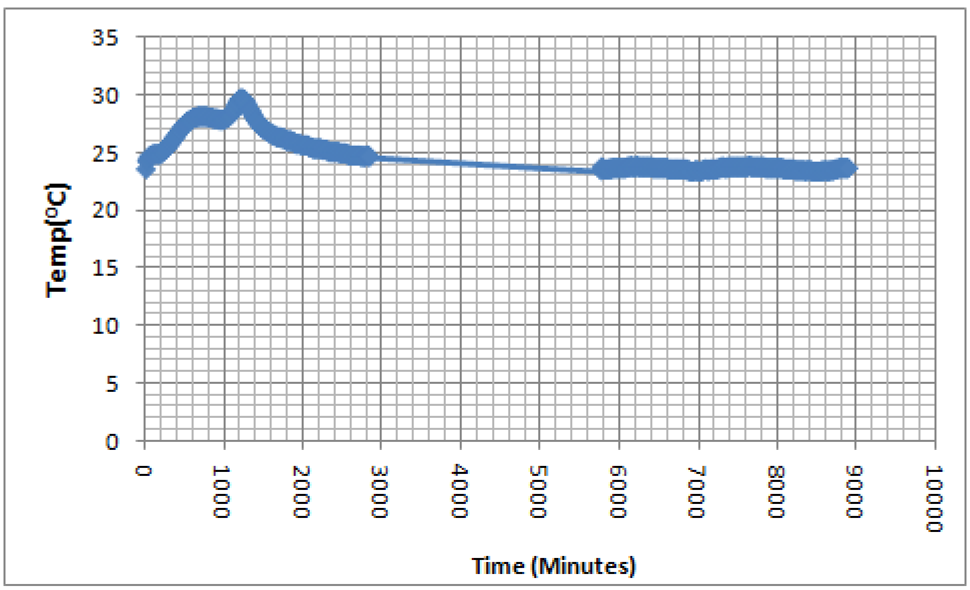


**Figure 4.3: Sample one temperature data against time (minutes)**

### 4.1.3. Heat of Hydration in Sample Two

Figure 4.4 shows temperature changes due heat of hydration in sample two taken after every 10 minutes for 10 days. Sample two was only a cement and water mix with no aggregates. It had a water to cement ratio (w/c) of 0.45 cured under sealed but unsaturated conditions. There was an increase of 13% in temperature within the first 12 hours of mixing, which dropped by 2% on the second day, beyond which, the temperature rose by an extra 8% before dropping by 11% through a series of rises and drops.

Although the general trend seems to be the same, sample two heat of hydration was noted to be lower than sample one in the first 24 hours. This can be explained by the difference in water to cement ratio (w/c). As presented in Table 3.1 under Chapter 3, sample one had w/c ratio of 0.35 which was lower than that of sample two which had a w/c ratio of 0.45.

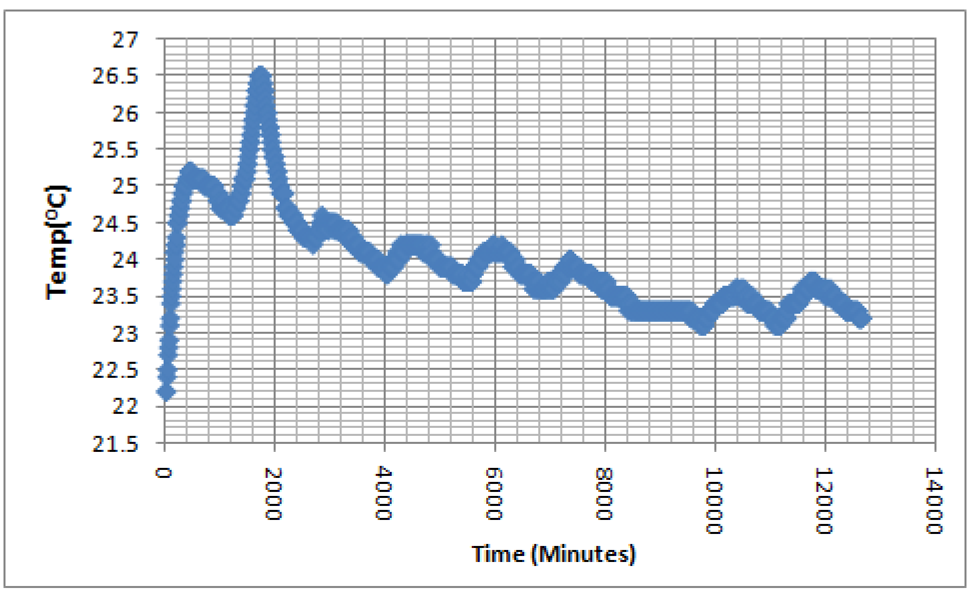


**Figure 4.4: Sample two temperature data against time (minutes)**

### 4.1.4. Heat of Hydration in Sample Three

Figure 4.5 shows temperature changes due heat of hydration in sample three taken after every 10 minutes for 10 days. Sample three was a concrete mix as shown in Table 3.1 in chapter 3. It had a water to cement ratio (w/c) of 0.35 cured under sealed but unsaturated conditions. There was an increase of 12% in temperature within the first 12 hours of mixing, which dropped by 1% then continued to increase by an extra 2% on the second day, beyond which, the temperature dropped by 8%.

Although the general trend seems to be the same as for the previous samples, sample two heat of hydration was noted to be lower than that of samples one and three which can be explained by the lower w/c ratios in samples one and three as compared to sample two.

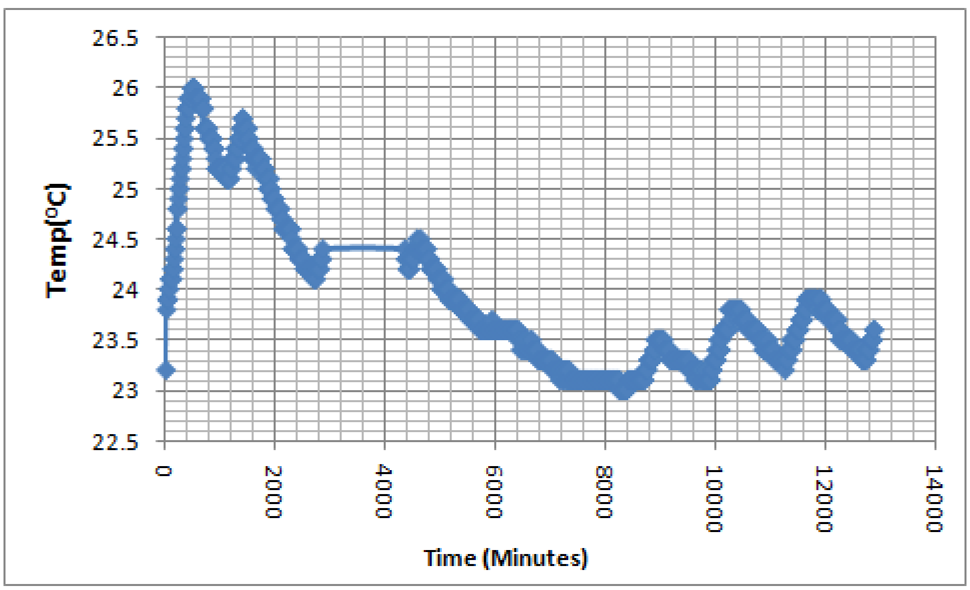


**Figure 4.5: Sample three temperature data against time (minutes)**

### 4.1.5. Heat of Hydration in Sample Four

Figure 4.6 shows temperature changes due heat of hydration in sample four taken after every 10 minutes for 11 days. Sample four was a concrete mix as shown in Table 3.1 in chapter 3. It had a water to cement ratio (w/c) of 0.45 cured under sealed but unsaturated conditions. The heat of hydration trend was noted to be the same as of the previous samples in that there was an initial increase in temperature within the first 12 hours after mixing after which the temperature dropped before stabilizing at room temperature.

Samples two and sample four heat of hydration trend was noted to be very similar. This can be explained by their equal water to cement ratio. This also shows that presence of aggregates do not affect the amount of heat of hydration of a mix. It was however noted that sample four cooled a faster rate than sample two which could imply that heat as absorbed by the aggregates in sample four.

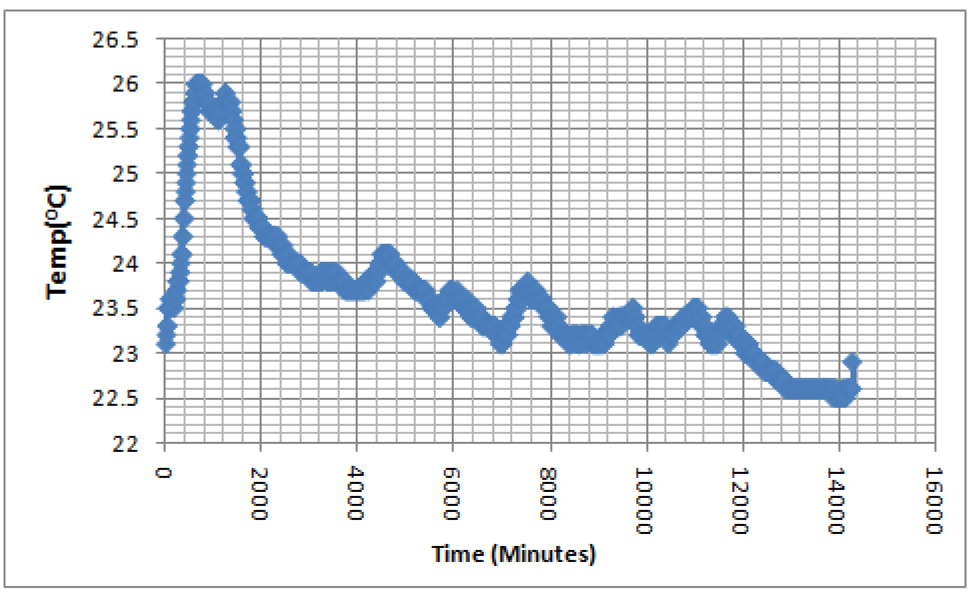


**Figure 4.6: Sample four temperature data against time (minutes)**

### 4.1.6. Heat of Hydration in Sample Five

For sample five, there was a power interruption hence only one day's heat of hydration data was collected. Figure 4.7 shows temperature changes due heat of hydration in sample five taken after every 10 minutes for 500 minutes. Sample five was a concrete mix as shown in Table 3.1 in chapter 3. It had a water to cement ratio (w/c) of 0.45 cured under sealed and saturated conditions.

The general internal temperature trend within this period was noted to be similar though lower than that of sample two which had an equal water to cement ratio. It was noted to be lower than that of sample four which and a similar mix proportion but which was not cured under saturated conditions. The lower internal temperature recorded can be explained by the fact that sample five was cured under saturated conditions as compared with sample two and four which were not cured under saturated conditions. Presence of curing water provided a cooling effect to the hydrating cement paste.

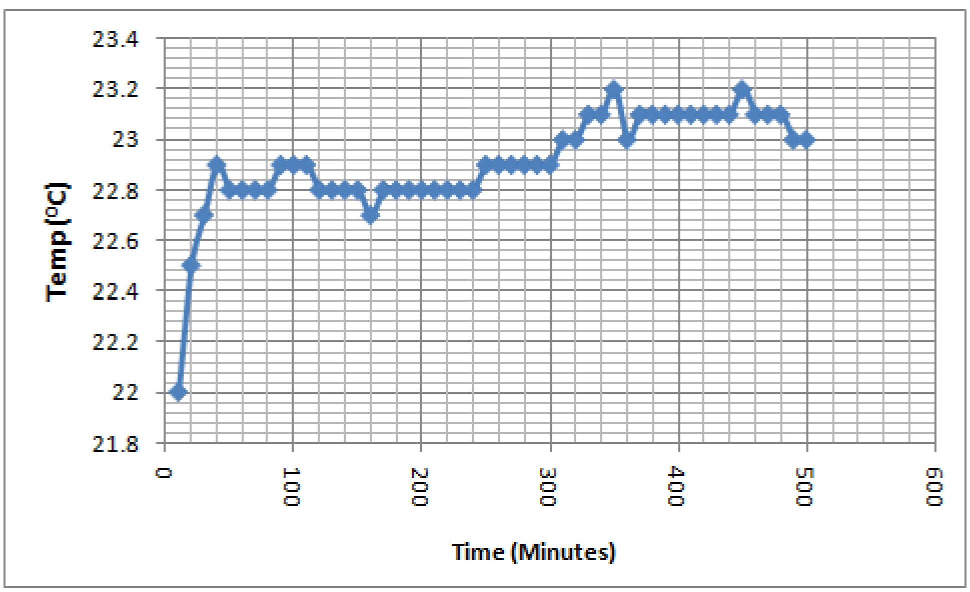


**Figure 4.7: Sample five temperature data against time (minutes)**

### 4.1.7. Heat of Hydration in Sample Six

Figure 4.8 presents internal temperature data for sample six taken after every 10 minutes for 7 days. Sample six was a concrete mix as shown in Table 3.1 in chapter 3. It had a water to cement ratio (w/c) of 0.35 cured under sealed and saturated conditions.

The general trend was observed to be lower than that of sample three which had an equal water to cement ratio and similar mix proportions but which was not cured under saturated conditions. The lower internal temperature recorded can be explained by the fact that sample six was cured under saturated conditions as compared with sample three which was not cured under saturated conditions. Presence of curing water provided a cooling effect to the hydrating cement paste.

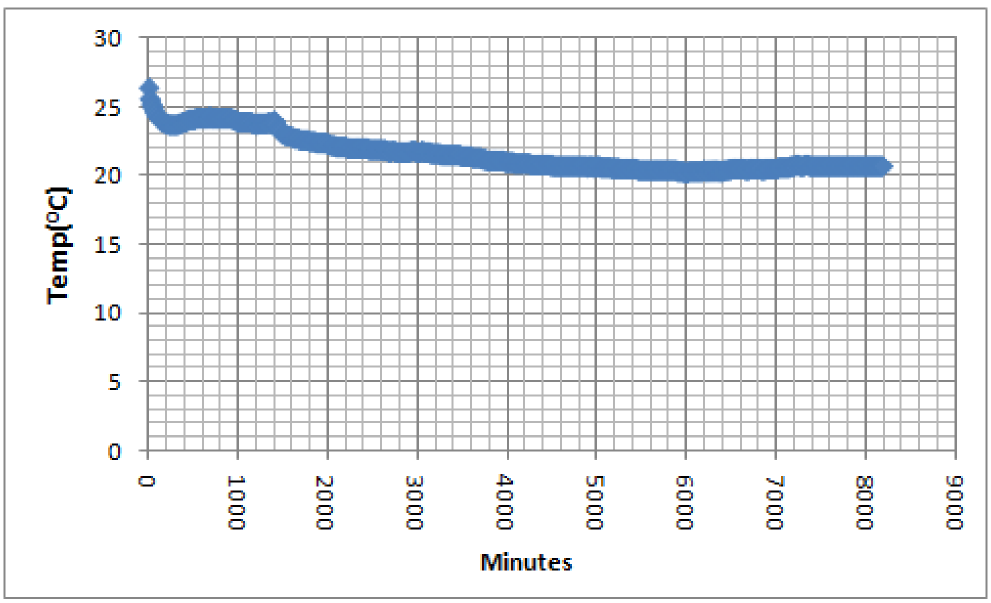


**Figure 4.8: Sample six temperature data against time (minutes)**

### 4.1.8. Heat of Hydration in Sample Seven

There was an omission in setting the temperature logger to record within the first 26 hours. However the logger was set to record after the 26 hours and data recorded as follows.Sample seven was only a cement and water mix with no aggregates. It had a water to cement ratio (w/c) of 0.45 cured under sealed and saturated conditions.

Figure 4.9 presents inner temperature data for sample seven taken after every 10 minutes for 10 days. Although the general trend seems to be the same as for other samples, sample seven temperature trend was noted to be lower than that of sample two which had a similar mix proportions but cured under unsaturated conditions. This can be explained by the curing in saturated conditions for sample seven which provided a cooling effect.

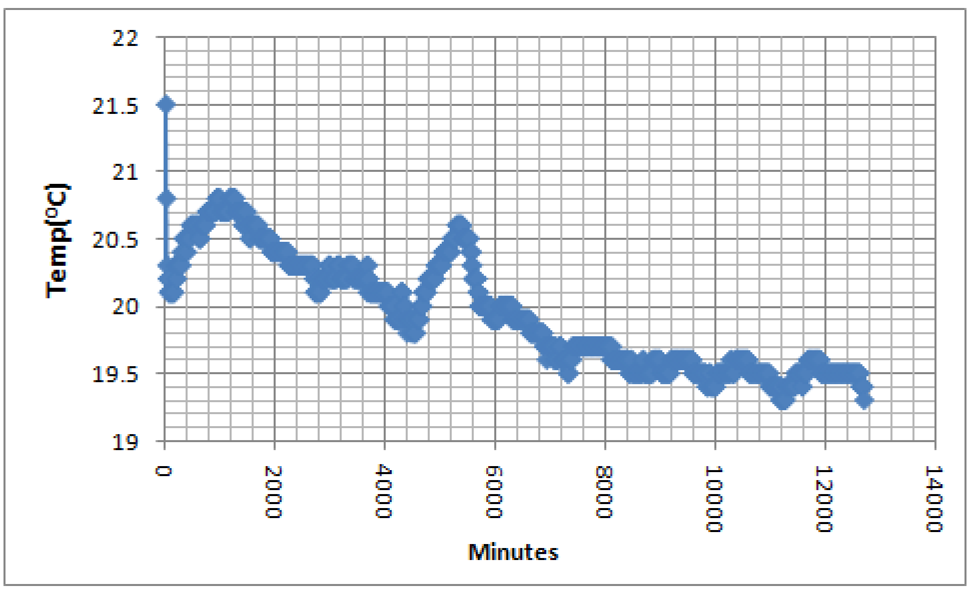


**Figure 4.9: Sample seven temperature data against time (minutes)**

### 4.1.9. Heat of Hydration in Sample Eight

Figure 4.10 presents internal temperature data for sample eight taken after every 10 minutes for 10 days. Sample eight was only a cement and water mix with no aggregates. It had a water to cement ratio (w/c) of 0.35 cured under sealed and saturated conditions.

It was noted that the general internal temperature trend seemed to be the same as of the other samples. It was however noted that the temperature values were much less and more stable than that of sample one which had a similar mix. This can be explained by the curing in saturated conditions for sample eight as compared to sample one which was cured under unsaturated conditions.

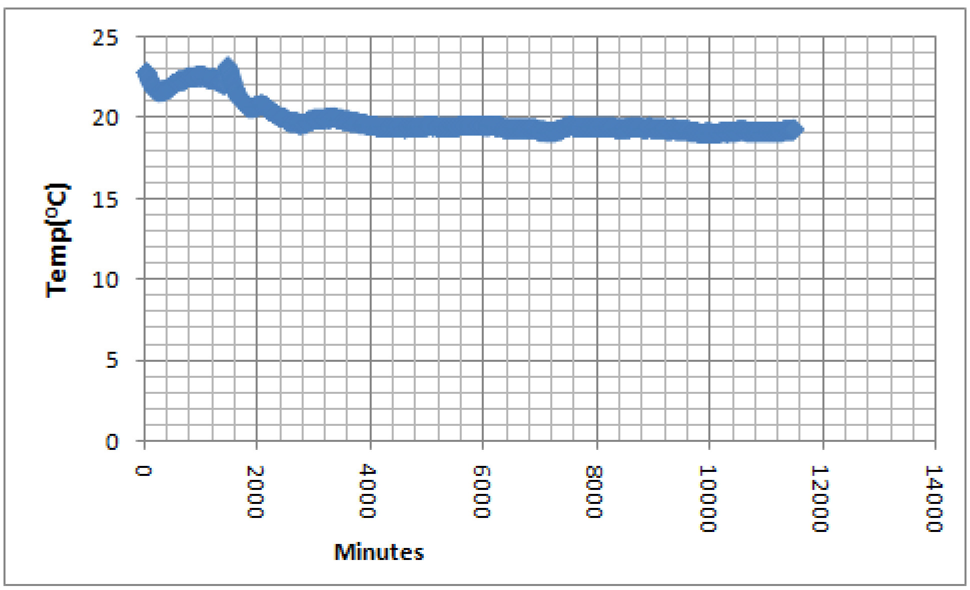


**Figure 4.10: Sample eight temperature data against time (minutes)**

## 4.2. Autogenous Shrinkage Results

### 4.2.1. Introduction

A 30mV (millivolt) Bridge/Strain101A Data logger as manufactured by MadgeTech (www.madgetech.com) was used in these experiments. This logger is made to interface with and measure strain gauges and load cells. The device provides an excitation voltage of 2.5V and has a ±30mV (millivolt) input. (Please see Appendix A for more details on the logger).

Figures 4.11 to 4.14 show the autogenous shrinkage strain for the various samples tested as presented earlier in Table 3.1 under Chapter 3. Since the data was recorded for every 10 minutes for about 10 days, detailed results are presented in tabular form in Appendix B. However the graphs presented here are for the whole 10 days duration per sample.

### 4.2.2. Conversion from Voltage to Strain

The strain gauges used had a resistance of 60±0.5 ohms (Ω) and a gauge factor of 1.68±3% (obtained from the manufacturer's manual included as Appendix A)

A fundamental parameter of the strain gauge is its sensitivity to strain, expressed quantitatively as the gauge factor (GF). It is defined as the ratio of fractional change in electrical resistance (R) to the fractional change in length (strain) (www.ni.com):

$$GF = \frac{\Delta R/R}{\Delta L/L} = \frac{\Delta R}{\varepsilon} \qquad \text{Equation 4.1}$$

If the nominal resistance of the strain gauge is designated as R, then the strain-induced change in resistance, ΔR, can be expressed from Equation 4.1 as follows:

$\Delta R = R \cdot GF \cdot \varepsilon$ where ε is the strain.

The results obtained from the strain gauge data logger in voltage were converted to strain induced resistance expressed in ohms(Ω) as demonstrated in table 4.1 for the first few hours for sample one. These were then converted to strain. Detailed results are presented under Appendix B.

### 4.2.3. Sample One Autogenous Shrinkage Strain

**Table 4.1: Sample One Strain Data**

| Date | Time | Voltage (V) | Conversion of recorded voltage to resistance (Ω) | Strain |
|---|---|---|---|---|
| 2/4/2015 | 3:17:05 PM | 0.000001 | 0.0000048 | 4.7619E-08 |
| 2/4/2015 | 3:27:05 PM | 0.000002 | 0.0000096 | 9.52381E-08 |
| 2/4/2015 | 3:37:05 PM | 0.000001 | 0.0000048 | 4.7619E-08 |
| 2/4/2015 | 3:47:05 PM | 0.000001 | 0.0000048 | 4.7619E-08 |
| 2/4/2015 | 3:57:05 PM | 0.000002 | 0.0000096 | 9.52381E-08 |
| 2/4/2015 | 4:07:05 PM | 0.000002 | 0.0000096 | 9.52381E-08 |
| 2/4/2015 | 4:17:05 PM | 0.000002 | 0.0000096 | 9.52381E-08 |
| 2/4/2015 | 4:27:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 4:37:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 4:47:05 PM | 0.000002 | 0.0000096 | 9.52381E-08 |
| 2/4/2015 | 4:57:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 5:07:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 5:17:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 5:27:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 5:37:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 5:47:05 PM | 0.000004 | 0.0000192 | 1.90476E-07 |
| 2/4/2015 | 5:57:05 PM | 0.000004 | 0.0000192 | 1.90476E-07 |
| 2/4/2015 | 6:07:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 6:17:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |
| 2/4/2015 | 6:27:05 PM | 0.000004 | 0.0000192 | 1.90476E-07 |
| 2/4/2015 | 6:37:05 PM | 0.000004 | 0.0000192 | 1.90476E-07 |
| 2/4/2015 | 6:47:05 PM | 0.000002 | 0.0000096 | 9.52381E-08 |

| Date | Time | Voltage (V) | Conversion of recorded voltage to resistance (Ω) | Strain |
|---|---|---|---|---|
| 2/4/2015 | 6:57:05 PM | 0.000003 | 0.0000144 | 1.42857E-07 |

Figure 4.11 shows sample one hydration strain recorded every 10 minutes for 10 days. Immediately upon mixing, it was noted that the strain values increased, thereafter undergoing a series of increasing and decreasing strain constantly throughout the period. This can be explained by the expansion and shrinkage of the paste as hydration took place. As water was taken up by cement for hydration, shrinkage took place. As more hydration products were formed, expansion took place. Thus the positive and the negative values indicate expansion and shrinkage respectively.

Eurocode 2 states that autogenous shrinkage 'should be considered specifically when new concrete is cast against hardened concrete' and suggests that the shrinkage strain will be 2.5 ($f_{ck}$ – 10) x 10-6, where $f_{ck}$ is the cylinder strength of the concrete.

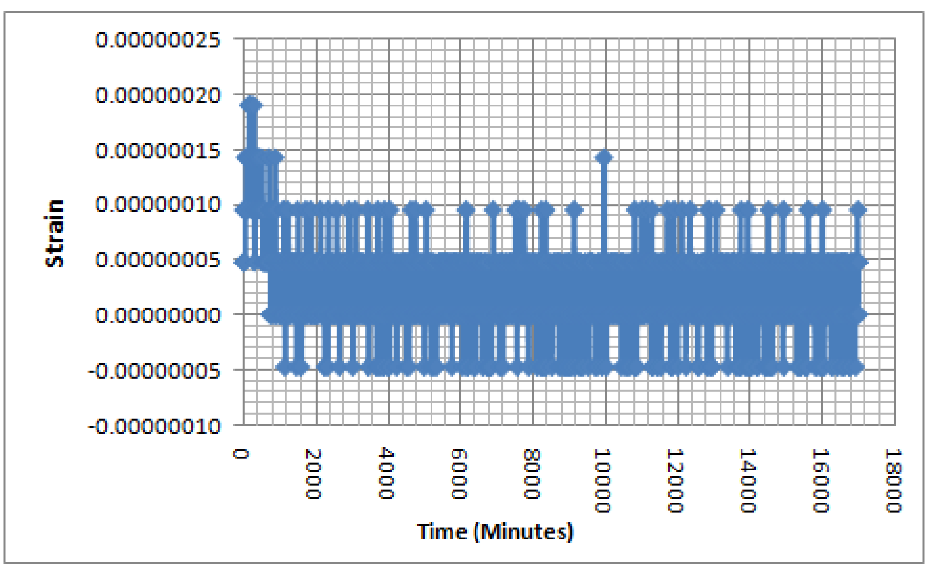


**Figure 4.11: Sample one strain against time (minutes)**

### 4.2.4. Sample Two Autogenous Shrinkage Strain

Figure 4.12 shows sample two hydration strain recorded every 10 minutes for 10 days. Immediately upon mixing, it was noted that the strain values increased, thereafter undergoing a series of increasing and decreasing strain though out the period. The strain induced decreased with time unlike for sample one which increased and decreased constantly.

It was observed that the strain data for the hydrating sample two for the ten days was all positive implying that no shrinkage took place during this period. This can be explained by the fact that sample two had a higher water to cement ratio (0.45 for sample two as compared to 0.35 for sample one). Therefore, there was more available water for cement hydration in sample two and thus reduced self-dessication. Thus the lower the water to cement ratio, the higher the autogenous shrinkage. The decreasing strain is an indication of decreasing formation of hydration products and decreasing rate of hydration.

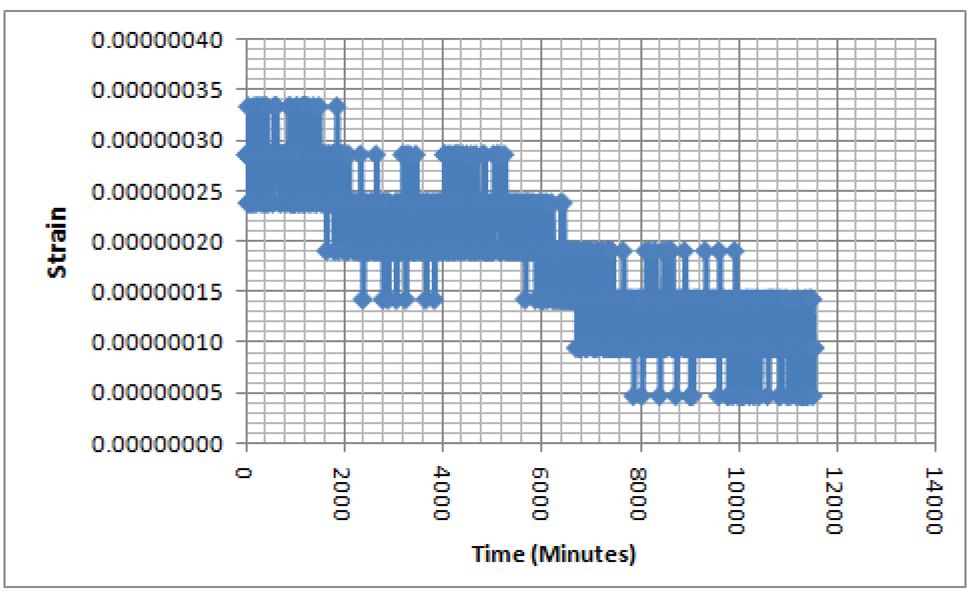


**Figure 4.12: Sample two strain against date**

### 4.2.5. Samples Three, Four, Five and Six: Autogenous Shrinkage Strain Data

Samples three, four, five and six were set up as described earlier in chapter three. However, the strain data logger was poorly connected and hence no data could be captured. For sample six, the connecting wire was cut hence the strain data could not be recorded.

It was however not possible to repeat these experiments in this particular research due to scarcity of strain gauges. The strain gauges used had to be imported and it would take a long time to arrive. These strain gauges were also not re-usable after being embedded into concrete and cement paste.

### 4.2.6. Sample Seven Autogenous Shrinkage Strain

Figure 4.13 shows the strain of a hydrating sample seven recorded every 10 minutes for 10 days. The rate of change of strain was less than for sample one and two. Since the sample was cured under saturated conditions, the lower strain values can be explained by the availability of enough water for cement hydration hence lower tension due to self-dessication. As water was taken by cement for hydration, the water was replaced by the curing water. Hence the overall volume change was minimal hence lower strain in the hydrating Ordinary Portland Cement paste.

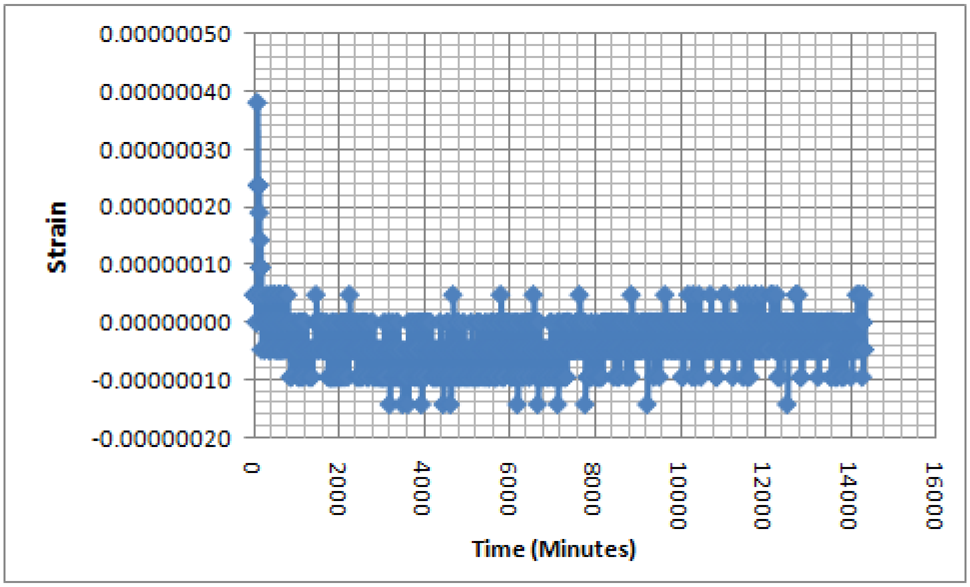


Figure 4. 13: Sample seven strain against date

### 4.2.7. Sample Eight Autogenous Shrinkage Strain

Figure 4.14 shows the strain of hydrating sample eight recorded every 10 minutes for 10 days. The strain values resemble closely those of sample seven. Even though the two samples had different water to cement ratios. Since these two samples were cured under saturated conditions, the lower strain values can be explained by the availability of enough water for cement hydration hence lower rate of volume change and hence lower rate of change of strain.

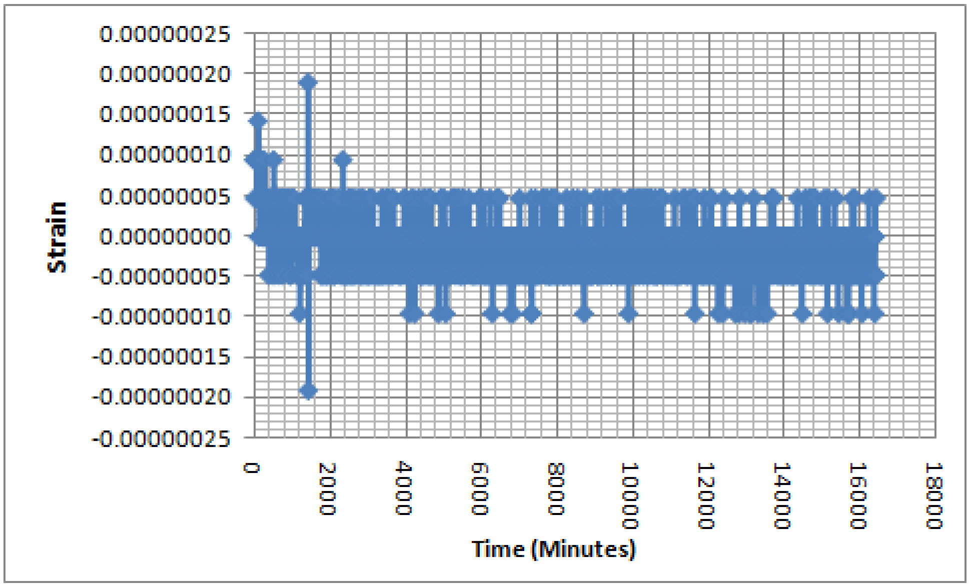


**Figure 4. 14: Sample eight strain against date**

### 4.2.8. Comparison of Various Samples Autogenous Shrinkage

Autogenous shrinkage strain is the self-created bulk strain of cement paste, mortar or concrete during hydration with no moisture lost to the surrounding environment. Figures 4.15 and 4.16 show graphs of strain against time for samples one and two; seven and eight respectively. The mix and curing conditions details are as presented in Table 3.1 in Chapter 3.

As mentioned previously, positive strain values signify increase in volume while negative strain values signify shrinkage. Positive strain values in a hydrating cement paste indicate formation of hydration products and absorption of more water by the hydrating cement paste while negative strain values indicate shrinkage. For samples cured under sealed conditions with no moisture loss to the surrounding environment, this strain is autogenous shrinkage.

From table 3.1 in Chapter 3, samples one and two were similar except that sample one had a w/c ratio of 0.35 while sample two had a w/c ratio of 0.45. Both were cured under sealed but unsaturated conditions.

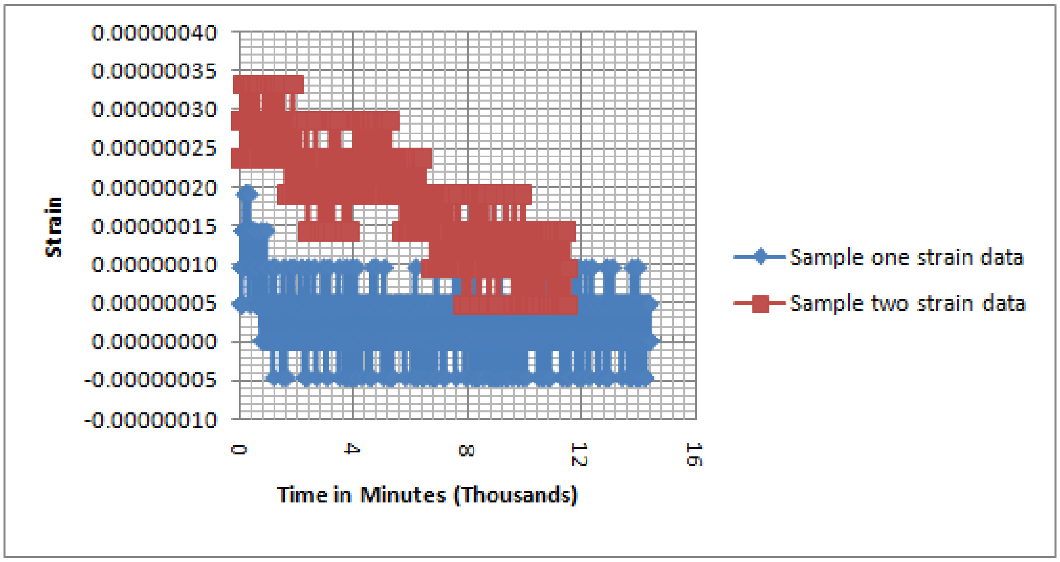


**Figure 4. 15: Samples one and two strain against date**

Figure 4.15 show that sample two recorded higher positive strain compared to sample one. Sample one recorded more negative strain values. This meant that there was higher autogenous shrinkage in sample one. It was noted that no negative strain was observed in sample two indicating no autogenous shrinkage within the testing period. This means that higher w/c ratio reduces autogenous shrinkage.

Even though samples seven and eight were cured under saturated conditions, autogenous shrinkage strain was still observed. According to Empha (2015), autogenous shrinkage becomes important with w/c<0.45 and increases with the decrease of w/c. Contrary to drying shrinkage, autogenous shrinkage occurs without any loss of moisture from the concrete. In low water-to-cement (w/c) high-performance concretes (HPC), the traditional external curing is not effective since due to a very fine structure of porosity, water provided on the surfaces is not able to penetrate the interior of the element. This explains why even in curing under sealed and saturated conditions, autogenous shrinkage was still observed in samples seven and eight.

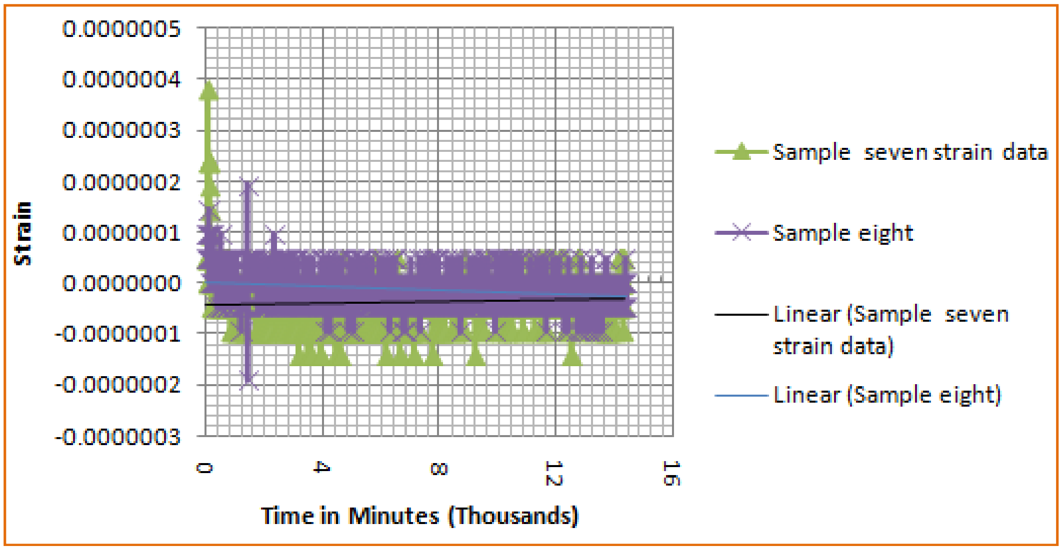


**Figure 4. 16: Samples seven and eight strain against date**

Surprisingly, as observed in Figure 4.16, sample seven showed higher autogenous shrinkage strain than sample eight which had a lower w/c ratio than sample seven. This shows that curing under saturated conditions can actually make up for the low w/c ratio and lead to reduced autogenous shrinkage.

Autogenous shrinkage is the major shrinkage component of concretes that contain much less water than would be required for complete hydration. The relative surplus of cement leads to an internal drying, irrespective of whether the concrete dries out to the ambient air or not. This process of so called self-desiccation is associated with autogenous shrinkage.

## 4.3. Stereo Microscopy Images

### 4.3.1. General

Hydrated Ordinary Portland Cement paste contains pores and microcracks with size ranging from the nanometre to millimetre scales. Various samples were observed under two separate stereo microscopes and images taken under varying magnifications.

### 4.3.2. Cracking in Hydrating Ordinary Portland Cement Paste

Figures 4.17 and 4.18 shows microscopy images of samples one and three after hydrating under sealed and unsaturated conditions for 10 days. The darkest areas indicate the macro-pores. The difference in colour was due to use of different microscopes.

Cracks were observed in sample one and three and not at all in samples two, four, five, six and seven. As these samples were cured under sealed but unsaturated conditions, it was observed that conventional curing by sealing the surface to prevent evaporation is not enough and water curing is essential.

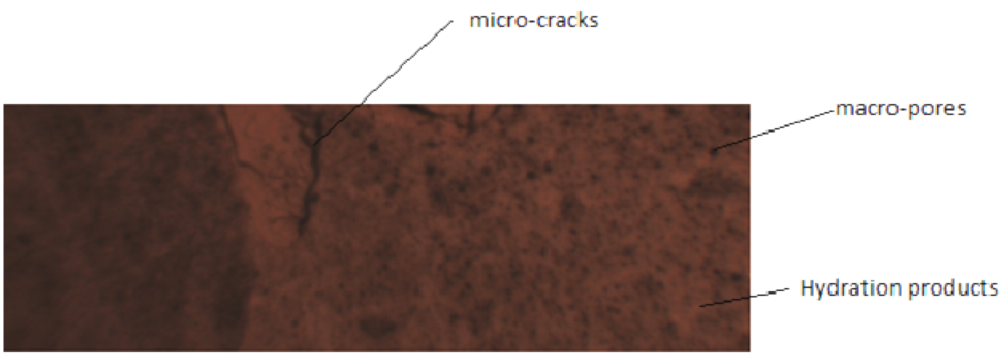


**Figure 4.17: x80 magnification location 1 - sample one**


**Figure 4. 18: x400 magnification - sample three**

At low water/cement ratios, as water is drawn into the hydration process, demand for more water creates very fine capillaries. The surface tension within the capillaries causes autogenous shrinkage which can lead to cracking. This can be largely avoided by keeping the surface of the concrete continuously wet. With wet curing, water is drawn into the capillaries and the shrinkage is reduced.

Out of all the Samples scanned at a resolution not greater than x1000, it was observed that only samples one and three developed some cracks. This can be explained by the lower water to cement ratio of these samples and the failure to cure under saturated conditions. At low water/cement ratios, water is aggressively drawn into the hydration process and the demand for more water creates very fine capillaries. The surface tension within the capillaries causes autogenous shrinkage which can lead to cracking.

Temperature strongly influences the autogenous shrinkage and, presumably, the cracking risk as well. Temperature rise causes expansion. This occurs at a time when the concrete/cement paste is hardening. As the temperature rises and the concrete undergoes non-uniform or rapid cooling, stresses due to thermal contraction in conjunction with structural restraint can result in cracking before or after the concrete eventually cools to the surrounding temperature.

The results indicated that curing under saturated conditions leads to a decrease in autogenous shrinkage and cracking. Curing under saturated conditions provides the necessary water required for hydration and hence reduces self-desiccation. Water also helps in cooling of the hydrating cement paste hence reduces the risk of cracking.

### 4.3.3. Pore Structure of Hydrating Ordinary Portland Cement Paste

The scans of the various samples as presented in this Chapter 4 show that the formation of pore structure depends on w/c ratios. Higher w/c ratios lead to reduced pore sizes as shown for samples three, four and seven as compared to the rest of the samples with lower w/c ratios. Stereo Microscopy was done for various locations within each sample and a similar pattern as that one shown in Figure 4.19 observed.

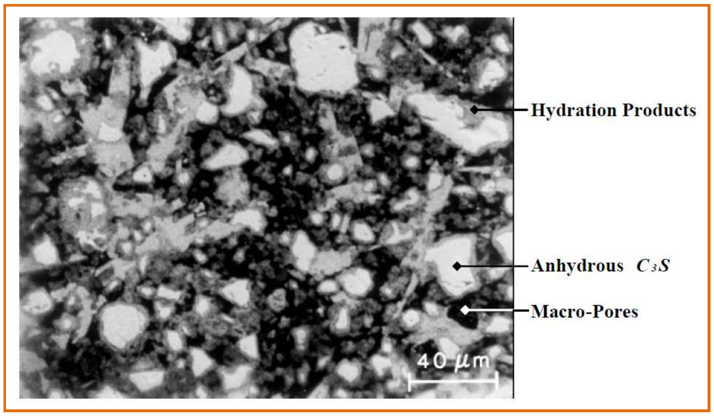


**Figure 4.19: Scanning Electron Micrograph of a *C-S-H* Paste (Tennis** *et al.,* **1997)**

Higher w/c ratios provides more water for hydration hence increased formation of hydration products. Therefore the pores sizes reduce with increasing w/c ratios as hydration products occupy the pore spaces previously occupied by water. Lower w/c ratios results in taking of water for cement hydration leading to larger pores previously occupied by the water.

Figures 4.20 and 4.21 shows microscopy images of samples one and two taken at a magnification of x1000. It was observed that at equal magnification, sample one showed bigger macro-pores than sample two. Sample two showed a higher degree of hydration than sample one. This can be explained by the availability of more water for hydration in sample two than in sample one. As presented in Table 3.1 under chapter 3, sample one had a w/c ratio of 0.35 while sample two had a w/c ratio of 0.45.

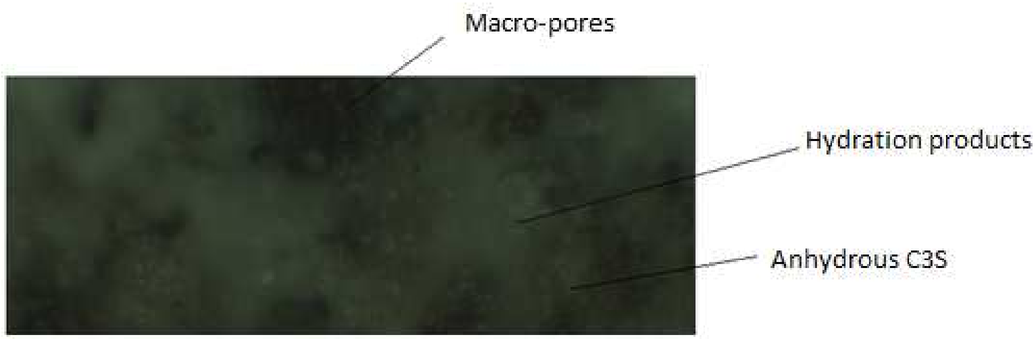


**Figure 4. 20: x1000 magnification - sample one**

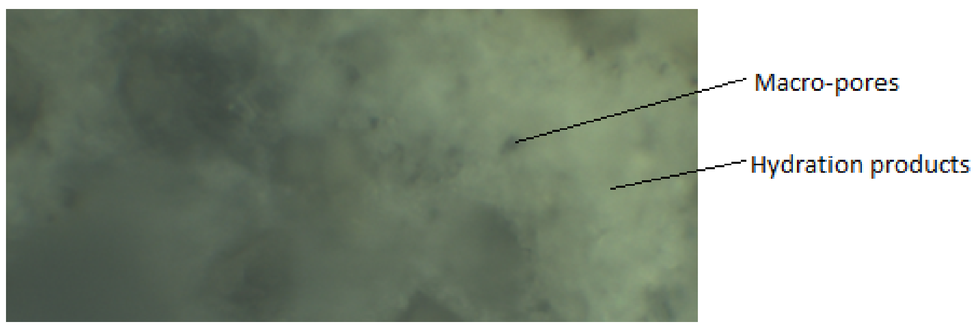


**Figure 4.21: x1000 magnification - sample two**

Figures 4.22 and 4.23 shows microscopy images of samples three and four taken at a magnification of x200.As for sample one and two, sample three  showed bigger macro-pores than sample four. This too can be explained by the different water to cement ratios. the lower the w/c ratio the bigger the macro-pores and the lesser the hydration products.

Images taken for samples six and seven were darker as these had been cured under saturated conditions hence the excess amount of water hindered clear viewing.

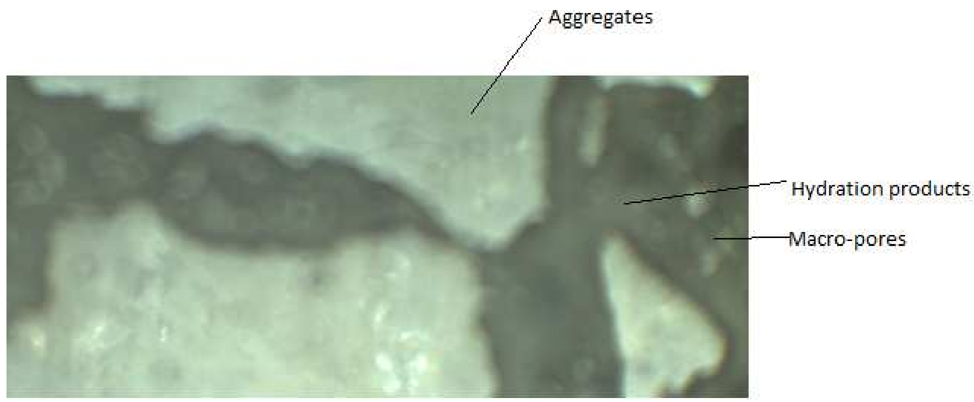


**Figure 4.22: x200 magnification - sample three**

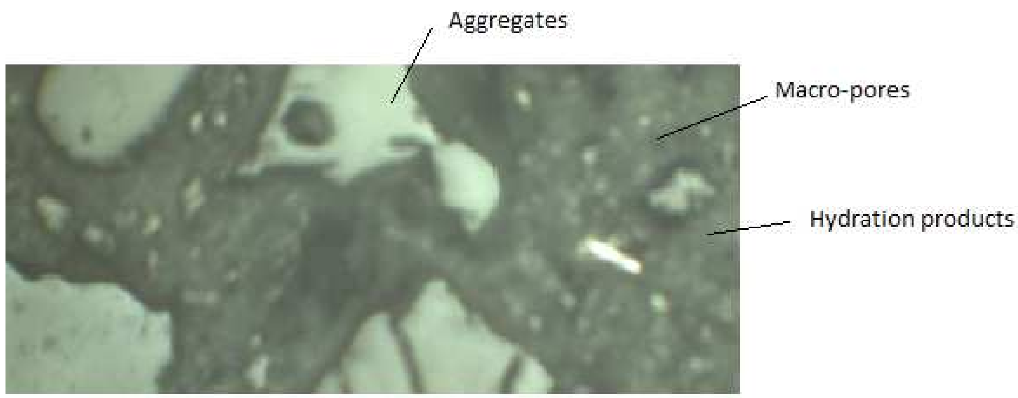


**Figure 4.23: x200 magnification - sample four**

Figures 4.24 and 4.25 shows microscopy images of samples six and seven taken at a magnification of x400.The macro-pores in sample six were observed to be bigger than those of sample seven at equal magnification. This is because sample seven and a higher w/c ratio than sample six. Also, the presence of aggregates in sample six could have led to bigger macro-pores as more water is absorbed by the aggregates. Sample seven had no aggregates.

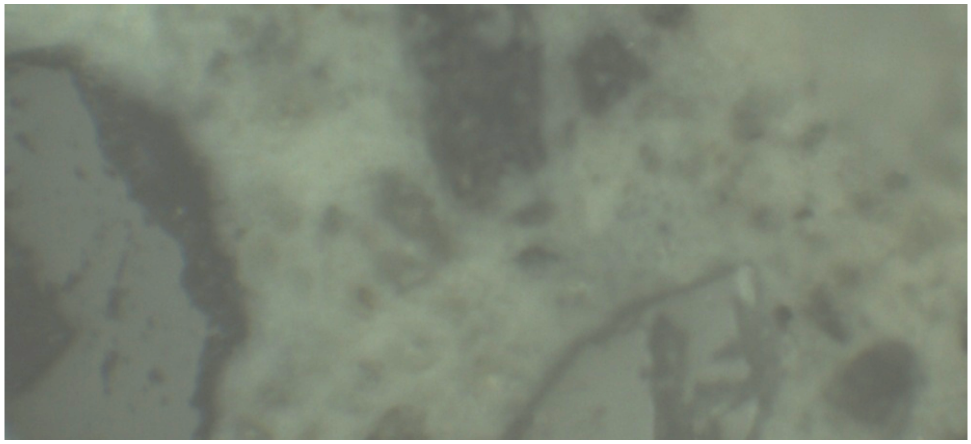

**Figure 4.24: x400 magnification - sample six**

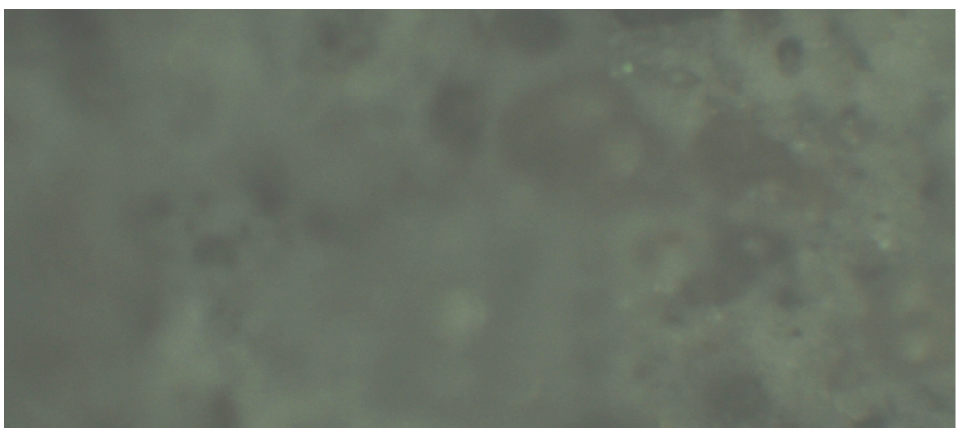

**Figure 4.25: x400 magnification - sample seven**

# 5. CONCLUSIONS AND RECOMMENDATIONS

## 5.1. Conclusions

It was observed in this study that the pores sizes of a hydrating Ordinary Portland Cement that contain much less water than is required for complete hydration reduce with increasing w/c ratios as hydration products occupy the pore spaces previously occupied by water. Higher w/c ratios provides more water for hydration hence increased formation of hydration products. Lower w/c ratios results in taking of water for cement hydration leading to larger pores previously occupied by the water. The risk of cracking increases with increasing autogenous shrinkage. Autogenous shrinkage has been observed in this study to be minimised by curing in saturated condition and increasing the water to cement ratio.

It was also observed that lower water to cement (w/c) ratio led to increased autogenous shrinkage as seen in comparison of autogenous shrinkage-induced strain results of sample one and two. Sample one recorded autogenous strain while sample two recorded no autogenous strain within the tested period. Sample one had a lower w/c ratio than sample two.

Mixes with higher water-cement ratios have more water and microstructural space available for hydration of the cement (more cement hydrates at a faster rate), resulting in an increased rate of heat development. Samples two and four recorded higher heat of hydration than samples one and three which had lower w/c ratios.

Curing under saturated conditions was seen to reduce autogenous shrinkage irrespective of the initial water to cement ratio.Curing in saturated conditions ensures replacement and availability of more water for hydration of Ordinary Portland Cement paste. This reduces self-dessication and thereby autogenous shrinkage. Presence of curing water thus results in less recorded pores and cracking. Availability of water for curing reduces internal temperature due to cooling aided by the presence of water.

## 5.2. Recommendations for Further Research

1. Autogenous shrinkage affects the pore structure of hydrating cement. Further research is recommended in this area to relate the development of pore structure with autogenous shrinkage. This can be done by mercury intrusion or other appropriate means.
2. It was initially intended in this research to also evaluate the effect of aggregates on autogenous shrinkage. However, no shrinkage data could be collected for the samples that contained aggregates due to a faulty connection of elongating wires of the strain gauge during this period. It is recommended that further research be carried out on the effect of aggregates on autogenous shrinkage.
3. Case studies are recommended to acquire practical evidence that autogenous shrinkage causes problems in concrete practice in this Kenya.

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# 7. APPENDIX A - DATA LOGGERS MANUALS

EXTECH INSTRUMENTS

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PRODUCT DATASHEET

## 4-Channel Datalogging Thermometer

*Records data on an SD card in Excel® format*

*For easy transfer to a PC for analysis*

### Features:

- 4-Channel datalogging with 6 Thermocouple types (J, K, E, T, R,S) and 2-Channel datalogging with RTD (Pt100Ω) probes
- Displays [T1, T2, T3, T4] or differential [T1-T2] reading
- Offset adjustment used for zero function to make relative measurements
- Stores 99 readings manually and 20M readings via 2G SD card
- Records readings with real date and time stamp
- User programmable sampling rate: 1 to 3600 seconds
- Min/Max and Data Hold functions
- Auto power off with disable function
- Built-in PC interface
- Complete with 6 AA batteries, four general purpose Type K bead wire temperature probes, SD card, and hard carrying case

Simultaneously measures 4 temperature inputs for multiple source monitoring



**Optional Temperature Probes:**

Model TP875 — Optional Type K Bead Wire Temperature Probe measures from -58 to 1000°F (-50 to 538°C) with subminiature connector. Includes a banana adaptor connector for use with meters with banana adaptor inputs.

Model 850185 — Optional RTD (PT100) Temperature Probe measures from (-22 to 482°F/-30 to 250°C).

Model TP200 and TP400 — Optional Type K Pipe Clamp Temperature Probe for hands-free superheat/sub-cooling temperature measurement from -4°F to 200°F (-20°C to 93°C) for TP200 and -4 to 450°F (-20 to 232°C)

*Visit www.extech.com for a wide selection of Temperature Probes including Penetration and Surface Probes.*

| Specifications | |
|---|---|
| Type J | -148 to 2102°F (-100 to 1150°C) |
| Type K | -148 to 2372°F (-100 to 1300°C) |
| Type T | -58 to 752°F (-50 to 400°C) |
| Type E | -58 to 1652°F (-50 to 900°C) |
| Type R | 32 to 3092°F (0 to 1700°C) |
| Type S | 32 to 2732°F (0 to 1500°C) |
| RTD (Pt100) | -327 to 1562°F (-200 to 850°C) |
| Resolution | 0.1°/1° |
| Basic Accuracy | ±0.4% rdg (+1.8°F/+1°C) Types J,K,E,T, Pt100<br>±0.5% rdg (+2°F/+1°C) Types R,S |
| Datalogging | 20M data records using a 2G SD card |
| Dimensions | 7.2 x 2.9 x 1.9" (182 x 73 x 47.5mm) |
| Weight | 17.6oz (500g) |

## Ordering Information:

**SDL200** ....................4-Channel Datalogging Thermometer
**SDL200-NIST** ............SDL200 w/Certificate of Calibration Traceable to NIST standards

**872502** ....................Type J Bead Wire Probe (-40 to 392°F/-40 to 200°C)
**TP870** ......................Type K Bead Wire Probe (-40 to 482°F/-40 to 250°C)
**TP200** ......................Type K Clamp Probe (-4 to 200°F/-20 to 93°F)
**TP400** ......................Type K Clamp Probe (-4 to 450°F/-20 to 232°C)
**850185** ....................RTD (PT100) Temperature Probe (-40 to 392°F/-40 to 200°C)
**153117** ....................117V AC Adaptor
**UA100-240** ...............100-240V AC Adaptor with 4 plugs (US, EU, UK, AU)

# BRIDGE101A
## BRIDGE/STRAIN GAUGE DATA LOGGER

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WE BUILD DATA LOGGERS

**Features**

- Multiple Start/Stop Function
- Ultra High Speed Download
- 1 Million Reading Storage Capacity
- Memory Wrap
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- Optional Password Protection
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- Field Upgradeable

**Benefits**

- Simple Setup and Installation
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- Long-Term Field Deployment

**Applications**

- Strain Gauge
- Load Cell
- Pressure Transducer
- Torque Sensors
- Load Bolts
- Position Transducer


The Bridge101A Data Logger measures and records voltage, typically used in conjunction with strain gauges, load cells or other low-level DC voltage sources. This device is designed to accurately measure and record the output of the gauge to determine parameter levels such as stress, torque, strain, and pressure on a structure or item over a period of time.

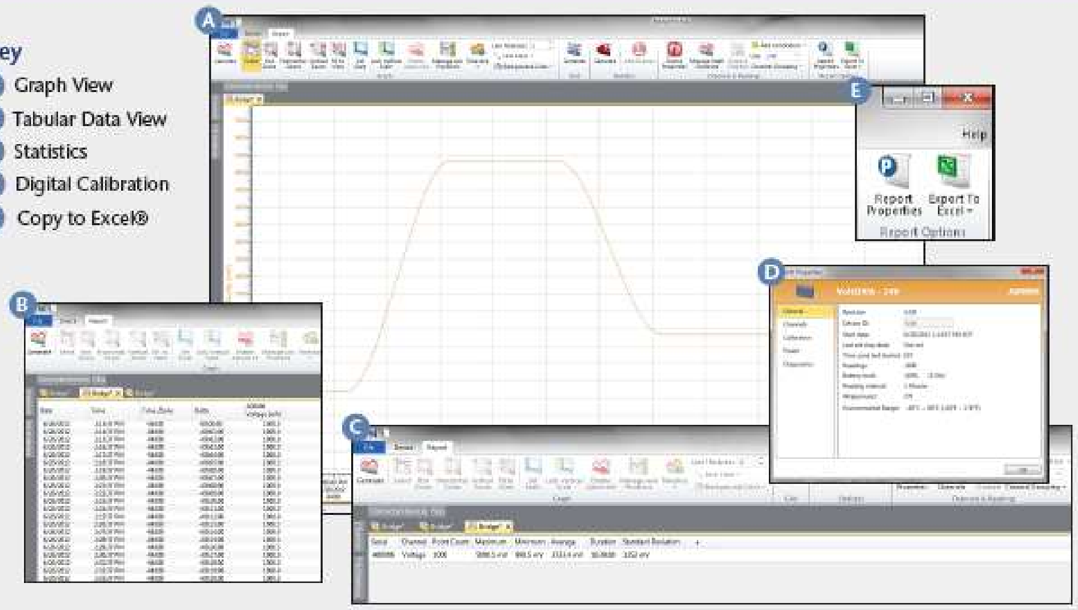
Available in three different measurement ranges (±30 mV, ±160 mV or ±1200 mV), the Bridge101A offers a reading rate of up to 4 Hz with memory capacity of 1,000,000 readings (memory wrap optional). The device can be configured to start at a specified date and time up to 24 months in advance and the pushbutton start/stop feature allows the user to initiate or cease logging data in the field if desired.

The MadgeTech Data Logger Software offers user programmable Engineering Units which allows collected data to be presented in the established unit being measured. Equipped with endless data analysis and reporting tools, the MadgeTech software simplifies device management and provides the user with graph, tabular or summary reports with the ability to export data to Excel as needed.

## MADGETECH DATA LOGGER SOFTWARE

**Key**

- A Graph View
- B Tabular Data View
- C Statistics
- D Digital Calibration
- E Copy to Excel®



**Software Features:**

- Multiple graph overlay
- Statistics
- Digital calibration
- Zoom in/ zoom out
- Lethality equations (F0, PU)
- Mean Kinetic Temperature
- Full time zone support
- Data annotation
- Min./Max./Average lines
- Data table view
- Automatic report generation
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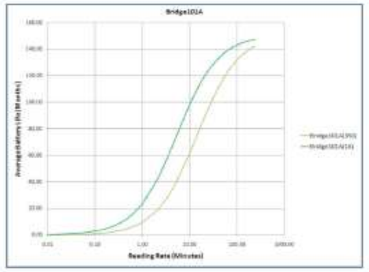
## BRIDGE101A SPECIFICATIONS*

*SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE. SPECIFIC WARRANTY REMEDY LIMITATIONS APPLY. CALL 1-603-456-2011 OR GO TO WWW.MADGETECH.COM FOR DETAILS.

| Nominal Range: | ±30 mV | ±150 mV | ±1000 mV |
|---|---|---|---|
| **Measurement Range:** | ±30 mV | ±160 mV | ±1200 mV |
| **Resolution:** | 1 µV | 5 µV | 50 µV |
| **Calibrated Accuracy:** | ±0.01% FSR; ±3 Microvolts | ±0.01% FSR; ±16 Microvolts | ±0.01% FSR; ±120 Micro-volts |
| **Input Range:** | 0 to 2.5V | 0 to 2.5 V | 0 to 2.5 V |
| **Reference Voltage:** | 2.5 V | 2.5 V | 2.5 V |
| **Reading Rate:** | 4Hz to 1 every 24 hours | | |
| **Memory:** | 1,000,000 readings; software configurable memory wrap<br>330,000 readings in multiple start/stop | | |
| **Wrap Around:** | Yes | | |
| **Start Modes:** | • Immediate start<br>• Delay start up to 24 months<br>• Multiple pushbutton start/stop | | |
| **Stop Modes:** | • Manual through software<br>• Timed (specific date and time) | | |
| **Multiple Start/ Stop Mode:** | Start and stop the device multiple times without having to download data or communicate with a PC | | |
| **Multiple Start/Stop Mode Activation:** | • To start the device:<br>Press and hold the pushbutton for 5 seconds, the green LED will flash during this time. The device has started logging.<br>• To stop the device:<br>Press and hold the pushbutton for 5 seconds, the red LED will flash during this time. The device has stopped logging. | | |
| **Real Time Recording:** | The device may be used with PC to monitor and record data in real time | | |
| **LED Functionality:** | • Green LED blinks:<br>10 second rate to indicate logging<br>15 second rate to indicate delay start<br>• Red LED blinks:<br>10 second rate to indicate low battery and/or full memory<br>1 second rate to indicate an alarm condition | | |

| | |
|---|---|
| **Password Protection:** | An optional password may be programmed into the device to restrict access to configuration options. Data may be read out without the password. |
| **Engineering Units:** | Native measurement units can be scaled to display measurement units of another type. This is useful when monitoring voltage outputs from different types of sensors such as strain gauges and load cells. |
| **Battery Type:** | 3.6V lithium battery included; **user replaceable** |
| **Battery Life:** | 10 months typical at a 1 minute reading rate with a 350 Ω load<br>2 years typical at a 1 minute reading rate with a 1000 Ω load<br>  |
| **Time Accuracy:** | ±1 minute/month (at 20 °C/68 °F, stand alone data logging) |
| **Computer Interface:** | USB (interface cable required); 115,200 baud |
| **Software:** | XP SP3/Vista/Windows 7/Windows 8 (MadgeTech 4 Only) |
| **Operating Environment:** | -40 °C to +80 °C (-40 °F to +176 °F),<br>0 %RH to 90 %RH non-condensing |
| **Dimensions:** | 1.4 in x 2.5 in x 0.6 in<br>(36 mm x 64 mm x 16 mm) |
| **Weight:** | 0.8 oz (24 g) |
| **Materials:** | ABS Plastic |
| **Approvals:** | CE |

# 8. APPENDIX B - DETAILED STRAIN DATA

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 10.00 | 4.7619E-08 | 2.85714E-07 | 4.7619E-08 | 9.52381E-08 |
| 20.00 | 9.52381E-08 | 2.85714E-07 | 4.7619E-08 | 4.7619E-08 |
| 30.00 | 4.7619E-08 | 2.85714E-07 | 4.7619E-08 | 9.52381E-08 |
| 40.00 | 4.7619E-08 | 2.38095E-07 | 4.7619E-08 | 9.52381E-08 |
| 50.00 | 9.52381E-08 | 3.33333E-07 | 4.7619E-08 | 9.52381E-08 |
| 60.00 | 9.52381E-08 | 2.38095E-07 | 0 | 9.52381E-08 |
| 70.00 | 9.52381E-08 | 2.85714E-07 | 0 | 9.52381E-08 |
| 80.00 | 1.42857E-07 | 2.38095E-07 | 3.80952E-07 | 9.52381E-08 |
| 90.00 | 1.42857E-07 | 2.85714E-07 | 2.38095E-07 | 4.7619E-08 |
| 100.00 | 9.52381E-08 | 2.38095E-07 | 2.38095E-07 | 9.52381E-08 |
| 110.00 | 1.42857E-07 | 2.38095E-07 | 2.38095E-07 | 1.42857E-07 |
| 120.00 | 1.42857E-07 | 2.85714E-07 | 2.38095E-07 | 4.7619E-08 |
| 130.00 | 1.42857E-07 | 2.38095E-07 | 1.90476E-07 | 0 |
| 140.00 | 1.42857E-07 | 2.38095E-07 | 9.52381E-08 | 0 |
| 150.00 | 1.42857E-07 | 2.85714E-07 | 1.42857E-07 | 0 |
| 160.00 | 1.90476E-07 | 2.85714E-07 | 9.52381E-08 | 4.7619E-08 |
| 170.00 | 1.90476E-07 | 3.33333E-07 | 9.52381E-08 | 9.52381E-08 |
| 180.00 | 1.42857E-07 | 2.38095E-07 | -4.7619E-08 | 9.52381E-08 |
| 190.00 | 1.42857E-07 | 2.85714E-07 | 4.7619E-08 | 9.52381E-08 |
| 200.00 | 1.90476E-07 | 2.38095E-07 | 0 | 4.7619E-08 |
| 210.00 | 1.90476E-07 | 2.85714E-07 | 0 | 0 |
| 220.00 | 9.52381E-08 | 2.38095E-07 | 0 | 0 |
| 230.00 | 1.42857E-07 | 3.33333E-07 | 0 | 4.7619E-08 |
| 240.00 | 1.42857E-07 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 250.00 | 1.42857E-07 | 3.33333E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 260.00 | 1.42857E-07 | 2.85714E-07 | 0 | 4.7619E-08 |
| 270.00 | 1.42857E-07 | 2.85714E-07 | 0 | 9.52381E-08 |
| 280.00 | 1.42857E-07 | 2.85714E-07 | 0 | 0 |
| 290.00 | 9.52381E-08 | 2.38095E-07 | 0 | 0 |
| 300.00 | 1.90476E-07 | 3.33333E-07 | 0 | 0 |
| 310.00 | 9.52381E-08 | 2.85714E-07 | 0 | 4.7619E-08 |
| 320.00 | 4.7619E-08 | 2.85714E-07 | 4.7619E-08 | 0 |
| 330.00 | 9.52381E-08 | 2.85714E-07 | 0 | 0 |
| 340.00 | 1.42857E-07 | 3.33333E-07 | -4.7619E-08 | 4.7619E-08 |
| 350.00 | 9.52381E-08 | 2.38095E-07 | 0 | 0 |
| 360.00 | 1.42857E-07 | 2.85714E-07 | -4.7619E-08 | 0 |
| 370.00 | 1.42857E-07 | 2.38095E-07 | 0 | 0 |
| 380.00 | 1.42857E-07 | 2.85714E-07 | 0 | 4.7619E-08 |
| 390.00 | 9.52381E-08 | 2.85714E-07 | 4.7619E-08 | -4.7619E-08 |
| 400.00 | 9.52381E-08 | 3.33333E-07 | -4.7619E-08 | 0 |
| 410.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 420.00 | 1.42857E-07 | 2.85714E-07 | 0 | 0 |
| 430.00 | 1.42857E-07 | 3.33333E-07 | 4.7619E-08 | 4.7619E-08 |
| 440.00 | 9.52381E-08 | 2.38095E-07 | 0 | 0 |
| 450.00 | 1.42857E-07 | 2.38095E-07 | 0 | 0 |
| 460.00 | 9.52381E-08 | 2.85714E-07 | 0 | 0 |
| 470.00 | 9.52381E-08 | 2.85714E-07 | 0 | 0 |
| 480.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 490.00 | 9.52381E-08 | 2.85714E-07 | 4.7619E-08 | 4.7619E-08 |
| 500.00 | 9.52381E-08 | 2.85714E-07 | 4.7619E-08 | 0 |
| 510.00 | 9.52381E-08 | 2.85714E-07 | 0 | 4.7619E-08 |
| 520.00 | 1.42857E-07 | 2.85714E-07 | 0 | 9.52381E-08 |
| 530.00 | 9.52381E-08 | 2.85714E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 540.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 550.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 560.00 | 9.52381E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 570.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 580.00 | 9.52381E-08 | 3.33333E-07 | 4.7619E-08 | 4.7619E-08 |
| 590.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 600.00 | 4.7619E-08 | 2.85714E-07 | 4.7619E-08 | 0 |
| 610.00 | 4.7619E-08 | 3.33333E-07 | 0 | 0 |
| 620.00 | 4.7619E-08 | 3.33333E-07 | -4.7619E-08 | 0 |
| 630.00 | 4.7619E-08 | 2.85714E-07 | 4.7619E-08 | 0 |
| 640.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 650.00 | 4.7619E-08 | 2.85714E-07 | 0 | 0 |
| 660.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 670.00 | 4.7619E-08 | 2.85714E-07 | 0 | 0 |
| 680.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 690.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 700.00 | 4.7619E-08 | 2.85714E-07 | 0 | 0 |
| 710.00 | 1.42857E-07 | 2.38095E-07 | 0 | 4.7619E-08 |
| 720.00 | 4.7619E-08 | 2.85714E-07 | 4.7619E-08 | 0 |
| 730.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 740.00 | 9.52381E-08 | 2.85714E-07 | 0 | 0 |
| 750.00 | 0 | 2.85714E-07 | 4.7619E-08 | 0 |
| 760.00 | 0 | 2.85714E-07 | 4.7619E-08 | 4.7619E-08 |
| 770.00 | 9.52381E-08 | 2.85714E-07 | 4.7619E-08 | 4.7619E-08 |
| 780.00 | 9.52381E-08 | 2.85714E-07 | 0 | -4.7619E-08 |
| 790.00 | 9.52381E-08 | 2.85714E-07 | 4.7619E-08 | 4.7619E-08 |
| 800.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 810.00 | 0 | 2.85714E-07 | 0 | 4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 820.00 | 9.52381E-08 | 2.85714E-07 | 0 | 0 |
| 830.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 840.00 | 9.52381E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 850.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 860.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 870.00 | 0 | 3.33333E-07 | 0 | 0 |
| 880.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 890.00 | 1.42857E-07 | 2.85714E-07 | -9.52381E-08 | 4.7619E-08 |
| 900.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 910.00 | 0 | 3.33333E-07 | -4.7619E-08 | 0 |
| 920.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 930.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 940.00 | 0 | 2.85714E-07 | 0 | -4.7619E-08 |
| 950.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 960.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 970.00 | 4.7619E-08 | 2.85714E-07 | 0 | -4.7619E-08 |
| 980.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 990.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1000.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1010.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1020.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 1030.00 | 4.7619E-08 | 3.33333E-07 | -4.7619E-08 | 4.7619E-08 |
| 1040.00 | 0 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1050.00 | 0 | 3.33333E-07 | 0 | 0 |
| 1060.00 | 4.7619E-08 | 2.85714E-07 | 0 | 4.7619E-08 |
| 1070.00 | 0 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1080.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 1090.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 1100.00 | 4.7619E-08 | 2.85714E-07 | 0 | 0 |
| 1110.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1120.00 | 9.52381E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1130.00 | 9.52381E-08 | 2.85714E-07 | 0 | 0 |
| 1140.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1150.00 | 0 | 3.33333E-07 | 0 | -4.7619E-08 |
| 1160.00 | -4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 1170.00 | 4.7619E-08 | 3.33333E-07 | -4.7619E-08 | 0 |
| 1180.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 1190.00 | 4.7619E-08 | 3.33333E-07 | -4.7619E-08 | -4.7619E-08 |
| 1200.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1210.00 | 4.7619E-08 | 3.33333E-07 | -4.7619E-08 | -9.52381E-08 |
| 1220.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 1230.00 | 9.52381E-08 | 3.33333E-07 | -4.7619E-08 | 0 |
| 1240.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1250.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1260.00 | 0 | 3.33333E-07 | -4.7619E-08 | -4.7619E-08 |
| 1270.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1280.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 1290.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1300.00 | 0 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 1310.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 1320.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1330.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1340.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 1350.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | -4.7619E-08 |
| 1360.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1370.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 1380.00 | 0 | 3.33333E-07 | -4.7619E-08 | 4.7619E-08 |
| 1390.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 1400.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1410.00 | 0 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 1420.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1430.00 | 4.7619E-08 | 2.85714E-07 | 0 | 1.90476E-07 |
| 1440.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -1.90476E-07 |
| 1450.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 1460.00 | 4.7619E-08 | 2.85714E-07 | 4.7619E-08 | 0 |
| 1470.00 | -4.7619E-08 | 2.85714E-07 | 0 | 4.7619E-08 |
| 1480.00 | 4.7619E-08 | 2.85714E-07 | 0 | 0 |
| 1490.00 | 0 | 3.33333E-07 | 0 | 4.7619E-08 |
| 1500.00 | 0 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 1510.00 | 9.52381E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1520.00 | 4.7619E-08 | 2.85714E-07 | 0 | 0 |
| 1530.00 | 0 | 2.38095E-07 | 0 | 4.7619E-08 |
| 1540.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1550.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1560.00 | 0 | 2.85714E-07 | 0 | 4.7619E-08 |
| 1570.00 | 4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 1580.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 1590.00 | 4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 1600.00 | -4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 1610.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1620.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 1630.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1640.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 1650.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 1660.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 1670.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1680.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1690.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1700.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1710.00 | 0 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 1720.00 | 0 | 2.38095E-07 | 0 | 4.7619E-08 |
| 1730.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1740.00 | 9.52381E-08 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 1750.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1760.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1770.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 1780.00 | 0 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1790.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | -4.7619E-08 |
| 1800.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 1810.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1820.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1830.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 1840.00 | 0 | 2.38095E-07 | 0 | 0 |
| 1850.00 | 0 | 3.33333E-07 | -9.52381E-08 | 4.7619E-08 |
| 1860.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 1870.00 | 9.52381E-08 | 2.85714E-07 | 0 | 0 |
| 1880.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 1890.00 | 0 | 2.85714E-07 | -9.52381E-08 | -4.7619E-08 |
| 1900.00 | 0 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 1910.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1920.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1930.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 1940.00 | 0 | 2.38095E-07 | 0 | -4.7619E-08 |
| 1950.00 | 0 | 2.85714E-07 | -9.52381E-08 | 0 |
| 1960.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 1970.00 | 0 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 1980.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 1990.00 | 0 | 2.85714E-07 | -4.7619E-08 | 4.7619E-08 |
| 2000.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2010.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 2020.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 2030.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 2040.00 | 0 | 2.85714E-07 | -9.52381E-08 | 0 |
| 2050.00 | 4.7619E-08 | 2.38095E-07 | 0 | -4.7619E-08 |
| 2060.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 2070.00 | 4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 2080.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 2090.00 | 0 | 2.85714E-07 | -9.52381E-08 | -4.7619E-08 |
| 2100.00 | 4.7619E-08 | 2.38095E-07 | 0 | -4.7619E-08 |
| 2110.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2120.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2130.00 | 4.7619E-08 | 2.38095E-07 | 0 | -4.7619E-08 |
| 2140.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 2150.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 2160.00 | 4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 2170.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2180.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 2190.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2200.00 | 0 | 1.90476E-07 | 0 | 0 |
| 2210.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 2220.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2230.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2240.00 | 0 | 1.90476E-07 | 0 | 4.7619E-08 |
| 2250.00 | 0 | 2.38095E-07 | 4.7619E-08 | 0 |
| 2260.00 | -4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2270.00 | 0 | 2.38095E-07 | 0 | 0 |
| 2280.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 2290.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2300.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2310.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2320.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 2330.00 | -4.7619E-08 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 2340.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2350.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 9.52381E-08 |
| 2360.00 | 9.52381E-08 | 2.38095E-07 | 0 | -4.7619E-08 |
| 2370.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2380.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 2390.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 2400.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 2410.00 | 4.7619E-08 | 2.38095E-07 | 0 | -4.7619E-08 |
| 2420.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 2430.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2440.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 2450.00 | 0 | 2.38095E-07 | 0 | -4.7619E-08 |
| 2460.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 2470.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 2480.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2490.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 2500.00 | 0 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 2510.00 | 0 | 1.90476E-07 | 0 | -4.7619E-08 |
| 2520.00 | 0 | 1.90476E-07 | -9.52381E-08 | 4.7619E-08 |
| 2530.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 2540.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2550.00 | 4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 2560.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 2570.00 | 0 | 2.38095E-07 | 0 | -4.7619E-08 |
| 2580.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2590.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 2600.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 2610.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 2620.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 2630.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 2640.00 | 4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 2650.00 | 4.7619E-08 | 2.85714E-07 | 0 | 0 |
| 2660.00 | -4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2670.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 2680.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 2690.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 2700.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 2710.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2720.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2730.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2740.00 | 0 | 1.90476E-07 | 0 | 0 |
| 2750.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2760.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2770.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 2780.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2790.00 | 0 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 2800.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2810.00 | 4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 2820.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 2830.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 2840.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 2850.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 2860.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 2870.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 2880.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 2890.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 2900.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 2910.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 2920.00 | 9.52381E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2930.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 2940.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2950.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2960.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 2970.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 2980.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 2990.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 3000.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3010.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3020.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3030.00 | -4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 3040.00 | 0 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 3050.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 3060.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 3070.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3080.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 3090.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3100.00 | 9.52381E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3110.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 3120.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3130.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3140.00 | 0 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 3150.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3160.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 3170.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3180.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3190.00 | 4.7619E-08 | 2.85714E-07 | -1.42857E-07 | 0 |
| 3200.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3210.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 3220.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3230.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3240.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3250.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 3260.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 3270.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3280.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 3290.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3300.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3310.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 3320.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3330.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 3340.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3350.00 | 0 | 2.38095E-07 | 0 | -4.7619E-08 |
| 3360.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3370.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 3380.00 | 4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 3390.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3400.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3410.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 4.7619E-08 |
| 3420.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 3430.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 3440.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3450.00 | 9.52381E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3460.00 | 0 | 2.85714E-07 | -9.52381E-08 | 0 |
| 3470.00 | -4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3480.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3490.00 | 0 | 2.38095E-07 | -1.42857E-07 | 0 |
| 3500.00 | 0 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 3510.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3520.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 3530.00 | 0 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 3540.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 3550.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 3560.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3570.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3580.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3590.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 3600.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3610.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 3620.00 | 0 | 1.90476E-07 | -1.42857E-07 | -4.7619E-08 |
| 3630.00 | 0 | 1.90476E-07 | 0 | 0 |
| 3640.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3650.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 3660.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 3670.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 3680.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 3690.00 | -4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 3700.00 | -4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3710.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3720.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3730.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3740.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3750.00 | 0 | 1.90476E-07 | 0 | -4.7619E-08 |
| 3760.00 | 0 | 1.90476E-07 | 0 | 0 |
| 3770.00 | -4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3780.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3790.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3800.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3810.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 3820.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 3830.00 | 0 | 1.42857E-07 | 0 | 0 |
| 3840.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3850.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 3860.00 | -4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 3870.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 3880.00 | -4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 3890.00 | 4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 3900.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 3910.00 | 9.52381E-08 | 2.38095E-07 | 0 | 0 |
| 3920.00 | 0 | 2.38095E-07 | 0 | -4.7619E-08 |
| 3930.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 3940.00 | 0 | 2.38095E-07 | -1.42857E-07 | 0 |
| 3950.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3960.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 3970.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 3980.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 3990.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4000.00 | 4.7619E-08 | 2.38095E-07 | 0 | -4.7619E-08 |
| 4010.00 | -4.7619E-08 | 1.90476E-07 | 0 | 4.7619E-08 |
| 4020.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 4030.00 | 0 | 2.38095E-07 | 0 | 0 |
| 4040.00 | -4.7619E-08 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 4050.00 | 0 | 2.85714E-07 | -9.52381E-08 | 0 |
| 4060.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4070.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 4080.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 4090.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4100.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 4110.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | -9.52381E-08 |
| 4120.00 | 0 | 1.90476E-07 | 0 | -4.7619E-08 |
| 4130.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4140.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 4150.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 4160.00 | 4.7619E-08 | 2.85714E-07 | 0 | -4.7619E-08 |
| 4170.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 4180.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4190.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4200.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 4210.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 4220.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 4230.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 4240.00 | -4.7619E-08 | 2.85714E-07 | -9.52381E-08 | -4.7619E-08 |
| 4250.00 | 0 | 1.90476E-07 | -4.7619E-08 | -9.52381E-08 |
| 4260.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 4270.00 | 0 | 2.85714E-07 | -4.7619E-08 | -4.7619E-08 |
| 4280.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 4290.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 4300.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 4310.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 4320.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 4330.00 | 0 | 2.85714E-07 | -4.7619E-08 | 0 |
| 4340.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4350.00 | 0 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 4360.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 4370.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 4380.00 | 0 | 2.38095E-07 | 0 | 0 |
| 4390.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4400.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 4410.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | -4.7619E-08 |
| 4420.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 4430.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4440.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4450.00 | 0 | 1.90476E-07 | -1.42857E-07 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 4460.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4470.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4480.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4490.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 4.7619E-08 |
| 4500.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4510.00 | -4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 4520.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4530.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 4540.00 | 0 | 1.90476E-07 | 0 | -4.7619E-08 |
| 4550.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4560.00 | 0 | 2.38095E-07 | 0 | 0 |
| 4570.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 4580.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 4590.00 | -4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 4600.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4610.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4620.00 | 0 | 2.38095E-07 | -1.42857E-07 | 4.7619E-08 |
| 4630.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 4640.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4650.00 | 9.52381E-08 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 4660.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 4670.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 4680.00 | 0 | 2.85714E-07 | 4.7619E-08 | -4.7619E-08 |
| 4690.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4700.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 4710.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 4720.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4730.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 4740.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4750.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 4760.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4770.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 4780.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 4790.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 4800.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 4810.00 | 0 | 2.38095E-07 | 0 | 0 |
| 4820.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 4830.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 4840.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 4850.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 4860.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 4870.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4880.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -9.52381E-08 |
| 4890.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 4900.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 4910.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 4920.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4930.00 | 0 | 2.38095E-07 | 0 | 0 |
| 4940.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 4950.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 4960.00 | 0 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 4970.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 4980.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 4990.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5000.00 | -4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5010.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 5020.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5030.00 | 0 | 2.85714E-07 | -9.52381E-08 | 4.7619E-08 |
| 5040.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5050.00 | 9.52381E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5060.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 5070.00 | 0 | 2.38095E-07 | -4.7619E-08 | -9.52381E-08 |
| 5080.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5090.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5100.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 5110.00 | 4.7619E-08 | 2.38095E-07 | 0 | -4.7619E-08 |
| 5120.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 5130.00 | 4.7619E-08 | 2.85714E-07 | -4.7619E-08 | 0 |
| 5140.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5150.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5160.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 5170.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5180.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 5190.00 | -4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5200.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5210.00 | 0 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 5220.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 5230.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 5240.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5250.00 | 4.7619E-08 | 2.85714E-07 | -9.52381E-08 | 0 |
| 5260.00 | 0 | 2.38095E-07 | 0 | 0 |
| 5270.00 | -4.7619E-08 | 2.38095E-07 | 0 | 4.7619E-08 |
| 5280.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 5290.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 5300.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5310.00 | 0 | 1.90476E-07 | -9.52381E-08 | 4.7619E-08 |
| 5320.00 | 0 | 1.90476E-07 | 0 | 4.7619E-08 |
| 5330.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5340.00 | -4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5350.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5360.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5370.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 5380.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5390.00 | 0 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 5400.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5410.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5420.00 | 0 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 5430.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 5440.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5450.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 5460.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5470.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | -4.7619E-08 |
| 5480.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5490.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5500.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5510.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 5520.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 5530.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 5540.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 5550.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5560.00 | 0 | 1.90476E-07 | 0 | -4.7619E-08 |
| 5570.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 5580.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 5590.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5600.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5610.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 5620.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5630.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 5640.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5650.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5660.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 5670.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 5680.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 4.7619E-08 |
| 5690.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5700.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5710.00 | 0 | 2.38095E-07 | 0 | 0 |
| 5720.00 | 0 | 2.38095E-07 | -9.52381E-08 | 0 |
| 5730.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5740.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 5750.00 | 0 | 1.90476E-07 | 0 | -4.7619E-08 |
| 5760.00 | 0 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 5770.00 | -4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 5780.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5790.00 | 0 | 2.38095E-07 | 4.7619E-08 | 0 |
| 5800.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5810.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5820.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5830.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 5840.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 5850.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 5860.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 5870.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 5880.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 5890.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5900.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5910.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5920.00 | 4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 5930.00 | 0 | 1.90476E-07 | 0 | 0 |
| 5940.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 5950.00 | 0 | 2.38095E-07 | -4.7619E-08 | 4.7619E-08 |
| 5960.00 | 4.7619E-08 | 2.38095E-07 | 0 | 0 |
| 5970.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 5980.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 5990.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6000.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6010.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6020.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6030.00 | 4.7619E-08 | 2.38095E-07 | -9.52381E-08 | 0 |
| 6040.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6050.00 | 0 | 1.90476E-07 | -9.52381E-08 | 4.7619E-08 |
| 6060.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 6070.00 | -4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 6080.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 6090.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 6100.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6110.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 6120.00 | 0 | 2.38095E-07 | 0 | -4.7619E-08 |
| 6130.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 6140.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 6150.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6160.00 | 9.52381E-08 | 1.90476E-07 | 0 | 0 |
| 6170.00 | 4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 6180.00 | 4.7619E-08 | 1.90476E-07 | -1.42857E-07 | 0 |
| 6190.00 | -4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6200.00 | -4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 6210.00 | 4.7619E-08 | 2.38095E-07 | -4.7619E-08 | -4.7619E-08 |
| 6220.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 6230.00 | 0 | 1.42857E-07 | -9.52381E-08 | 4.7619E-08 |
| 6240.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6250.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6260.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6270.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6280.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6290.00 | 0 | 1.90476E-07 | 0 | -9.52381E-08 |
| 6300.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6310.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 6320.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6330.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 6340.00 | 0 | 1.90476E-07 | 0 | 0 |
| 6350.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 6360.00 | -4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6370.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6380.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6390.00 | 0 | 2.38095E-07 | -4.7619E-08 | 0 |
| 6400.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 6410.00 | 0 | 1.90476E-07 | 0 | 4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 6420.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6430.00 | -4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 6440.00 | 0 | 2.38095E-07 | 0 | 0 |
| 6450.00 | 0 | 1.90476E-07 | 0 | -4.7619E-08 |
| 6460.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |
| 6470.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 6480.00 | 4.7619E-08 | 1.42857E-07 | 0 | 4.7619E-08 |
| 6490.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6500.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6510.00 | 4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 6520.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 6530.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6540.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6550.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6560.00 | 0 | 1.42857E-07 | 4.7619E-08 | -4.7619E-08 |
| 6570.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 6580.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 6590.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6600.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6610.00 | 0 | 1.90476E-07 | -9.52381E-08 | 0 |
| 6620.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6630.00 | -4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 6640.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6650.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6660.00 | 0 | 1.90476E-07 | -1.42857E-07 | -4.7619E-08 |
| 6670.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6680.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 6690.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 6700.00 | 0 | 1.90476E-07 | 0 | 0 |
| 6710.00 | 4.7619E-08 | 9.52381E-08 | -9.52381E-08 | 0 |
| 6720.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 6730.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6740.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6750.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6760.00 | -4.7619E-08 | 1.90476E-07 | -9.52381E-08 | -9.52381E-08 |
| 6770.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 6780.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 6790.00 | 0 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |
| 6800.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 6810.00 | 0 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |
| 6820.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6830.00 | -4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -9.52381E-08 |
| 6840.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6850.00 | -4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 6860.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6870.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 6880.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 6890.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 6900.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6910.00 | 9.52381E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 6920.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 6930.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6940.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 6950.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 6960.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 6970.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 6980.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 6990.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 7000.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 7010.00 | 0 | 1.42857E-07 | -9.52381E-08 | 4.7619E-08 |
| 7020.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 7030.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7040.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 7050.00 | 0 | 9.52381E-08 | -9.52381E-08 | -4.7619E-08 |
| 7060.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7070.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 7080.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7090.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7100.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7110.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7120.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 7130.00 | 4.7619E-08 | 1.42857E-07 | -1.42857E-07 | 0 |
| 7140.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7150.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |
| 7160.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7170.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7180.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7190.00 | 0 | 1.90476E-07 | 0 | 0 |
| 7200.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7210.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7220.00 | 0 | 1.90476E-07 | -9.52381E-08 | -4.7619E-08 |
| 7230.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 7240.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 7250.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 7260.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7270.00 | 0 | 1.42857E-07 | 0 | 0 |
| 7280.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 7290.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7300.00 | 0 | 9.52381E-08 | 0 | 0 |
| 7310.00 | 0 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 7320.00 | 0 | 1.42857E-07 | -9.52381E-08 | -9.52381E-08 |
| 7330.00 | 0 | 9.52381E-08 | -9.52381E-08 | -9.52381E-08 |
| 7340.00 | 4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 7350.00 | 0 | 1.90476E-07 | 0 | 0 |
| 7360.00 | 4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 7370.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7380.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 7390.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 7400.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7410.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7420.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7430.00 | 0 | 1.42857E-07 | 0 | 4.7619E-08 |
| 7440.00 | 0 | 1.90476E-07 | -4.7619E-08 | 0 |
| 7450.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7460.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7470.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7480.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7490.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7500.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7510.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7520.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7530.00 | 9.52381E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 7540.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7550.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 7560.00 | 9.52381E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7570.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7580.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 7590.00 | 0 | 1.42857E-07 | 0 | 0 |
| 7600.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7610.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 7620.00 | 4.7619E-08 | 1.42857E-07 | 0 | 4.7619E-08 |
| 7630.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 7640.00 | 9.52381E-08 | 1.42857E-07 | 4.7619E-08 | 0 |
| 7650.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7660.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 4.7619E-08 |
| 7670.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7680.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7690.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7700.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 7710.00 | 0 | 1.42857E-07 | 0 | 0 |
| 7720.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7730.00 | 0 | 1.42857E-07 | 0 | 0 |
| 7740.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7750.00 | 0 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 7760.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7770.00 | 9.52381E-08 | 9.52381E-08 | -1.42857E-07 | -4.7619E-08 |
| 7780.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7790.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 7800.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7810.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 7820.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7830.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 7840.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7850.00 | 4.7619E-08 | 9.52381E-08 | -9.52381E-08 | -4.7619E-08 |
| 7860.00 | 0 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 7870.00 | 4.7619E-08 | 4.7619E-08 | -9.52381E-08 | 4.7619E-08 |
| 7880.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7890.00 | -4.7619E-08 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |
| 7900.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7910.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7920.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 7930.00 | 0 | 9.52381E-08 | -9.52381E-08 | -4.7619E-08 |
| 7940.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 7950.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 7960.00 | 0 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 7970.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 7980.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 7990.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8000.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8010.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8020.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8030.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 8040.00 | 0 | 4.7619E-08 | -9.52381E-08 | 0 |
| 8050.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8060.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8070.00 | 0 | 9.52381E-08 | -9.52381E-08 | 0 |
| 8080.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8090.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 8100.00 | 0 | 9.52381E-08 | -9.52381E-08 | -4.7619E-08 |
| 8110.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8120.00 | -4.7619E-08 | 1.90476E-07 | -9.52381E-08 | 0 |
| 8130.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8140.00 | 4.7619E-08 | 9.52381E-08 | -9.52381E-08 | -4.7619E-08 |
| 8150.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8160.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 8170.00 | 4.7619E-08 | 9.52381E-08 | -9.52381E-08 | -4.7619E-08 |
| 8180.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8190.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 8200.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 8210.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8220.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8230.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8240.00 | 9.52381E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8250.00 | 0 | 9.52381E-08 | 0 | 4.7619E-08 |
| 8260.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8270.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8280.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8290.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8300.00 | 0 | 9.52381E-08 | 0 | 0 |
| 8310.00 | -4.7619E-08 | 1.90476E-07 | 0 | -4.7619E-08 |
| 8320.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8330.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 8340.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8350.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8360.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8370.00 | 9.52381E-08 | 9.52381E-08 | 0 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 8380.00 | -4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 8390.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8400.00 | 0 | 4.7619E-08 | -4.7619E-08 | 0 |
| 8410.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8420.00 | 0 | 1.42857E-07 | 0 | 4.7619E-08 |
| 8430.00 | 0 | 9.52381E-08 | 0 | 0 |
| 8440.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8450.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 8460.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8470.00 | 4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 8480.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8490.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8500.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8510.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8520.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8530.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8540.00 | 0 | 9.52381E-08 | -9.52381E-08 | 0 |
| 8550.00 | 0 | 1.90476E-07 | 0 | 4.7619E-08 |
| 8560.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 8570.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8580.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 8590.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 8600.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8610.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 8620.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8630.00 | 0 | 1.42857E-07 | 0 | 0 |
| 8640.00 | 0 | 9.52381E-08 | 0 | 0 |
| 8650.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 8660.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8670.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8680.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8690.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 8700.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8710.00 | 4.7619E-08 | 9.52381E-08 | 0 | -9.52381E-08 |
| 8720.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 8730.00 | -4.7619E-08 | 4.7619E-08 | -4.7619E-08 | 0 |
| 8740.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8750.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 8760.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8770.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8780.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8790.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8800.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8810.00 | 0 | 1.42857E-07 | 0 | 0 |
| 8820.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8830.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8840.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8850.00 | 0 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |
| 8860.00 | -4.7619E-08 | 1.42857E-07 | 4.7619E-08 | 0 |
| 8870.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 8880.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 8890.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 8900.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8910.00 | -4.7619E-08 | 1.90476E-07 | 0 | 0 |
| 8920.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8930.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 8940.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 8950.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 8960.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 8970.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 8980.00 | 0 | 1.42857E-07 | 0 | 0 |
| 8990.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9000.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 9010.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 9020.00 | 4.7619E-08 | 4.7619E-08 | 0 | 0 |
| 9030.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 9040.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9050.00 | 0 | 4.7619E-08 | -4.7619E-08 | -4.7619E-08 |
| 9060.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9070.00 | 0 | 4.7619E-08 | -4.7619E-08 | -4.7619E-08 |
| 9080.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9090.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9100.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 9110.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 9120.00 | 0 | 1.42857E-07 | 0 | 4.7619E-08 |
| 9130.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 9140.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9150.00 | 9.52381E-08 | 9.52381E-08 | 0 | 0 |
| 9160.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 9170.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 9180.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 9190.00 | 0 | 9.52381E-08 | 0 | 0 |
| 9200.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 9210.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 9220.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 9230.00 | 4.7619E-08 | 9.52381E-08 | -1.42857E-07 | -4.7619E-08 |
| 9240.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9250.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9260.00 | 0 | 9.52381E-08 | 0 | 0 |
| 9270.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9280.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 9290.00 | 0 | 1.42857E-07 | 0 | 0 |
| 9300.00 | -4.7619E-08 | 9.52381E-08 | 0 | 4.7619E-08 |
| 9310.00 | 0 | 1.42857E-07 | 0 | 0 |
| 9320.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9330.00 | -4.7619E-08 | 1.90476E-07 | -4.7619E-08 | 0 |
| 9340.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 9350.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9360.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 9370.00 | 0 | 9.52381E-08 | 0 | 0 |
| 9380.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9390.00 | -4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 9400.00 | 0 | 1.42857E-07 | 0 | 0 |
| 9410.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9420.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9430.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9440.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 9450.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 9460.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 9470.00 | 0 | 9.52381E-08 | 0 | 4.7619E-08 |
| 9480.00 | 0 | 1.42857E-07 | 0 | 0 |
| 9490.00 | 0 | 1.42857E-07 | 0 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
| --- | --- | --- | --- | --- |
| 9500.00 | 0 | 9.52381E-08 | 0 | 0 |
| 9510.00 | 0 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 9520.00 | 0 | 9.52381E-08 | -9.52381E-08 | 0 |
| 9530.00 | 0 | 1.42857E-07 | 0 | 0 |
| 9540.00 | -4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 9550.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9560.00 | 0 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 9570.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9580.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9590.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9600.00 | 0 | 4.7619E-08 | 0 | 0 |
| 9610.00 | 4.7619E-08 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 9620.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 9630.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 9640.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9650.00 | 4.7619E-08 | 9.52381E-08 | 4.7619E-08 | 0 |
| 9660.00 | 0 | 9.52381E-08 | 0 | 4.7619E-08 |
| 9670.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 9680.00 | 0 | 9.52381E-08 | 0 | 0 |
| 9690.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9700.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 9710.00 | 0 | 1.42857E-07 | 0 | 0 |
| 9720.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9730.00 | -4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9740.00 | 0 | 1.42857E-07 | 0 | 0 |
| 9750.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9760.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9770.00 | 0 | 9.52381E-08 | 0 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 9780.00 | -4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 9790.00 | 4.7619E-08 | 4.7619E-08 | -4.7619E-08 | -4.7619E-08 |
| 9800.00 | 0 | 4.7619E-08 | -4.7619E-08 | 0 |
| 9810.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 9820.00 | 0 | 9.52381E-08 | 0 | 0 |
| 9830.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9840.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9850.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 9860.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 9870.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9880.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 9890.00 | 0 | 4.7619E-08 | -4.7619E-08 | -9.52381E-08 |
| 9900.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9910.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 9920.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9930.00 | 0 | 1.90476E-07 | -4.7619E-08 | -4.7619E-08 |
| 9940.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 9950.00 | 0 | 9.52381E-08 | 0 | 4.7619E-08 |
| 9960.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 9970.00 | 1.42857E-07 | 9.52381E-08 | 0 | -4.7619E-08 |
| 9980.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 9990.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10000.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10010.00 | 0 | 4.7619E-08 | -4.7619E-08 | 0 |
| 10020.00 | 0 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 10030.00 | -4.7619E-08 | 9.52381E-08 | 0 | 4.7619E-08 |
| 10040.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 10050.00 | 0 | 4.7619E-08 | -9.52381E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 10060.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 10070.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 10080.00 | 4.7619E-08 | 4.7619E-08 | -9.52381E-08 | 0 |
| 10090.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10100.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10110.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10120.00 | 0 | 4.7619E-08 | 0 | 4.7619E-08 |
| 10130.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 10140.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10150.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 10160.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10170.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10180.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 10190.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 10200.00 | 4.7619E-08 | 1.42857E-07 | 4.7619E-08 | 4.7619E-08 |
| 10210.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 10220.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10230.00 | 0 | 4.7619E-08 | -4.7619E-08 | 0 |
| 10240.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 10250.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10260.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10270.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10280.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 10290.00 | 4.7619E-08 | 1.42857E-07 | -9.52381E-08 | 0 |
| 10300.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 10310.00 | 4.7619E-08 | 1.42857E-07 | 4.7619E-08 | 0 |
| 10320.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10330.00 | 0 | 4.7619E-08 | -4.7619E-08 | 4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 10340.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 10350.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10360.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10370.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 10380.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 10390.00 | 0 | 1.42857E-07 | 0 | 4.7619E-08 |
| 10400.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 10410.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10420.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10430.00 | 0 | 4.7619E-08 | 0 | -4.7619E-08 |
| 10440.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 10450.00 | 4.7619E-08 | 9.52381E-08 | 4.7619E-08 | 0 |
| 10460.00 | -4.7619E-08 | 9.52381E-08 | 0 | 4.7619E-08 |
| 10470.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10480.00 | 0 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 10490.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10500.00 | 0 | 9.52381E-08 | -9.52381E-08 | 0 |
| 10510.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10520.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 10530.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10540.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10550.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10560.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10570.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 10580.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10590.00 | 0 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 10600.00 | 0 | 4.7619E-08 | 0 | -4.7619E-08 |
| 10610.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 10620.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 10630.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10640.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 10650.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 10660.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 10670.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10680.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10690.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 10700.00 | 0 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 10710.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10720.00 | 4.7619E-08 | 1.42857E-07 | 4.7619E-08 | 0 |
| 10730.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10740.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 10750.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 10760.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10770.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10780.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10790.00 | 4.7619E-08 | 9.52381E-08 | 0 | 4.7619E-08 |
| 10800.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 10810.00 | -4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10820.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 10830.00 | 9.52381E-08 | 4.7619E-08 | -4.7619E-08 | -4.7619E-08 |
| 10840.00 | 0 | 1.42857E-07 | 0 | 0 |
| 10850.00 | 0 | 1.42857E-07 | 0 | 0 |
| 10860.00 | -4.7619E-08 | 4.7619E-08 | -9.52381E-08 | 0 |
| 10870.00 | -4.7619E-08 | 9.52381E-08 | -9.52381E-08 | 0 |
| 10880.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10890.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 10900.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10910.00 | 0 | 1.42857E-07 | 0 | 0 |
| 10920.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 10930.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 10940.00 | 0 | 9.52381E-08 | 0 | 0 |
| 10950.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 10960.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 10970.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 10980.00 | 0 | 1.42857E-07 | 0 | 0 |
| 10990.00 | 0 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |
| 11000.00 | 4.7619E-08 | 4.7619E-08 | -4.7619E-08 | 0 |
| 11010.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11020.00 | 9.52381E-08 | 9.52381E-08 | 0 | 0 |
| 11030.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 11040.00 | 4.7619E-08 | 9.52381E-08 | 4.7619E-08 | -4.7619E-08 |
| 11050.00 | 0 | 9.52381E-08 | 0 | 0 |
| 11060.00 | 0 | 4.7619E-08 | -4.7619E-08 | 0 |
| 11070.00 | 4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 11080.00 | 0 | 9.52381E-08 | 4.7619E-08 | -4.7619E-08 |
| 11090.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11100.00 | 0 | 9.52381E-08 | -4.7619E-08 | 4.7619E-08 |
| 11110.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11120.00 | 0 | 1.42857E-07 | 0 | -4.7619E-08 |
| 11130.00 | 9.52381E-08 | 9.52381E-08 | 0 | 0 |
| 11140.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 11150.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 11160.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 11170.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 11180.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 11190.00 | 0 | 4.7619E-08 | -4.7619E-08 | 0 |
| 11200.00 | 4.7619E-08 | 1.42857E-07 | 0 | 0 |
| 11210.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 11220.00 | 0 | 9.52381E-08 | 0 | 0 |
| 11230.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11240.00 | 0 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 11250.00 | 0 | 1.42857E-07 | -9.52381E-08 | -4.7619E-08 |
| 11260.00 | 4.7619E-08 | 9.52381E-08 | 0 | -4.7619E-08 |
| 11270.00 | 4.7619E-08 | 4.7619E-08 | 0 | -4.7619E-08 |
| 11280.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11290.00 | -4.7619E-08 | 4.7619E-08 | 0 | 0 |
| 11300.00 | 9.52381E-08 | 9.52381E-08 | 0 | 0 |
| 11310.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11320.00 | 0 | 9.52381E-08 | 0 | 4.7619E-08 |
| 11330.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11340.00 | 4.7619E-08 | 4.7619E-08 | 0 | 0 |
| 11350.00 | 0 | 4.7619E-08 | -4.7619E-08 | 0 |
| 11360.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 11370.00 | 4.7619E-08 | 1.42857E-07 | 0 | -4.7619E-08 |
| 11380.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11390.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 4.7619E-08 |
| 11400.00 | 4.7619E-08 | 4.7619E-08 | 4.7619E-08 | 0 |
| 11410.00 | 0 | 9.52381E-08 | 0 | 0 |
| 11420.00 | 0 | 4.7619E-08 | -4.7619E-08 | -4.7619E-08 |
| 11430.00 | 0 | 9.52381E-08 | 0 | -4.7619E-08 |
| 11440.00 | 4.7619E-08 | 1.42857E-07 | -4.7619E-08 | 0 |
| 11450.00 | -4.7619E-08 | 1.42857E-07 | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 11460.00 | -4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11470.00 | 0 | 9.52381E-08 | 0 | 0 |
| 11480.00 | 0 | 1.42857E-07 | -4.7619E-08 | 0 |
| 11490.00 | 0 | 1.42857E-07 | -9.52381E-08 | 0 |
| 11500.00 | 0 | 1.42857E-07 | 4.7619E-08 | 0 |
| 11510.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | -4.7619E-08 |
| 11520.00 | 0 | 4.7619E-08 | -4.7619E-08 | 4.7619E-08 |
| 11530.00 | 0 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11540.00 | 4.7619E-08 | 9.52381E-08 | -4.7619E-08 | 0 |
| 11550.00 | -4.7619E-08 | 9.52381E-08 | 0 | 0 |
| 11560.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 11570.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 11580.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 11590.00 | 4.7619E-08 | | -9.52381E-08 | 0 |
| 11600.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 11610.00 | 0 | | -4.7619E-08 | 4.7619E-08 |
| 11620.00 | 4.7619E-08 | | 4.7619E-08 | -4.7619E-08 |
| 11630.00 | 0 | | 0 | 0 |
| 11640.00 | 0 | | -4.7619E-08 | -9.52381E-08 |
| 11650.00 | 0 | | -9.52381E-08 | 4.7619E-08 |
| 11660.00 | 0 | | 0 | -4.7619E-08 |
| 11670.00 | 0 | | -4.7619E-08 | 0 |
| 11680.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 11690.00 | 0 | | -4.7619E-08 | 0 |
| 11700.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 11710.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 11720.00 | 0 | | 0 | 0 |
| 11730.00 | 9.52381E-08 | | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 11740.00 | 4.7619E-08 | | 0 | 0 |
| 11750.00 | 0 | | -4.7619E-08 | 0 |
| 11760.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 11770.00 | 0 | | 4.7619E-08 | -4.7619E-08 |
| 11780.00 | 4.7619E-08 | | 0 | 0 |
| 11790.00 | 4.7619E-08 | | 4.7619E-08 | 0 |
| 11800.00 | 0 | | 0 | -4.7619E-08 |
| 11810.00 | 4.7619E-08 | | 0 | 0 |
| 11820.00 | -4.7619E-08 | | 0 | -4.7619E-08 |
| 11830.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 11840.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 11850.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 11860.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 11870.00 | 0 | | -4.7619E-08 | 0 |
| 11880.00 | 0 | | 0 | -4.7619E-08 |
| 11890.00 | 4.7619E-08 | | -4.7619E-08 | 4.7619E-08 |
| 11900.00 | 9.52381E-08 | | -4.7619E-08 | -4.7619E-08 |
| 11910.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 11920.00 | 4.7619E-08 | | 0 | 0 |
| 11930.00 | 0 | | 4.7619E-08 | 0 |
| 11940.00 | 4.7619E-08 | | 0 | 0 |
| 11950.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 11960.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 11970.00 | 0 | | 0 | 0 |
| 11980.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 11990.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 12000.00 | 0 | | -4.7619E-08 | 0 |
| 12010.00 | -4.7619E-08 | | 0 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 12020.00 | 0 | | 0 | -4.7619E-08 |
| 12030.00 | 0 | | 0 | 0 |
| 12040.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12050.00 | 0 | | 0 | 0 |
| 12060.00 | 0 | | 0 | 4.7619E-08 |
| 12070.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 12080.00 | 4.7619E-08 | | -4.7619E-08 | 4.7619E-08 |
| 12090.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12100.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12110.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 12120.00 | 0 | | 0 | -4.7619E-08 |
| 12130.00 | 9.52381E-08 | | 0 | 0 |
| 12140.00 | 0 | | 4.7619E-08 | -4.7619E-08 |
| 12150.00 | 0 | | 0 | 0 |
| 12160.00 | 4.7619E-08 | | 4.7619E-08 | 0 |
| 12170.00 | 0 | | 0 | 0 |
| 12180.00 | 0 | | 0 | -4.7619E-08 |
| 12190.00 | 4.7619E-08 | | 4.7619E-08 | 0 |
| 12200.00 | 4.7619E-08 | | 0 | 0 |
| 12210.00 | 0 | | 0 | -4.7619E-08 |
| 12220.00 | 0 | | 0 | 0 |
| 12230.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12240.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12250.00 | 0 | | 0 | 0 |
| 12260.00 | 0 | | -4.7619E-08 | -9.52381E-08 |
| 12270.00 | 0 | | -4.7619E-08 | 0 |
| 12280.00 | 0 | | 4.7619E-08 | -4.7619E-08 |
| 12290.00 | 4.7619E-08 | | 0 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 12300.00 | 0 | | -4.7619E-08 | 0 |
| 12310.00 | 0 | | -9.52381E-08 | -4.7619E-08 |
| 12320.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 12330.00 | 4.7619E-08 | | 0 | 0 |
| 12340.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 12350.00 | 9.52381E-08 | | -9.52381E-08 | 0 |
| 12360.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 12370.00 | 0 | | 0 | 0 |
| 12380.00 | 0 | | 0 | -9.52381E-08 |
| 12390.00 | 0 | | 0 | 0 |
| 12400.00 | 4.7619E-08 | | 0 | 0 |
| 12410.00 | 4.7619E-08 | | 0 | 0 |
| 12420.00 | 0 | | -4.7619E-08 | 4.7619E-08 |
| 12430.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12440.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12450.00 | 4.7619E-08 | | 0 | 0 |
| 12460.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12470.00 | 0 | | 0 | -4.7619E-08 |
| 12480.00 | 0 | | -4.7619E-08 | 0 |
| 12490.00 | 0 | | 0 | -4.7619E-08 |
| 12500.00 | 0 | | 0 | 0 |
| 12510.00 | 0 | | 0 | 0 |
| 12520.00 | 0 | | -1.42857E-07 | -4.7619E-08 |
| 12530.00 | 0 | | 0 | 0 |
| 12540.00 | 0 | | 0 | -4.7619E-08 |
| 12550.00 | 4.7619E-08 | | 0 | 0 |
| 12560.00 | -4.7619E-08 | | 0 | -4.7619E-08 |
| 12570.00 | 0 | | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 12580.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12590.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12600.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12610.00 | 0 | | -4.7619E-08 | 0 |
| 12620.00 | 0 | | 0 | 0 |
| 12630.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12640.00 | 0 | | 0 | -4.7619E-08 |
| 12650.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12660.00 | 0 | | 0 | -4.7619E-08 |
| 12670.00 | 0 | | -4.7619E-08 | 0 |
| 12680.00 | 0 | | -4.7619E-08 | 0 |
| 12690.00 | 0 | | -4.7619E-08 | 0 |
| 12700.00 | 4.7619E-08 | | 0 | 0 |
| 12710.00 | 4.7619E-08 | | -4.7619E-08 | -9.52381E-08 |
| 12720.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12730.00 | 0 | | 4.7619E-08 | 0 |
| 12740.00 | 4.7619E-08 | | 4.7619E-08 | 0 |
| 12750.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 12760.00 | 0 | | -4.7619E-08 | 0 |
| 12770.00 | 0 | | 0 | -4.7619E-08 |
| 12780.00 | 0 | | 4.7619E-08 | 0 |
| 12790.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12800.00 | 0 | | 0 | -4.7619E-08 |
| 12810.00 | 0 | | -4.7619E-08 | -9.52381E-08 |
| 12820.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12830.00 | -4.7619E-08 | | -4.7619E-08 | 4.7619E-08 |
| 12840.00 | -4.7619E-08 | | -9.52381E-08 | -4.7619E-08 |
| 12850.00 | 9.52381E-08 | | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 12860.00 | 0 | | -9.52381E-08 | 0 |
| 12870.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 12880.00 | 9.52381E-08 | | 0 | -4.7619E-08 |
| 12890.00 | 0 | | -4.7619E-08 | 0 |
| 12900.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 12910.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12920.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12930.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12940.00 | -4.7619E-08 | | 0 | 0 |
| 12950.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 12960.00 | 0 | | -4.7619E-08 | -9.52381E-08 |
| 12970.00 | 0 | | 0 | -4.7619E-08 |
| 12980.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 12990.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13000.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13010.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 13020.00 | 0 | | -4.7619E-08 | 0 |
| 13030.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13040.00 | 4.7619E-08 | | 0 | 0 |
| 13050.00 | 0 | | 0 | 0 |
| 13060.00 | 0 | | -4.7619E-08 | 0 |
| 13070.00 | 9.52381E-08 | | 0 | -4.7619E-08 |
| 13080.00 | 0 | | -4.7619E-08 | 0 |
| 13090.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13100.00 | 0 | | 0 | -9.52381E-08 |
| 13110.00 | 0 | | 0 | 0 |
| 13120.00 | 0 | | -4.7619E-08 | -9.52381E-08 |
| 13130.00 | 4.7619E-08 | | -4.7619E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 13140.00 | 0 | | 0 | 0 |
| 13150.00 | 0 | | 0 | 0 |
| 13160.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13170.00 | 4.7619E-08 | | 0 | 0 |
| 13180.00 | 0 | | -4.7619E-08 | 0 |
| 13190.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13200.00 | 0 | | 0 | 4.7619E-08 |
| 13210.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13220.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13230.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13240.00 | 0 | | -4.7619E-08 | 0 |
| 13250.00 | 0 | | -9.52381E-08 | -4.7619E-08 |
| 13260.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13270.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13280.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13290.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13300.00 | 0 | | -4.7619E-08 | 0 |
| 13310.00 | 0 | | 0 | -9.52381E-08 |
| 13320.00 | 0 | | 0 | -4.7619E-08 |
| 13330.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13340.00 | 4.7619E-08 | | 0 | 0 |
| 13350.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13360.00 | 0 | | -4.7619E-08 | 0 |
| 13370.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 13380.00 | 0 | | -4.7619E-08 | 0 |
| 13390.00 | -4.7619E-08 | | 0 | 0 |
| 13400.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13410.00 | 4.7619E-08 | | 0 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 13420.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 13430.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13440.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13450.00 | 0 | | 0 | -9.52381E-08 |
| 13460.00 | 0 | | 0 | 0 |
| 13470.00 | 4.7619E-08 | | 0 | 0 |
| 13480.00 | 0 | | 0 | -4.7619E-08 |
| 13490.00 | 0 | | 0 | 0 |
| 13500.00 | 0 | | 0 | 0 |
| 13510.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13520.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13530.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13540.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13550.00 | 4.7619E-08 | | -9.52381E-08 | -9.52381E-08 |
| 13560.00 | 0 | | 0 | -4.7619E-08 |
| 13570.00 | 4.7619E-08 | | 0 | 0 |
| 13580.00 | 4.7619E-08 | | -9.52381E-08 | 0 |
| 13590.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13600.00 | 0 | | 0 | 0 |
| 13610.00 | 0 | | 0 | 0 |
| 13620.00 | 0 | | 0 | 0 |
| 13630.00 | -4.7619E-08 | | 0 | -4.7619E-08 |
| 13640.00 | 0 | | 0 | 0 |
| 13650.00 | 4.7619E-08 | | 0 | 0 |
| 13660.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 13670.00 | 0 | | 0 | 4.7619E-08 |
| 13680.00 | 0 | | -9.52381E-08 | 4.7619E-08 |
| 13690.00 | 4.7619E-08 | | -9.52381E-08 | 0 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 13700.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 13710.00 | 4.7619E-08 | | 0 | 0 |
| 13720.00 | 4.7619E-08 | | 0 | 0 |
| 13730.00 | -4.7619E-08 | | 0 | 4.7619E-08 |
| 13740.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 13750.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13760.00 | 9.52381E-08 | | -4.7619E-08 | 0 |
| 13770.00 | 0 | | 0 | 0 |
| 13780.00 | 0 | | -4.7619E-08 | 0 |
| 13790.00 | 0 | | 0 | 0 |
| 13800.00 | 0 | | 0 | -4.7619E-08 |
| 13810.00 | 0 | | -9.52381E-08 | -4.7619E-08 |
| 13820.00 | 0 | | 0 | 0 |
| 13830.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13840.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13850.00 | 0 | | -4.7619E-08 | 0 |
| 13860.00 | 4.7619E-08 | | -9.52381E-08 | 0 |
| 13870.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 13880.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 13890.00 | 0 | | 0 | 0 |
| 13900.00 | 0 | | -4.7619E-08 | 0 |
| 13910.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13920.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13930.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 13940.00 | -4.7619E-08 | | 0 | 0 |
| 13950.00 | 9.52381E-08 | | 0 | 0 |
| 13960.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 13970.00 | 0 | | -4.7619E-08 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 13980.00 | 0 | | 0 | 0 |
| 13990.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 14000.00 | -4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 14010.00 | 0 | | 0 | 0 |
| 14020.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 14030.00 | 0 | | -9.52381E-08 | 0 |
| 14040.00 | -4.7619E-08 | | -4.7619E-08 | 0 |
| 14050.00 | 4.7619E-08 | | -4.7619E-08 | -4.7619E-08 |
| 14060.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 14070.00 | 0 | | 0 | -4.7619E-08 |
| 14080.00 | 0 | | -4.7619E-08 | 0 |
| 14090.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 14100.00 | 4.7619E-08 | | 0 | 0 |
| 14110.00 | 4.7619E-08 | | 0 | 0 |
| 14120.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 14130.00 | 4.7619E-08 | | 0 | 0 |
| 14140.00 | 0 | | 0 | 0 |
| 14150.00 | 0 | | -4.7619E-08 | 0 |
| 14160.00 | 0 | | 4.7619E-08 | -4.7619E-08 |
| 14170.00 | 0 | | 0 | -4.7619E-08 |
| 14180.00 | 0 | | 0 | -4.7619E-08 |
| 14190.00 | 4.7619E-08 | | -4.7619E-08 | 0 |
| 14200.00 | -4.7619E-08 | | 4.7619E-08 | -4.7619E-08 |
| 14210.00 | -4.7619E-08 | | 0 | 0 |
| 14220.00 | 0 | | -4.7619E-08 | -4.7619E-08 |
| 14230.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 14240.00 | 0 | | 4.7619E-08 | 0 |
| 14250.00 | 4.7619E-08 | | 0 | -4.7619E-08 |

| Time (minutes) | Strain -one | Strain - two | Strain - seven | Strain - eight |
|---|---|---|---|---|
| 14260.00 | 0 | | 0 | -4.7619E-08 |
| 14270.00 | 0 | | 0 | -4.7619E-08 |
| 14280.00 | 4.7619E-08 | | 0 | 0 |
| 14290.00 | 4.7619E-08 | | -9.52381E-08 | 0 |
| 14300.00 | 0 | | 0 | 0 |
| 14310.00 | 4.7619E-08 | | 0 | -4.7619E-08 |
| 14320.00 | 0 | | 4.7619E-08 | 0 |
| 14330.00 | 0 | | -4.7619E-08 | 0 |
| 14340.00 | 0 | | -4.7619E-08 | 0 |
| 14350.00 | 0 | | | 4.7619E-08 |
| 14360.00 | 0 | | | -4.7619E-08 |
| 14370.00 | 4.7619E-08 | | | 0 |
| 14380.00 | 0 | | | -4.7619E-08 |
| 14390.00 | 0 | | | 0 |

# 9. APPENDIX C:DETAILED HEAT OF HYDRATION DATA

| Time (minutes) | Temperature ($^0$C) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 10 | 23.5 | 22.2 | 23.2 | 23.1 | 22 | 26.4 | | 22.8 |
| 20 | 24.2 | 22.2 | 23.8 | 23.2 | 22.5 | 25.6 | | 22.8 |
| 30 | 24.3 | 22.4 | 23.9 | 23.3 | 22.7 | 25.5 | | 22.8 |
| 40 | 24.5 | 22.5 | 23.9 | 23.3 | 22.9 | 25.2 | | 22.6 |
| 50 | 24.6 | 22.7 | 23.9 | 23.5 | 22.8 | 25.1 | | 22.6 |
| 60 | 24.6 | 22.8 | 24 | 23.5 | 22.8 | 24.9 | | 22.4 |
| 70 | 24.7 | 22.9 | 24 | 23.5 | 22.8 | 24.7 | | 22.4 |
| 80 | 24.7 | 23.1 | 24.1 | 23.5 | 22.8 | 24.6 | | 22.3 |
| 90 | 24.7 | 23.2 | 24.1 | 23.6 | 22.9 | 24.4 | | 22.2 |
| 100 | 24.8 | 23.4 | 24.1 | 23.5 | 22.9 | 24.4 | | 22.1 |
| 110 | 24.8 | 23.5 | 24.1 | 23.6 | 22.9 | 24.2 | | 22.1 |
| 120 | 24.8 | 23.6 | 24.2 | 23.6 | 22.8 | 24.2 | | 22 |
| 130 | 24.8 | 23.7 | 24.1 | 23.6 | 22.8 | 24.1 | | 21.9 |
| 140 | 24.8 | 23.8 | 24.2 | 23.6 | 22.8 | 24 | | 21.9 |
| 150 | 24.8 | 23.9 | 24.2 | 23.6 | 22.8 | 24 | | 21.8 |
| 160 | 24.8 | 24.1 | 24.3 | 23.6 | 22.7 | 23.9 | | 21.7 |
| 170 | 24.8 | 24 | 24.4 | 23.6 | 22.8 | 23.9 | | 21.7 |
| 180 | 24.8 | 24.2 | 24.4 | 23.5 | 22.8 | 23.9 | | 21.7 |
| 190 | 24.8 | 24.2 | 24.5 | 23.6 | 22.8 | 23.8 | | 21.7 |
| 200 | 24.9 | 24.3 | 24.6 | 23.6 | 22.8 | 23.8 | | 21.7 |
| 210 | 25 | 24.5 | 24.6 | 23.6 | 22.8 | 23.8 | | 21.6 |
| 220 | 25 | 24.5 | 24.8 | 23.6 | 22.8 | 23.8 | | 21.6 |
| 230 | 25.1 | 24.5 | 24.8 | 23.7 | 22.8 | 23.7 | | 21.6 |
| 240 | 25.2 | 24.6 | 24.9 | 23.7 | 22.8 | 23.7 | | 21.6 |
| 250 | 25.2 | 24.6 | 25 | 23.8 | 22.9 | 23.7 | | 21.6 |
| 260 | 25.3 | 24.7 | 25 | 23.8 | 22.9 | 23.7 | | 21.6 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 270 | 25.3 | 24.7 | 25.1 | 23.8 | 22.9 | 23.7 | | 21.6 |
| 280 | 25.4 | 24.8 | 25.2 | 23.8 | 22.9 | 23.7 | | 21.7 |
| 290 | 25.5 | 24.8 | 25.2 | 23.8 | 22.9 | 23.7 | | 21.7 |
| 300 | 25.6 | 24.8 | 25.2 | 23.9 | 22.9 | 23.7 | | 21.7 |
| 310 | 25.7 | 24.9 | 25.3 | 23.9 | 23 | 23.7 | | 21.6 |
| 320 | 25.8 | 24.9 | 25.4 | 24 | 23 | 23.7 | | 21.6 |
| 330 | 25.8 | 25 | 25.4 | 24.1 | 23.1 | 23.7 | | 21.7 |
| 340 | 26 | 25 | 25.5 | 24.1 | 23.1 | 23.8 | | 21.7 |
| 350 | 26 | 25 | 25.6 | 24.1 | 23.2 | 23.8 | | 21.7 |
| 360 | 26.2 | 25 | 25.6 | 24.3 | 23 | 23.8 | | 21.7 |
| 370 | 26.2 | 25 | 25.7 | 24.3 | 23.1 | 23.8 | | 21.7 |
| 380 | 26.3 | 25 | 25.8 | 24.5 | 23.1 | 23.9 | | 21.7 |
| 390 | 26.4 | 25.1 | 25.8 | 24.5 | 23.1 | 23.9 | | 21.8 |
| 400 | 26.5 | 25.1 | 25.8 | 24.7 | 23.1 | 23.9 | | 21.8 |
| 410 | 26.6 | 25.1 | 25.9 | 24.7 | 23.1 | 23.9 | | 21.8 |
| 420 | 26.7 | 25.1 | 25.8 | 24.8 | 23.1 | 23.9 | | 21.8 |
| 430 | 26.8 | 25.2 | 25.8 | 24.9 | 23.1 | 24 | | 21.8 |
| 440 | 26.9 | 25.2 | 25.9 | 25 | 23.1 | 24 | | 21.8 |
| 450 | 26.9 | 25.2 | 25.9 | 25.1 | 23.2 | 24.1 | | 21.9 |
| 460 | 27.1 | 25.2 | 25.9 | 25.2 | 23.1 | 24.1 | | 21.9 |
| 470 | 27.1 | 25.2 | 25.9 | 25.2 | 23.1 | 24.1 | | 22 |
| 480 | 27.2 | 25.1 | 26 | 25.3 | 23.1 | 24.1 | | 22.1 |
| 490 | 27.3 | 25.1 | 26 | 25.3 | 23 | 24.1 | | 22.1 |
| 500 | 27.4 | 25.1 | 26 | 25.4 | 23 | 24.1 | | 22.1 |
| 510 | 27.5 | 25.1 | 26 | 25.5 | | 24.1 | | 22.1 |
| 520 | 27.5 | 25.1 | 26 | 25.5 | | 24.1 | | 22.1 |
| 530 | 27.6 | 25.1 | 26 | 25.6 | | 24.2 | | 22.1 |
| 540 | 27.7 | 25.1 | 25.9 | 25.7 | | 24.2 | | 22.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 550 | 27.7 | 25.1 | 25.9 | 25.7 | | 24.2 | | 22.2 |
| 560 | 27.7 | 25.1 | 25.9 | 25.7 | | 24.2 | | 22.2 |
| 570 | 27.8 | 25.1 | 25.9 | 25.8 | | 24.2 | | 22.2 |
| 580 | 27.8 | 25.1 | 25.9 | 25.8 | | 24.2 | | 22.3 |
| 590 | 27.8 | 25.1 | 25.9 | 25.8 | | 24.2 | | 22.3 |
| 600 | 27.9 | 25.1 | 25.9 | 25.8 | | 24.2 | | 22.3 |
| 610 | 28 | 25.1 | 25.9 | 25.9 | | 24.2 | | 22.3 |
| 620 | 28 | 25.1 | 25.9 | 25.9 | | 24.2 | | 22.3 |
| 630 | 28 | 25.1 | 25.9 | 26 | | 24.2 | | 22.3 |
| 640 | 28 | 25.1 | 25.9 | 26 | | 24.2 | | 22.3 |
| 650 | 28 | 25.1 | 25.9 | 26 | | 24.2 | | 22.3 |
| 660 | 28.1 | 25.1 | 25.8 | 26 | | 24.2 | | 22.3 |
| 670 | 28.1 | 25.1 | 25.8 | 26 | | 24.2 | | 22.3 |
| 680 | 28.1 | 25.1 | 25.8 | 26 | | 24.3 | | 22.3 |
| 690 | 28.1 | 25.1 | 25.8 | 26 | | 24.2 | | 22.3 |
| 700 | 28.1 | 25.1 | 25.8 | 26 | | 24.3 | | 22.4 |
| 710 | 28.1 | 25 | 25.6 | 26 | | 24.2 | | 22.4 |
| 720 | 28.1 | 25 | 25.6 | 26 | | 24.2 | | 22.4 |
| 730 | 28.1 | 25 | 25.6 | 26 | | 24.2 | | 22.4 |
| 740 | 28.1 | 25 | 25.6 | 26 | | 24.2 | | 22.5 |
| 750 | 28.1 | 25 | 25.6 | 26 | | 24.2 | | 22.5 |
| 760 | 28.1 | 25 | 25.6 | 26 | | 24.2 | | 22.5 |
| 770 | 28.1 | 25 | 25.6 | 26 | | 24.2 | | 22.5 |
| 780 | 28.1 | 25 | 25.6 | 25.9 | | 24.2 | | 22.5 |
| 790 | 28.1 | 25 | 25.5 | 25.9 | | 24.2 | | 22.5 |
| 800 | 28 | 25 | 25.5 | 25.9 | | 24.2 | | 22.5 |
| 810 | 28 | 25 | 25.5 | 25.9 | | 24.2 | | 22.5 |
| 820 | 28 | 25 | 25.5 | 25.9 | | 24.2 | | 22.5 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 830 | 28 | 25 | 25.5 | 25.9 | | 24.2 | | 22.5 |
| 840 | 28 | 25 | 25.5 | 25.8 | | 24.2 | | 22.5 |
| 850 | 28 | 25 | 25.5 | 25.8 | | 24.2 | | 22.5 |
| 860 | 27.9 | 25 | 25.5 | 25.8 | | 24.2 | | 22.5 |
| 870 | 27.9 | 25 | 25.4 | 25.8 | | 24.2 | | 22.5 |
| 880 | 27.9 | 25 | 25.4 | 25.8 | | 24.2 | | 22.5 |
| 890 | 27.9 | 25 | 25.4 | 25.8 | | 24.2 | | 22.5 |
| 900 | 27.9 | 24.9 | 25.4 | 25.8 | | 24.2 | | 22.6 |
| 910 | 27.9 | 24.9 | 25.3 | 25.7 | | 24.2 | | 22.5 |
| 920 | 27.9 | 24.9 | 25.2 | 25.7 | | 24.2 | | 22.6 |
| 930 | 27.8 | 24.9 | 25.2 | 25.7 | | 24.2 | | 22.6 |
| 940 | 27.8 | 24.9 | 25.2 | 25.7 | | 24.1 | | 22.6 |
| 950 | 27.8 | 24.8 | 25.2 | 25.7 | | 24.1 | | 22.6 |
| 960 | 27.8 | 24.8 | 25.2 | 25.7 | | 24.1 | | 22.5 |
| 970 | 27.8 | 24.9 | 25.2 | 25.7 | | 24.1 | | 22.5 |
| 980 | 27.8 | 24.8 | 25.2 | 25.7 | | 24 | | 22.6 |
| 990 | 27.8 | 24.8 | 25.2 | 25.7 | | 24 | | 22.6 |
| 1000 | 27.9 | 24.7 | 25.2 | 25.7 | | 23.9 | | 22.6 |
| 1010 | 27.9 | 24.7 | 25.2 | 25.7 | | 23.9 | | 22.6 |
| 1020 | 27.9 | 24.7 | 25.2 | 25.7 | | 23.9 | | 22.6 |
| 1030 | 28 | 24.7 | 25.2 | 25.7 | | 23.9 | | 22.5 |
| 1040 | 28 | 24.7 | 25.2 | 25.7 | | 23.9 | | 22.6 |
| 1050 | 28 | 24.7 | 25.2 | 25.7 | | 23.9 | | 22.5 |
| 1060 | 28.1 | 24.8 | 25.2 | 25.7 | | 23.9 | | 22.5 |
| 1070 | 28.2 | 24.8 | 25.2 | 25.7 | | 23.9 | | 22.5 |
| 1080 | 28.2 | 24.7 | 25.2 | 25.7 | | 23.9 | | 22.5 |
| 1090 | 28.3 | 24.7 | 25.2 | 25.6 | | 23.9 | | 22.5 |
| 1100 | 28.4 | 24.7 | 25.1 | 25.6 | | 23.9 | | 22.4 |

| Time (minutes) | Temperature ($^0$C) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 1110 | 28.5 | 24.7 | 25.1 | 25.6 | | 23.9 | | 22.4 |
| 1120 | 28.6 | 24.7 | 25.1 | 25.7 | | 23.9 | | 22.4 |
| 1130 | 28.7 | 24.7 | 25.1 | 25.7 | | 23.9 | | 22.4 |
| 1140 | 28.9 | 24.7 | 25.1 | 25.7 | | 23.9 | | 22.4 |
| 1150 | 29.1 | 24.6 | 25.1 | 25.7 | | 23.9 | | 22.4 |
| 1160 | 29.2 | 24.7 | 25.1 | 25.7 | | 23.8 | | 22.4 |
| 1170 | 29.3 | 24.7 | 25.1 | 25.7 | | 23.8 | | 22.4 |
| 1180 | 29.5 | 24.7 | 25.1 | 25.8 | | 23.8 | | 22.4 |
| 1190 | 29.6 | 24.6 | 25.2 | 25.8 | | 23.8 | | 22.4 |
| 1200 | 29.6 | 24.6 | 25.2 | 25.8 | | 23.8 | | 22.5 |
| 1210 | 29.6 | 24.6 | 25.2 | 25.8 | | 23.7 | | 22.4 |
| 1220 | 29.7 | 24.6 | 25.3 | 25.8 | | 23.8 | | 22.4 |
| 1230 | 29.6 | 24.6 | 25.3 | 25.8 | | 23.8 | | 22.3 |
| 1240 | 29.5 | 24.6 | 25.3 | 25.9 | | 23.8 | | 22.4 |
| 1250 | 29.6 | 24.7 | 25.3 | 25.9 | | 23.8 | | 22.4 |
| 1260 | 29.5 | 24.8 | 25.3 | 25.8 | | 23.8 | | 22.3 |
| 1270 | 29.4 | 24.7 | 25.4 | 25.8 | | 23.8 | | 22.3 |
| 1280 | 29.2 | 24.7 | 25.4 | 25.8 | | 23.8 | | 22.3 |
| 1290 | 29.2 | 24.7 | 25.3 | 25.8 | | 23.8 | | 22.2 |
| 1300 | 29 | 24.8 | 25.4 | 25.8 | | 23.8 | | 22.2 |
| 1310 | 28.8 | 24.8 | 25.4 | 25.8 | | 23.8 | | 22.2 |
| 1320 | 28.7 | 24.8 | 25.4 | 25.8 | | 23.8 | | 22.2 |
| 1330 | 28.7 | 24.8 | 25.5 | 25.8 | | 23.8 | | 22.2 |
| 1340 | 28.6 | 24.8 | 25.5 | 25.7 | | 23.9 | | 22.2 |
| 1350 | 28.4 | 24.8 | 25.5 | 25.7 | | 23.9 | | 22.2 |
| 1360 | 28.3 | 24.9 | 25.5 | 25.7 | | 23.8 | | 22.2 |
| 1370 | 28.1 | 24.9 | 25.6 | 25.8 | | 23.8 | | 22.1 |
| 1380 | 28.1 | 24.9 | 25.6 | 25.7 | | 23.9 | | 22.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 1390 | 27.9 | 25 | 25.6 | 25.7 | | 23.9 | | 22 |
| 1400 | 27.8 | 25 | 25.7 | 25.6 | | 24 | | 22.1 |
| 1410 | 27.7 | 25.1 | 25.7 | 25.6 | | 24 | | 22.1 |
| 1420 | 27.6 | 25.1 | 25.6 | 25.6 | | 23.9 | | 22.1 |
| 1430 | 27.5 | 25.1 | 25.6 | 25.5 | | 23.7 | | 22.5 |
| 1440 | 27.4 | 25.1 | 25.6 | 25.4 | | 23.5 | | 22.9 |
| 1450 | 27.4 | 25.1 | 25.6 | 25.4 | | 23.4 | | 23.1 |
| 1460 | 27.2 | 25.1 | 25.6 | 25.4 | | 23.3 | | 23.2 |
| 1470 | 27.3 | 25.2 | 25.6 | 25.4 | | 23.3 | 21.5 | 23 |
| 1480 | 27.1 | 25.2 | 25.5 | 25.5 | | 23.2 | 20.8 | 23 |
| 1490 | 27.1 | 25.3 | 25.6 | 25.4 | | 23.2 | 20.3 | 22.9 |
| 1500 | 27 | 25.3 | 25.6 | 25.3 | | 23 | 20.2 | 22.8 |
| 1510 | 26.9 | 25.4 | 25.5 | 25.3 | | 23 | 20.2 | 22.6 |
| 1520 | 27 | 25.5 | 25.5 | 25.3 | | 23 | 20.1 | 22.6 |
| 1530 | 26.9 | 25.5 | 25.4 | 25.3 | | 22.9 | 20.1 | 22.4 |
| 1540 | 26.9 | 25.6 | 25.4 | 25.3 | | 22.9 | 20.1 | 22.3 |
| 1550 | 26.8 | 25.6 | 25.4 | 25.3 | | 22.9 | 20.1 | 22.2 |
| 1560 | 26.7 | 25.7 | 25.4 | 25.1 | | 22.9 | 20.1 | 22.1 |
| 1570 | 26.7 | 25.7 | 25.4 | 25.1 | | 22.9 | 20.1 | 21.9 |
| 1580 | 26.7 | 25.8 | 25.3 | 25.1 | | 22.9 | 20.1 | 21.8 |
| 1590 | 26.6 | 25.9 | 25.4 | 25.1 | | 22.8 | 20.1 | 21.8 |
| 1600 | 26.5 | 25.9 | 25.3 | 25 | | 22.8 | 20.1 | 21.7 |
| 1610 | 26.5 | 26 | 25.4 | 25 | | 22.8 | 20.1 | 21.6 |
| 1620 | 26.5 | 26.1 | 25.3 | 25 | | 22.8 | 20.1 | 21.5 |
| 1630 | 26.5 | 26.1 | 25.3 | 25 | | 22.7 | 20.3 | 21.4 |
| 1640 | 26.4 | 26.2 | 25.2 | 24.9 | | 22.7 | 20.3 | 21.4 |
| 1650 | 26.4 | 26.3 | 25.3 | 24.9 | | 22.7 | 20.3 | 21.3 |
| 1660 | 26.3 | 26.3 | 25.3 | 24.9 | | 22.7 | 20.2 | 21.2 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 1670 | 26.3 | 26.3 | 25.3 | 24.9 | | 22.7 | 20.2 | 21.2 |
| 1680 | 26.3 | 26.4 | 25.3 | 24.8 | | 22.7 | 20.3 | 21.2 |
| 1690 | 26.3 | 26.4 | 25.3 | 24.8 | | 22.6 | 20.3 | 21.2 |
| 1700 | 26.3 | 26.5 | 25.3 | 24.8 | | 22.6 | 20.3 | 21.1 |
| 1710 | 26.3 | 26.5 | 25.3 | 24.7 | | 22.6 | 20.3 | 21.1 |
| 1720 | 26.2 | 26.5 | 25.3 | 24.7 | | 22.6 | 20.3 | 21 |
| 1730 | 26.2 | 26.5 | 25.3 | 24.7 | | 22.6 | 20.3 | 21 |
| 1740 | 26.2 | 26.5 | 25.3 | 24.7 | | 22.6 | 20.3 | 21 |
| 1750 | 26.2 | 26.5 | 25.2 | 24.7 | | 22.6 | 20.3 | 21 |
| 1760 | 26.2 | 26.5 | 25.2 | 24.7 | | 22.6 | 20.4 | 20.9 |
| 1770 | 26.1 | 26.4 | 25.2 | 24.7 | | 22.6 | 20.4 | 20.9 |
| 1780 | 26 | 26.4 | 25.2 | 24.7 | | 22.6 | 20.4 | 20.8 |
| 1790 | 26 | 26.3 | 25.2 | 24.7 | | 22.5 | 20.5 | 20.8 |
| 1800 | 26 | 26.3 | 25.2 | 24.6 | | 22.5 | 20.5 | 20.8 |
| 1810 | 26 | 26.3 | 25.2 | 24.6 | | 22.5 | 20.5 | 20.7 |
| 1820 | 26 | 26.2 | 25.1 | 24.6 | | 22.5 | 20.5 | 20.6 |
| 1830 | 26 | 26.1 | 25.1 | 24.5 | | 22.5 | 20.5 | 20.6 |
| 1840 | 26 | 26 | 25.1 | 24.5 | | 22.5 | 20.4 | 20.6 |
| 1850 | 26 | 26 | 25.1 | 24.5 | | 22.5 | 20.4 | 20.6 |
| 1860 | 25.9 | 26 | 25 | 24.5 | | 22.5 | 20.5 | 20.6 |
| 1870 | 25.9 | 25.9 | 25 | 24.5 | | 22.4 | 20.5 | 20.6 |
| 1880 | 25.9 | 25.8 | 25 | 24.5 | | 22.4 | 20.5 | 20.6 |
| 1890 | 25.8 | 25.8 | 25.1 | 24.5 | | 22.4 | 20.5 | 20.6 |
| 1900 | 25.7 | 25.8 | 25.1 | 24.5 | | 22.4 | 20.5 | 20.6 |
| 1910 | 25.7 | 25.7 | 25 | 24.5 | | 22.4 | 20.5 | 20.6 |
| 1920 | 25.7 | 25.7 | 25 | 24.5 | | 22.4 | 20.6 | 20.6 |
| 1930 | 25.7 | 25.6 | 24.9 | 24.5 | | 22.4 | 20.6 | 20.7 |
| 1940 | 25.7 | 25.5 | 24.9 | 24.5 | | 22.4 | 20.6 | 20.7 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 1950 | 25.7 | 25.5 | 24.9 | 24.4 | | 22.4 | 20.6 | 20.6 |
| 1960 | 25.7 | 25.4 | 24.9 | 24.4 | | 22.4 | 20.6 | 20.7 |
| 1970 | 25.6 | 25.4 | 24.9 | 24.4 | | 22.4 | 20.6 | 20.7 |
| 1980 | 25.6 | 25.4 | 24.9 | 24.4 | | 22.4 | 20.6 | 20.7 |
| 1990 | 25.6 | 25.4 | 24.9 | 24.4 | | 22.4 | 20.6 | 20.7 |
| 2000 | 25.6 | 25.3 | 24.8 | 24.4 | | 22.3 | 20.6 | 20.7 |
| 2010 | 25.6 | 25.3 | 24.8 | 24.4 | | 22.3 | 20.6 | 20.7 |
| 2020 | 25.6 | 25.2 | 24.8 | 24.4 | | 22.3 | 20.6 | 20.7 |
| 2030 | 25.6 | 25.2 | 24.8 | 24.4 | | 22.2 | 20.6 | 20.8 |
| 2040 | 25.6 | 25.2 | 24.8 | 24.4 | | 22.2 | 20.6 | 20.8 |
| 2050 | 25.6 | 25.1 | 24.8 | 24.3 | | 22.2 | 20.6 | 20.8 |
| 2060 | 25.6 | 25.1 | 24.8 | 24.3 | | 22.2 | 20.6 | 20.8 |
| 2070 | 25.5 | 25 | 24.8 | 24.3 | | 22.2 | 20.5 | 20.8 |
| 2080 | 25.4 | 25 | 24.8 | 24.3 | | 22.2 | 20.5 | 20.8 |
| 2090 | 25.4 | 25 | 24.8 | 24.3 | | 22.1 | 20.5 | 20.7 |
| 2100 | 25.4 | 24.9 | 24.7 | 24.3 | | 22.1 | 20.5 | 20.7 |
| 2110 | 25.4 | 24.9 | 24.7 | 24.3 | | 22.1 | 20.6 | 20.7 |
| 2120 | 25.3 | 24.9 | 24.7 | 24.3 | | 22.1 | 20.6 | 20.7 |
| 2130 | 25.3 | 24.9 | 24.7 | 24.3 | | 22.1 | 20.6 | 20.7 |
| 2140 | 25.3 | 24.9 | 24.6 | 24.3 | | 22.1 | 20.6 | 20.7 |
| 2150 | 25.3 | 24.9 | 24.6 | 24.3 | | 22.1 | 20.6 | 20.7 |
| 2160 | 25.3 | 24.9 | 24.6 | 24.3 | | 22.1 | 20.6 | 20.6 |
| 2170 | 25.3 | 24.9 | 24.6 | 24.3 | | 22.1 | 20.6 | 20.5 |
| 2180 | 25.3 | 24.7 | 24.6 | 24.3 | | 22.1 | 20.6 | 20.5 |
| 2190 | 25.3 | 24.7 | 24.6 | 24.3 | | 22.1 | 20.6 | 20.4 |
| 2200 | 25.3 | 24.7 | 24.6 | 24.3 | | 22.1 | 20.6 | 20.4 |
| 2210 | 25.3 | 24.7 | 24.6 | 24.3 | | 22.1 | 20.7 | 20.4 |
| 2220 | 25.3 | 24.7 | 24.6 | 24.3 | | 22 | 20.7 | 20.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 2230 | 25.3 | 24.7 | 24.6 | 24.3 | | 22 | 20.7 | 20.4 |
| 2240 | 25.2 | 24.6 | 24.6 | 24.3 | | 22 | 20.7 | 20.4 |
| 2250 | 25.2 | 24.6 | 24.6 | 24.3 | | 22 | 20.7 | 20.4 |
| 2260 | 25.2 | 24.6 | 24.6 | 24.3 | | 22 | 20.7 | 20.3 |
| 2270 | 25.2 | 24.6 | 24.6 | 24.3 | | 22 | 20.7 | 20.3 |
| 2280 | 25.2 | 24.6 | 24.6 | 24.3 | | 22 | 20.7 | 20.3 |
| 2290 | 25.2 | 24.6 | 24.6 | 24.3 | | 22 | 20.7 | 20.2 |
| 2300 | 25.2 | 24.6 | 24.5 | 24.2 | | 22 | 20.7 | 20.2 |
| 2310 | 25.1 | 24.6 | 24.4 | 24.2 | | 22 | 20.7 | 20.2 |
| 2320 | 25 | 24.6 | 24.4 | 24.2 | | 22 | 20.7 | 20.2 |
| 2330 | 25 | 24.6 | 24.4 | 24.3 | | 22 | 20.7 | 20.2 |
| 2340 | 25 | 24.5 | 24.4 | 24.3 | | 22 | 20.7 | 20.1 |
| 2350 | 25 | 24.5 | 24.4 | 24.2 | | 22 | 20.7 | 20.1 |
| 2360 | 25 | 24.5 | 24.4 | 24.2 | | 22 | 20.7 | 20.1 |
| 2370 | 25 | 24.5 | 24.4 | 24.2 | | 22 | 20.7 | 20.1 |
| 2380 | 25 | 24.5 | 24.4 | 24.2 | | 22 | 20.7 | 20 |
| 2390 | 25 | 24.5 | 24.4 | 24.2 | | 22 | 20.8 | 20 |
| 2400 | 25 | 24.5 | 24.4 | 24.2 | | 22 | 20.8 | 20 |
| 2410 | 25 | 24.4 | 24.4 | 24.2 | | 22 | 20.8 | 20 |
| 2420 | 25 | 24.4 | 24.4 | 24.1 | | 22 | 20.8 | 20 |
| 2430 | 25 | 24.4 | 24.3 | 24.2 | | 22 | 20.8 | 20 |
| 2440 | 25 | 24.4 | 24.3 | 24.1 | | 22 | 20.8 | 20 |
| 2450 | 25 | 24.4 | 24.3 | 24.2 | | 22 | 20.8 | 20 |
| 2460 | 24.9 | 24.4 | 24.3 | 24.1 | | 21.9 | 20.7 | 20 |
| 2470 | 24.9 | 24.4 | 24.3 | 24.1 | | 21.9 | 20.7 | 20 |
| 2480 | 24.9 | 24.4 | 24.3 | 24.1 | | 21.9 | 20.7 | 19.9 |
| 2490 | 24.9 | 24.4 | 24.3 | 24.1 | | 21.9 | 20.7 | 19.8 |
| 2500 | 24.9 | 24.4 | 24.3 | 24.1 | | 21.9 | 20.7 | 19.8 |

| Time (minutes) | Temperature ($^0$C) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 2510 | 24.9 | 24.4 | 24.3 | 24.1 | | 21.9 | 20.7 | 19.8 |
| 2520 | 24.9 | 24.3 | 24.3 | 24 | | 21.9 | 20.7 | 19.8 |
| 2530 | 24.9 | 24.3 | 24.2 | 24.1 | | 21.9 | 20.7 | 19.8 |
| 2540 | 24.9 | 24.3 | 24.2 | 24 | | 21.9 | 20.7 | 19.8 |
| 2550 | 24.8 | 24.3 | 24.2 | 24 | | 21.9 | 20.7 | 19.7 |
| 2560 | 24.8 | 24.3 | 24.2 | 24 | | 21.9 | 20.7 | 19.7 |
| 2570 | 24.8 | 24.3 | 24.2 | 24.1 | | 21.9 | 20.7 | 19.7 |
| 2580 | 24.7 | 24.3 | 24.2 | 24 | | 21.9 | 20.7 | 19.7 |
| 2590 | 24.7 | 24.3 | 24.2 | 24 | | 21.9 | 20.7 | 19.7 |
| 2600 | 24.7 | 24.3 | 24.2 | 24 | | 21.9 | 20.7 | 19.7 |
| 2610 | 24.7 | 24.3 | 24.2 | 24 | | 21.8 | 20.7 | 19.7 |
| 2620 | 24.7 | 24.3 | 24.2 | 24 | | 21.9 | 20.8 | 19.7 |
| 2630 | 24.7 | 24.3 | 24.2 | 24 | | 21.9 | 20.8 | 19.7 |
| 2640 | 24.7 | 24.3 | 24.2 | 24 | | 21.9 | 20.8 | 19.7 |
| 2650 | 24.7 | 24.3 | 24.2 | 24 | | 21.8 | 20.8 | 19.7 |
| 2660 | 24.7 | 24.3 | 24.2 | 24 | | 21.8 | 20.8 | 19.7 |
| 2670 | 24.7 | 24.3 | 24.2 | 24 | | 21.8 | 20.8 | 19.7 |
| 2680 | 24.7 | 24.3 | 24.2 | 24 | | 21.8 | 20.8 | 19.7 |
| 2690 | 24.7 | 24.2 | 24.2 | 24 | | 21.7 | 20.8 | 19.7 |
| 2700 | 24.7 | 24.3 | 24.1 | 24 | | 21.7 | 20.8 | 19.7 |
| 2710 | 24.7 | 24.3 | 24.1 | 24 | | 21.8 | 20.8 | 19.6 |
| 2720 | 24.7 | 24.3 | 24.2 | 24 | | 21.8 | 20.8 | 19.6 |
| 2730 | 24.6 | 24.3 | 24.2 | 24 | | 21.8 | 20.8 | 19.6 |
| 2740 | 24.6 | 24.3 | 24.1 | 24 | | 21.8 | 20.7 | 19.5 |
| 2750 | 24.6 | 24.3 | 24.2 | 24 | | 21.8 | 20.7 | 19.6 |
| 2760 | 24.7 | 24.3 | 24.2 | 24 | | 21.7 | 20.7 | 19.6 |
| 2770 | 24.6 | 24.4 | 24.2 | 24 | | 21.7 | 20.7 | 19.6 |
| 2780 | 24.6 | 24.4 | 24.2 | 24 | | 21.7 | 20.7 | 19.6 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 2790 | 24.6 | 24.4 | 24.2 | 24 | | 21.7 | 20.7 | 19.6 |
| 2800 | 24.7 | 24.4 | 24.3 | 24 | | 21.7 | 20.7 | 19.6 |
| 2810 | 24.7 | 24.4 | 24.3 | 23.9 | | 21.7 | 20.7 | 19.6 |
| 2820 | 24.7 | 24.4 | 24.2 | 23.9 | | 21.7 | 20.7 | 19.6 |
| 2830 | 24.6 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.7 | 19.6 |
| 2840 | 24.6 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.7 | 19.6 |
| 2850 | 23.4 | 24.6 | 24.3 | 23.9 | | 21.7 | 20.7 | 19.6 |
| 2860 | 23.7 | 24.5 | 24.4 | 23.9 | | 21.7 | 20.7 | 19.7 |
| 2870 | 23.6 | 24.5 | 24.4 | 23.9 | | 21.7 | 20.6 | 19.7 |
| 2880 | 23.5 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.6 | 19.7 |
| 2890 | 23.5 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.7 | 19.8 |
| 2900 | 23.5 | 24.4 | 24.3 | 23.9 | | 21.7 | 20.7 | 19.8 |
| 2910 | 23.5 | 24.4 | 24.2 | 23.9 | | 21.7 | 20.7 | 19.8 |
| 2920 | 23.5 | 24.5 | 24.2 | 23.9 | | 21.7 | 20.7 | 19.8 |
| 2930 | 23.5 | 24.5 | 24.3 | 23.9 | | 21.8 | 20.7 | 19.8 |
| 2940 | 23.5 | 24.5 | 24.2 | 23.9 | | 21.8 | 20.7 | 19.8 |
| 2950 | 23.5 | 24.5 | 24.2 | 23.9 | | 21.8 | 20.6 | 19.8 |
| 2960 | 23.5 | 24.4 | 24.2 | 23.9 | | 21.8 | 20.6 | 19.8 |
| 2970 | 23.6 | 24.4 | 24.3 | 23.9 | | 21.8 | 20.6 | 19.8 |
| 2980 | 23.5 | 24.5 | 24.3 | 23.9 | | 21.8 | 20.6 | 19.9 |
| 2990 | 23.6 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.5 | 19.9 |
| 3000 | 23.6 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.5 | 19.9 |
| 3010 | 23.6 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.6 | 19.9 |
| 3020 | 23.6 | 24.5 | 24.4 | 23.9 | | 21.7 | 20.6 | 19.9 |
| 3030 | 23.6 | 24.5 | 24.3 | 23.9 | | 21.7 | 20.6 | 19.9 |
| 3040 | 23.6 | 24.5 | 24.4 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3050 | 23.6 | 24.5 | 24.4 | 23.8 | | 21.8 | 20.6 | 19.9 |
| 3060 | 23.6 | 24.5 | 24.4 | 23.8 | | 21.8 | 20.6 | 19.9 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 3070 | 23.6 | 24.4 | 24.4 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3080 | 23.6 | 24.5 | 24.4 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3090 | 23.6 | 24.5 | 24.5 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3100 | 23.6 | 24.5 | 24.4 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3110 | 23.6 | 24.4 | 24.4 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3120 | 23.6 | 24.5 | 24.4 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3130 | 23.6 | 24.4 | 24.4 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3140 | 23.6 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.6 | 19.9 |
| 3150 | 23.6 | 24.4 | 24.5 | 23.8 | | 21.7 | 20.6 | 19.9 |
| 3160 | 23.6 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 19.9 |
| 3170 | 23.6 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 19.9 |
| 3180 | 23.7 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 19.9 |
| 3190 | 23.7 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 19.9 |
| 3200 | 23.7 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 19.9 |
| 3210 | 23.7 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 20 |
| 3220 | 23.7 | 24.4 | 24.4 | 23.9 | | 21.6 | 20.5 | 20 |
| 3230 | 23.8 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 20 |
| 3240 | 23.7 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 20 |
| 3250 | 23.7 | 24.4 | 24.4 | 23.8 | | 21.6 | 20.5 | 19.9 |
| 3260 | 23.7 | 24.4 | 24.3 | 23.9 | | 21.5 | 20.5 | 19.9 |
| 3270 | 23.7 | 24.4 | 24.4 | 23.8 | | 21.5 | 20.5 | 19.9 |
| 3280 | 23.7 | 24.3 | 24.3 | 23.9 | | 21.5 | 20.5 | 20 |
| 3290 | 23.7 | 24.3 | 24.3 | 23.9 | | 21.5 | 20.5 | 20 |
| 3300 | 23.8 | 24.4 | 24.3 | 23.9 | | 21.5 | 20.5 | 20 |
| 3310 | 23.8 | 24.3 | 24.3 | 23.9 | | 21.5 | 20.5 | 20 |
| 3320 | 23.7 | 24.4 | 24.3 | 23.9 | | 21.5 | 20.5 | 20 |
| 3330 | 23.7 | 24.4 | 24.2 | 23.9 | | 21.5 | 20.5 | 20 |
| 3340 | 23.7 | 24.4 | 24.2 | 23.9 | | 21.5 | 20.5 | 20 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 3350 | 23.7 | 24.3 | 24.2 | 23.9 | | 21.5 | 20.5 | 20 |
| 3360 | 23.7 | 24.3 | 24.2 | 23.8 | | 21.5 | 20.5 | 20 |
| 3370 | 23.7 | 24.3 | 24.2 | 23.9 | | 21.5 | 20.5 | 20 |
| 3380 | 23.7 | 24.3 | 24.2 | 23.8 | | 21.5 | 20.5 | 20 |
| 3390 | 23.7 | 24.3 | 24.2 | 23.8 | | 21.5 | 20.4 | 19.9 |
| 3400 | 23.7 | 24.2 | 24.2 | 23.8 | | 21.5 | 20.4 | 19.9 |
| 3410 | 23.7 | 24.2 | 24.2 | 23.8 | | 21.5 | 20.4 | 19.9 |
| 3420 | 23.7 | 24.2 | 24.2 | 23.9 | | 21.5 | 20.4 | 19.9 |
| 3430 | 23.7 | 24.3 | 24.2 | 23.9 | | 21.5 | 20.4 | 19.9 |
| 3440 | 23.7 | 24.2 | 24.2 | 23.8 | | 21.5 | 20.4 | 19.9 |
| 3450 | 23.7 | 24.2 | 24.2 | 23.8 | | 21.5 | 20.4 | 19.9 |
| 3460 | 23.7 | 24.2 | 24.1 | 23.8 | | 21.5 | 20.4 | 19.9 |
| 3470 | 23.7 | 24.2 | 24.1 | 23.9 | | 21.5 | 20.4 | 19.9 |
| 3480 | 23.7 | 24.2 | 24.1 | 23.8 | | 21.5 | 20.4 | 19.9 |
| 3490 | 23.7 | 24.2 | 24.1 | 23.9 | | 21.4 | 20.4 | 19.9 |
| 3500 | 23.7 | 24.2 | 24.1 | 23.9 | | 21.4 | 20.4 | 19.8 |
| 3510 | 23.6 | 24.2 | 24.1 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3520 | 23.6 | 24.2 | 24 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3530 | 23.6 | 24.1 | 24 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3540 | 23.6 | 24.2 | 24.1 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3550 | 23.6 | 24.1 | 24.1 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3560 | 23.6 | 24.1 | 24 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3570 | 23.6 | 24.1 | 24 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3580 | 23.6 | 24.1 | 24.1 | 23.9 | | 21.4 | 20.4 | 19.8 |
| 3590 | 23.6 | 24.1 | 24 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3600 | 23.6 | 24.1 | 24 | 23.8 | | 21.4 | 20.4 | 19.8 |
| 3610 | 23.6 | 24.1 | 24 | 23.8 | | 21.3 | 20.4 | 19.8 |
| 3620 | 23.6 | 24.1 | 24 | 23.8 | | 21.3 | 20.4 | 19.8 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 3630 | 23.6 | 24.1 | 24 | 23.8 | | 21.3 | 20.4 | 19.7 |
| 3640 | 23.6 | 24.1 | 24 | 23.8 | | 21.3 | 20.4 | 19.7 |
| 3650 | 23.6 | 24.1 | 24 | 23.8 | | 21.3 | 20.4 | 19.7 |
| 3660 | 23.6 | 24.1 | 24 | 23.8 | | 21.3 | 20.4 | 19.7 |
| 3670 | 23.6 | 24.1 | 23.9 | 23.8 | | 21.3 | 20.4 | 19.7 |
| 3680 | 23.6 | 24.1 | 23.9 | 23.8 | | 21.3 | 20.4 | 19.7 |
| 3690 | 23.6 | 24.1 | 23.9 | 23.8 | | 21.3 | 20.4 | 19.7 |
| 3700 | 23.5 | 24.1 | 23.9 | 23.8 | | 21.3 | 20.3 | 19.7 |
| 3710 | 23.5 | 24.1 | 23.9 | 23.8 | | 21.3 | 20.3 | 19.7 |
| 3720 | 23.5 | 24.1 | 23.9 | 23.7 | | 21.2 | 20.3 | 19.7 |
| 3730 | 23.5 | 24 | 23.9 | 23.8 | | 21.2 | 20.3 | 19.7 |
| 3740 | 23.5 | 24 | 23.9 | 23.8 | | 21.2 | 20.3 | 19.7 |
| 3750 | 23.5 | 24 | 23.9 | 23.7 | | 21.2 | 20.3 | 19.7 |
| 3760 | 23.5 | 24 | 23.9 | 23.7 | | 21.2 | 20.3 | 19.7 |
| 3770 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.7 |
| 3780 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3790 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3800 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3810 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3820 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3830 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3840 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3850 | 23.5 | 24 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3860 | 23.5 | 23.9 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3870 | 23.5 | 23.9 | 23.9 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3880 | 23.5 | 24 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3890 | 23.5 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3900 | 23.5 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.6 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 3910 | 23.5 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.6 |
| 3920 | 23.5 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.5 |
| 3930 | 23.4 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.5 |
| 3940 | 23.5 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.5 |
| 3950 | 23.4 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.5 |
| 3960 | 23.4 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.5 |
| 3970 | 23.4 | 23.9 | 23.8 | 23.7 | | 21.1 | 20.3 | 19.5 |
| 3980 | 23.3 | 23.9 | 23.8 | 23.7 | | 21 | 20.3 | 19.5 |
| 3990 | 23.3 | 23.9 | 23.8 | 23.7 | | 21 | 20.3 | 19.5 |
| 4000 | 23.3 | 23.9 | 23.8 | 23.7 | | 21 | 20.3 | 19.5 |
| 4010 | 23.3 | 23.9 | 23.8 | 23.7 | | 21 | 20.3 | 19.5 |
| 4020 | 23.3 | 23.8 | 23.8 | 23.7 | | 21 | 20.3 | 19.5 |
| 4030 | 23.3 | 23.9 | 23.8 | 23.7 | | 21 | 20.3 | 19.5 |
| 4040 | 23.4 | 23.8 | 23.8 | 23.7 | | 21 | 20.3 | 19.5 |
| 4050 | 23.4 | 23.8 | 23.7 | 23.7 | | 21 | 20.3 | 19.5 |
| 4060 | 23.4 | 23.9 | 23.7 | 23.7 | | 21 | 20.3 | 19.5 |
| 4070 | 23.4 | 23.9 | 23.7 | 23.7 | | 21 | 20.3 | 19.5 |
| 4080 | 23.3 | 23.9 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.5 |
| 4090 | 23.3 | 23.9 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.5 |
| 4100 | 23.3 | 23.9 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.4 |
| 4110 | 23.3 | 23.9 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.4 |
| 4120 | 23.3 | 23.9 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.4 |
| 4130 | 23.4 | 23.9 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.4 |
| 4140 | 23.4 | 24 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.4 |
| 4150 | 23.4 | 24 | 23.7 | 23.7 | | 20.9 | 20.3 | 19.4 |
| 4160 | 23.5 | 24 | 23.7 | 23.8 | | 20.9 | 20.2 | 19.4 |
| 4170 | 23.5 | 23.9 | 23.7 | 23.8 | | 20.9 | 20.2 | 19.4 |
| 4180 | 23.5 | 24 | 23.7 | 23.8 | | 20.9 | 20.1 | 19.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 4190 | 23.5 | 24 | 23.7 | 23.8 | | 20.9 | 20.1 | 19.4 |
| 4200 | 23.4 | 24 | 23.7 | 23.7 | | 20.9 | 20.1 | 19.4 |
| 4210 | 23.4 | 24 | 23.7 | 23.8 | | 20.9 | 20.1 | 19.4 |
| 4220 | 23.4 | 24.1 | 23.7 | 23.7 | | 20.9 | 20.1 | 19.4 |
| 4230 | 23.5 | 24 | 23.6 | 23.7 | | 20.9 | 20.1 | 19.4 |
| 4240 | 23.5 | 24 | 23.6 | 23.8 | | 20.9 | 20.2 | 19.4 |
| 4250 | 23.5 | 24 | 23.6 | 23.8 | | 20.9 | 20.2 | 19.4 |
| 4260 | 23.5 | 24 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4270 | 23.5 | 24.1 | 23.6 | 23.8 | | 20.8 | 20.1 | 19.4 |
| 4280 | 23.5 | 24.1 | 23.6 | 23.8 | | 20.8 | 20.1 | 19.4 |
| 4290 | 23.5 | 24.2 | 23.6 | 23.8 | | 20.8 | 20.1 | 19.4 |
| 4300 | 23.5 | 24.2 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4310 | 23.5 | 24.1 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4320 | 23.5 | 24.1 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4330 | 23.5 | 24.1 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4340 | 23.6 | 24.1 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4350 | 23.6 | 24.1 | 23.6 | 23.9 | | 20.8 | 20.2 | 19.4 |
| 4360 | 23.6 | 24.1 | 23.6 | 23.9 | | 20.8 | 20.2 | 19.4 |
| 4370 | 23.6 | 24.2 | 23.6 | 23.9 | | 20.8 | 20.2 | 19.4 |
| 4380 | 23.7 | 24.2 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4390 | 23.7 | 24.2 | 23.6 | 23.8 | | 20.8 | 20.2 | 19.4 |
| 4400 | 23.7 | 24.2 | 23.6 | 23.9 | | 20.8 | 20.2 | 19.4 |
| 4410 | 23.6 | 24.2 | 23.6 | 23.9 | | 20.8 | 20.2 | 19.4 |
| 4420 | 23.6 | 24.2 | 23.6 | 23.9 | | 20.8 | 20.2 | 19.4 |
| 4430 | 23.6 | 24.2 | 23.6 | 23.9 | | 20.8 | 20.3 | 19.4 |
| 4440 | 23.6 | 24.2 | 23.7 | 23.9 | | 20.8 | 20.3 | 19.4 |
| 4450 | 23.7 | 24.2 | 23.6 | 24 | | 20.8 | 20.3 | 19.4 |
| 4460 | 23.6 | 24.2 | 23.6 | 24 | | 20.8 | 20.3 | 19.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 4470 | 23.7 | 24.2 | 23.6 | 24 | | 20.8 | 20.2 | 19.4 |
| 4480 | 23.7 | 24.2 | 23.6 | 24 | | 20.8 | 20.2 | 19.4 |
| 4490 | 23.7 | 24.2 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4500 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.8 | 20.2 | 19.4 |
| 4510 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4520 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4530 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4540 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4550 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4560 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4570 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4580 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.3 | 19.4 |
| 4590 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.3 | 19.4 |
| 4600 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.3 | 19.3 |
| 4610 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.3 | 19.3 |
| 4620 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.3 | 19.4 |
| 4630 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.3 | 19.4 |
| 4640 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4650 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4660 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4670 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4680 | 23.7 | 24.2 | 23.6 | 24.1 | | 20.7 | 20.2 | 19.4 |
| 4690 | 23.7 | 24.1 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4700 | 23.7 | 24.1 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4710 | 23.7 | 24.2 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4720 | 23.8 | 24.1 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4730 | 23.8 | 24.1 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4740 | 23.8 | 24.1 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 4750 | 23.7 | 24.2 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4760 | 23.7 | 24.1 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4770 | 23.7 | 24.2 | 23.6 | 24 | | 20.7 | 20.3 | 19.4 |
| 4780 | 23.7 | 24.2 | 23.6 | 24 | | 20.7 | 20.2 | 19.4 |
| 4790 | 23.7 | 24.1 | 23.6 | 24 | | 20.7 | 20.3 | 19.4 |
| 4800 | 23.7 | 24.1 | 23.6 | 24 | | 20.7 | 20.3 | 19.4 |
| 4810 | 23.7 | 24.1 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4820 | 23.7 | 24.1 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4830 | 23.7 | 24.1 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4840 | 23.7 | 24.2 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4850 | 23.7 | 24.1 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4860 | 23.7 | 24 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4870 | 23.7 | 24 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4880 | 23.7 | 24 | 23.6 | 23.9 | | 20.7 | 20.2 | 19.4 |
| 4890 | 23.7 | 24 | 23.6 | 23.9 | | 20.7 | 20.3 | 19.4 |
| 4900 | 23.7 | 24 | 23.6 | 23.9 | | 20.6 | 20.2 | 19.4 |
| 4910 | 23.7 | 24 | 23.6 | 23.9 | | 20.7 | 20.2 | 19.4 |
| 4920 | 23.7 | 24 | 23.5 | 23.9 | | 20.7 | 20.2 | 19.4 |
| 4930 | 23.6 | 24 | 23.5 | 23.9 | | 20.7 | 20.2 | 19.4 |
| 4940 | 23.6 | 24 | 23.5 | 23.9 | | 20.7 | 20.2 | 19.4 |
| 4950 | 23.6 | 24 | 23.5 | 23.9 | | 20.7 | 20.2 | 19.4 |
| 4960 | 23.6 | 24 | 23.4 | 23.9 | | 20.6 | 20.2 | 19.5 |
| 4970 | 23.6 | 24 | 23.5 | 23.8 | | 20.7 | 20.2 | 19.5 |
| 4980 | 23.6 | 24 | 23.5 | 23.8 | | 20.7 | 20.2 | 19.4 |
| 4990 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5000 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.7 | 20.2 | 19.4 |
| 5010 | 23.6 | 23.9 | 23.5 | 23.8 | | 20.7 | 20.2 | 19.5 |
| 5020 | 23.6 | 23.9 | 23.5 | 23.8 | | 20.7 | 20.2 | 19.5 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 5030 | 23.6 | 23.9 | 23.5 | 23.8 | | 20.7 | 20.2 | 19.5 |
| 5040 | 23.6 | 23.9 | 23.5 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5050 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5060 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5070 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5080 | 23.6 | 23.9 | 23.5 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5090 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5100 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.4 |
| 5110 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5120 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.3 | 19.5 |
| 5130 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.2 | 19.5 |
| 5140 | 23.6 | 23.9 | 23.5 | 23.8 | | 20.6 | 20.1 | 19.5 |
| 5150 | 23.6 | 23.9 | 23.4 | 23.8 | | 20.6 | 20.3 | 19.5 |
| 5160 | 23.5 | 23.9 | 23.5 | 23.8 | | 20.6 | 20.2 | 19.4 |
| 5170 | 23.5 | 23.9 | 23.4 | 23.8 | | 20.5 | 20.2 | 19.4 |
| 5180 | 23.5 | 23.9 | 23.4 | 23.7 | | 20.6 | 20.1 | 19.4 |
| 5190 | 23.5 | 23.9 | 23.4 | 23.7 | | 20.6 | 20.1 | 19.4 |
| 5200 | 23.5 | 23.9 | 23.4 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5210 | 23.5 | 23.9 | 23.4 | 23.7 | | 20.6 | 20.1 | 19.4 |
| 5220 | 23.5 | 23.9 | 23.4 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5230 | 23.5 | 23.8 | 23.4 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5240 | 23.5 | 23.8 | 23.4 | 23.7 | | 20.6 | 20.1 | 19.4 |
| 5250 | 23.5 | 23.8 | 23.4 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5260 | 23.5 | 23.8 | 23.4 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5270 | 23.5 | 23.8 | 23.4 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5280 | 23.5 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5290 | 23.5 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5300 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 5310 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5320 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5330 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5340 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5350 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5360 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5370 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5380 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5390 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5400 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5410 | 23.4 | 23.8 | 23.3 | 23.7 | | 20.5 | 20.1 | 19.4 |
| 5420 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.5 | 20.1 | 19.4 |
| 5430 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.5 | 20.1 | 19.4 |
| 5440 | 23.3 | 23.7 | 23.3 | 23.6 | | 20.5 | 20.1 | 19.4 |
| 5450 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.5 | 20.1 | 19.4 |
| 5460 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.4 | 20.1 | 19.4 |
| 5470 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.4 | 20.1 | 19.4 |
| 5480 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.4 | 20.1 | 19.4 |
| 5490 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.4 | 20.1 | 19.4 |
| 5500 | 23.4 | 23.7 | 23.3 | 23.6 | | 20.4 | 20.1 | 19.4 |
| 5510 | 23.4 | 23.8 | 23.3 | 23.6 | | 20.4 | 20.1 | 19.4 |
| 5520 | 23.3 | 23.7 | 23.3 | 23.6 | | 20.4 | 20 | 19.4 |
| 5530 | 23.3 | 23.7 | 23.3 | 23.6 | | 20.4 | 20 | 19.4 |
| 5540 | 23.3 | 23.7 | 23.2 | 23.5 | | 20.4 | 20 | 19.4 |
| 5550 | 23.3 | 23.7 | 23.2 | 23.5 | | 20.4 | 20 | 19.4 |
| 5560 | 23.3 | 23.7 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |
| 5570 | 23.3 | 23.7 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |
| 5580 | 23.3 | 23.7 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 5590 | 23.3 | 23.7 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |
| 5600 | 23.3 | 23.8 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |
| 5610 | 23.3 | 23.8 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |
| 5620 | 23.3 | 23.9 | 23.2 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5630 | 23.3 | 23.9 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |
| 5640 | 23.3 | 23.9 | 23.2 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5650 | 23.4 | 23.9 | 23.2 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5660 | 23.4 | 23.9 | 23.2 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5670 | 23.3 | 23.9 | 23.1 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5680 | 23.4 | 23.9 | 23.2 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5690 | 23.4 | 23.9 | 23.2 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5700 | 23.4 | 24 | 23.2 | 23.4 | | 20.4 | 19.9 | 19.5 |
| 5710 | 23.4 | 24 | 23.2 | 23.4 | | 20.4 | 19.9 | 19.5 |
| 5720 | 23.3 | 24 | 23.1 | 23.4 | | 20.4 | 19.9 | 19.5 |
| 5730 | 23.3 | 24 | 23.1 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5740 | 23.4 | 24 | 23.2 | 23.5 | | 20.4 | 19.9 | 19.5 |
| 5750 | 23.4 | 24 | 23.2 | 23.5 | | 20.4 | 20.1 | 19.5 |
| 5760 | 23.4 | 24 | 23.2 | 23.5 | | 20.4 | 20.1 | 19.5 |
| 5770 | 23.4 | 24 | 23.2 | 23.5 | | 20.4 | 20.1 | 19.5 |
| 5780 | 23.4 | 24 | 23.1 | 23.5 | | 20.4 | 20.1 | 19.5 |
| 5790 | 23.4 | 24.1 | 23.2 | 23.5 | | 20.4 | 20 | 19.5 |
| 5800 | 23.4 | 24.1 | 23.1 | 23.6 | | 20.4 | 19.9 | 19.5 |
| 5810 | 23.5 | 24.1 | 23.2 | 23.6 | | 20.4 | 20 | 19.5 |
| 5820 | 23.5 | 24.1 | 23.1 | 23.6 | | 20.4 | 19.9 | 19.5 |
| 5830 | 23.5 | 24.1 | 23.1 | 23.6 | | 20.4 | 20 | 19.5 |
| 5840 | 23.5 | 24.1 | 23.2 | 23.6 | | 20.4 | 19.9 | 19.5 |
| 5850 | 23.5 | 24.1 | 23.1 | 23.6 | | 20.4 | 19.9 | 19.5 |
| 5860 | 23.6 | 24.1 | 23.1 | 23.6 | | 20.4 | 19.8 | 19.5 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 5870 | 23.6 | 24.1 | 23.1 | 23.6 | | 20.4 | 19.9 | 19.5 |
| 5880 | 23.6 | 24.1 | 23.1 | 23.6 | | 20.4 | 19.9 | 19.5 |
| 5890 | 23.6 | 24.1 | 23.1 | 23.6 | | 20.4 | 19.9 | 19.5 |
| 5900 | 23.6 | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.5 |
| 5910 | 23.6 | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.5 |
| 5920 | 23.6 | 24.1 | 23.1 | 23.7 | | 20.3 | 19.9 | 19.5 |
| 5930 | 23.6 | 24.1 | 23.1 | 23.7 | | 20.3 | 19.9 | 19.5 |
| 5940 | 23.6 | 24.1 | 23.1 | 23.7 | | 20.3 | 19.8 | 19.5 |
| 5950 | 23.6 | 24.2 | 23.1 | 23.7 | | 20.3 | 19.8 | 19.5 |
| 5960 | 23.6 | 24.1 | 23.1 | 23.7 | | 20.3 | 19.9 | 19.5 |
| 5970 | 23.6 | 24.2 | 23.1 | 23.7 | | 20.3 | 19.9 | 19.5 |
| 5980 | 23.6 | 24.2 | 23.1 | 23.7 | | 20.2 | 19.9 | 19.5 |
| 5990 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.8 | 19.5 |
| 6000 | | 24.1 | 23.1 | 23.6 | | 20.2 | 19.8 | 19.4 |
| 6010 | | 24.1 | 23.1 | 23.6 | | 20.2 | 19.8 | 19.5 |
| 6020 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.8 | 19.5 |
| 6030 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.5 |
| 6040 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.5 |
| 6050 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.5 |
| 6060 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.5 |
| 6070 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.4 |
| 6080 | | 24.1 | 23.1 | 23.7 | | 20.3 | 19.9 | 19.5 |
| 6090 | | 24.1 | 23.1 | 23.6 | | 20.3 | 19.9 | 19.5 |
| 6100 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20 | 19.5 |
| 6110 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20 | 19.5 |
| 6120 | | 24.2 | 23.1 | 23.6 | | 20.3 | 20 | 19.5 |
| 6130 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20 | 19.5 |
| 6140 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20 | 19.5 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 6150 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20.1 | 19.5 |
| 6160 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20.1 | 19.5 |
| 6170 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20.1 | 19.5 |
| 6180 | | 24.1 | 23.1 | 23.6 | | 20.3 | 20.1 | 19.5 |
| 6190 | | 24.1 | 23.1 | 23.6 | | 20.4 | 20.1 | 19.5 |
| 6200 | | 24.1 | 23.1 | 23.6 | | 20.4 | 20.1 | 19.4 |
| 6210 | | 24.1 | 23.1 | 23.5 | | 20.4 | 20.1 | 19.5 |
| 6220 | | 24.1 | 23.1 | 23.5 | | 20.3 | 20.1 | 19.4 |
| 6230 | | 24.1 | 23.1 | 23.5 | | 20.3 | 20.2 | 19.4 |
| 6240 | | 24.1 | 23.1 | 23.5 | | 20.4 | 20.2 | 19.4 |
| 6250 | | 24.1 | 23.1 | 23.5 | | 20.3 | 20.2 | 19.5 |
| 6260 | | 24.1 | 23.1 | 23.5 | | 20.3 | 20.2 | 19.5 |
| 6270 | | 24.1 | 23.1 | 23.5 | | 20.4 | 20.2 | 19.5 |
| 6280 | | 24 | 23.1 | 23.6 | | 20.4 | 20.2 | 19.4 |
| 6290 | | 24 | 23.1 | 23.5 | | 20.3 | 20.2 | 19.4 |
| 6300 | | 24 | 23.1 | 23.5 | | 20.4 | 20.2 | 19.4 |
| 6310 | | 23.9 | 23.1 | 23.5 | | 20.3 | 20.2 | 19.4 |
| 6320 | | 24 | 23.1 | 23.5 | | 20.4 | 20.2 | 19.4 |
| 6330 | | 23.9 | 23.1 | 23.5 | | 20.4 | 20.2 | 19.4 |
| 6340 | | 24 | 23.1 | 23.5 | | 20.3 | 20.2 | 19.3 |
| 6350 | | 24 | 23.1 | 23.4 | | 20.4 | 20.2 | 19.3 |
| 6360 | | 23.9 | 23.1 | 23.5 | | 20.3 | 20.2 | 19.3 |
| 6370 | | 24 | 23.1 | 23.4 | | 20.3 | 20.2 | 19.3 |
| 6380 | | 23.9 | 23.1 | 23.5 | | 20.3 | 20.3 | 19.3 |
| 6390 | | 23.9 | 23.1 | 23.4 | | 20.4 | 20.3 | 19.3 |
| 6400 | | 23.9 | 23.1 | 23.4 | | 20.3 | 20.3 | 19.3 |
| 6410 | | 23.9 | 23.1 | 23.4 | | 20.3 | 20.3 | 19.3 |
| 6420 | | 23.9 | 23.1 | 23.4 | | 20.4 | 20.3 | 19.3 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 6430 | | 23.9 | 23.1 | 23.4 | | 20.4 | 20.3 | 19.3 |
| 6440 | | 23.8 | 23.1 | 23.5 | | 20.4 | 20.3 | 19.3 |
| 6450 | | 23.8 | 23.1 | 23.4 | | 20.4 | 20.3 | 19.3 |
| 6460 | | 23.8 | 23.1 | 23.4 | | 20.4 | 20.3 | 19.3 |
| 6470 | | 23.8 | 23.1 | 23.4 | | 20.4 | 20.3 | 19.3 |
| 6480 | | 23.8 | 23.1 | 23.5 | | 20.5 | 20.3 | 19.3 |
| 6490 | | 23.8 | 23.1 | 23.4 | | 20.4 | 20.3 | 19.3 |
| 6500 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.3 | 19.3 |
| 6510 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6520 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6530 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6540 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6550 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6560 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6570 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6580 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6590 | | 23.8 | 23.1 | 23.4 | | 20.5 | 20.4 | 19.3 |
| 6600 | | 23.8 | 23.1 | 23.3 | | 20.5 | 20.4 | 19.3 |
| 6610 | | 23.8 | 23.1 | 23.3 | | 20.5 | 20.4 | 19.3 |
| 6620 | | 23.8 | 23.1 | 23.3 | | 20.5 | 20.4 | 19.3 |
| 6630 | | 23.8 | 23.1 | 23.3 | | 20.5 | 20.4 | 19.3 |
| 6640 | | 23.8 | 23.1 | 23.3 | | 20.5 | 20.4 | 19.3 |
| 6650 | | 23.8 | 23.1 | 23.3 | | 20.5 | 20.4 | 19.3 |
| 6660 | | 23.7 | 23.1 | 23.3 | | 20.4 | 20.4 | 19.3 |
| 6670 | | 23.7 | 23.1 | 23.3 | | 20.5 | 20.5 | 19.3 |
| 6680 | | 23.7 | 23.1 | 23.3 | | 20.4 | 20.5 | 19.3 |
| 6690 | | 23.6 | 23.1 | 23.3 | | 20.4 | 20.5 | 19.3 |
| 6700 | | 23.7 | 23.1 | 23.3 | | 20.5 | 20.5 | 19.3 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 6710 | | 23.6 | 23.1 | 23.3 | | 20.5 | 20.5 | 19.3 |
| 6720 | | 23.7 | 23.1 | 23.3 | | 20.5 | 20.5 | 19.3 |
| 6730 | | 23.6 | 23.1 | 23.3 | | 20.5 | 20.5 | 19.3 |
| 6740 | | 23.7 | 23.1 | 23.3 | | 20.5 | 20.5 | 19.3 |
| 6750 | | 23.6 | 23 | 23.3 | | 20.5 | 20.5 | 19.3 |
| 6760 | | 23.7 | 23.1 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6770 | | 23.6 | 23 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6780 | | 23.6 | 23 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6790 | | 23.7 | 23 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6800 | | 23.7 | 23 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6810 | | 23.6 | 23 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6820 | | 23.6 | 23 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6830 | | 23.6 | 23 | 23.3 | | 20.5 | 20.6 | 19.3 |
| 6840 | | 23.6 | 23 | 23.3 | | 20.4 | 20.6 | 19.3 |
| 6850 | | 23.6 | 23 | 23.3 | | 20.4 | 20.6 | 19.3 |
| 6860 | | 23.6 | 23 | 23.2 | | 20.5 | 20.6 | 19.3 |
| 6870 | | 23.6 | 23 | 23.2 | | 20.4 | 20.5 | 19.3 |
| 6880 | | 23.6 | 23 | 23.2 | | 20.5 | 20.5 | 19.3 |
| 6890 | | 23.6 | 23 | 23.2 | | 20.5 | 20.5 | 19.3 |
| 6900 | | 23.6 | 23 | 23.2 | | 20.5 | 20.5 | 19.3 |
| 6910 | | 23.6 | 23.1 | 23.2 | | 20.5 | 20.5 | 19.3 |
| 6920 | | 23.6 | 23.1 | 23.2 | | 20.5 | 20.5 | 19.3 |
| 6930 | | 23.6 | 23.1 | 23.2 | | 20.5 | 20.5 | 19.2 |
| 6940 | | 23.6 | 23.1 | 23.2 | | 20.5 | 20.5 | 19.2 |
| 6950 | | 23.6 | 23.1 | 23.1 | | 20.5 | 20.5 | 19.2 |
| 6960 | | 23.7 | 23.1 | 23.2 | | 20.5 | 20.5 | 19.2 |
| 6970 | | 23.7 | 23.1 | 23.2 | | 20.5 | 20.5 | 19.2 |
| 6980 | | 23.6 | 23.1 | 23.1 | | 20.5 | 20.5 | 19.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 6990 | | 23.6 | 23.1 | 23.1 | | 20.5 | 20.5 | 19.2 |
| 7000 | | 23.6 | 23.1 | 23.1 | | 20.5 | 20.5 | 19.1 |
| 7010 | | 23.6 | 23.1 | 23.1 | | 20.5 | 20.4 | 19.1 |
| 7020 | | 23.6 | 23.1 | 23.2 | | 20.6 | 20.4 | 19.2 |
| 7030 | | 23.7 | 23.1 | 23.2 | | 20.6 | 20.3 | 19.2 |
| 7040 | | 23.6 | 23.1 | 23.2 | | 20.6 | 20.4 | 19.2 |
| 7050 | | 23.6 | 23.1 | 23.2 | | 20.6 | 20.3 | 19.1 |
| 7060 | | 23.6 | 23.1 | 23.2 | | 20.6 | 20.2 | 19.1 |
| 7070 | | 23.6 | 23.1 | 23.3 | | 20.6 | 20.2 | 19.2 |
| 7080 | | 23.7 | 23.1 | 23.3 | | 20.6 | 20.2 | 19.1 |
| 7090 | | 23.7 | 23.1 | 23.2 | | 20.6 | 20.2 | 19.1 |
| 7100 | | 23.7 | 23.1 | 23.2 | | 20.6 | 20.2 | 19.1 |
| 7110 | | 23.7 | 23.1 | 23.3 | | 20.6 | 20.2 | 19.1 |
| 7120 | | 23.7 | 23.1 | 23.2 | | 20.6 | 20.2 | 19.1 |
| 7130 | | 23.7 | 23.1 | 23.3 | | 20.6 | 20.2 | 19.1 |
| 7140 | | 23.7 | 23.1 | 23.3 | | 20.6 | 20.1 | 19.1 |
| 7150 | | 23.8 | 23.1 | 23.3 | | 20.6 | 20.1 | 19.1 |
| 7160 | | 23.8 | 23.1 | 23.3 | | 20.7 | 20.1 | 19.1 |
| 7170 | | 23.8 | 23.1 | 23.3 | | 20.7 | 20 | 19.1 |
| 7180 | | 23.8 | 23.1 | 23.3 | | 20.7 | 20 | 19.1 |
| 7190 | | 23.8 | 23.1 | 23.4 | | 20.7 | 20 | 19.1 |
| 7200 | | 23.7 | 23.1 | 23.4 | | 20.7 | 20 | 19.1 |
| 7210 | | 23.8 | 23.1 | 23.4 | | 20.7 | 20 | 19.1 |
| 7220 | | 23.8 | 23.2 | 23.4 | | 20.8 | 20 | 19.1 |
| 7230 | | 23.8 | 23.2 | 23.4 | | 20.8 | 20 | 19.1 |
| 7240 | | 23.8 | 23.2 | 23.4 | | 20.8 | 20 | 19.1 |
| 7250 | | 23.9 | 23.2 | 23.4 | | 20.8 | 20 | 19.1 |
| 7260 | | 23.9 | 23.2 | 23.4 | | 20.7 | 20 | 19.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 7270 | | 23.9 | 23.2 | 23.5 | | 20.7 | 20 | 19.1 |
| 7280 | | 23.9 | 23.3 | 23.5 | | 20.7 | 20 | 19.2 |
| 7290 | | 23.8 | 23.3 | 23.5 | | 20.7 | 20 | 19.2 |
| 7300 | | 23.9 | 23.3 | 23.5 | | 20.7 | 20 | 19.2 |
| 7310 | | 23.9 | 23.3 | 23.5 | | 20.7 | 20 | 19.2 |
| 7320 | | 23.9 | 23.3 | 23.5 | | 20.8 | 20 | 19.2 |
| 7330 | | 23.9 | 23.3 | 23.6 | | 20.8 | 20 | 19.2 |
| 7340 | | 23.9 | 23.3 | 23.6 | | 20.8 | 20 | 19.2 |
| 7350 | | 24 | 23.3 | 23.6 | | 20.8 | 20 | 19.2 |
| 7360 | | 24 | 23.3 | 23.7 | | 20.8 | 20 | 19.2 |
| 7370 | | 24 | 23.3 | 23.7 | | 20.7 | 20 | 19.2 |
| 7380 | | 23.9 | 23.4 | 23.6 | | 20.7 | 20 | 19.3 |
| 7390 | | 23.9 | 23.4 | 23.6 | | 20.7 | 19.9 | 19.3 |
| 7400 | | 23.9 | 23.4 | 23.7 | | 20.7 | 19.9 | 19.3 |
| 7410 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.3 |
| 7420 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7430 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7440 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7450 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7460 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7470 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7480 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7490 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7500 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.4 |
| 7510 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.5 |
| 7520 | | 23.9 | 23.5 | 23.7 | | 20.7 | 19.9 | 19.5 |
| 7530 | | 23.8 | 23.5 | 23.8 | | 20.7 | 20 | 19.5 |
| 7540 | | 23.8 | 23.5 | 23.7 | | 20.7 | 20 | 19.5 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 7550 | | 23.8 | 23.5 | 23.7 | | 20.7 | 20 | 19.5 |
| 7560 | | 23.8 | 23.5 | 23.7 | | 20.7 | 20 | 19.5 |
| 7570 | | 23.8 | 23.4 | 23.7 | | 20.7 | 20 | 19.5 |
| 7580 | | 23.8 | 23.4 | 23.7 | | 20.7 | 20 | 19.4 |
| 7590 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7600 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7610 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7620 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7630 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7640 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7650 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7660 | | 23.8 | 23.4 | 23.6 | | 20.7 | 20 | 19.4 |
| 7670 | | 23.8 | 23.4 | 23.7 | | 20.7 | 20 | 19.4 |
| 7680 | | 23.8 | 23.3 | 23.7 | | 20.7 | 20 | 19.4 |
| 7690 | | 23.8 | 23.3 | 23.6 | | 20.7 | 20 | 19.4 |
| 7700 | | 23.8 | 23.3 | 23.6 | | 20.7 | 20 | 19.4 |
| 7710 | | 23.8 | 23.3 | 23.7 | | 20.7 | 20 | 19.4 |
| 7720 | | 23.8 | 23.3 | 23.6 | | 20.7 | 20 | 19.4 |
| 7730 | | 23.8 | 23.3 | 23.6 | | 20.7 | 20 | 19.4 |
| 7740 | | 23.8 | 23.3 | 23.6 | | 20.7 | 20 | 19.4 |
| 7750 | | 23.8 | 23.3 | 23.6 | | 20.7 | 20 | 19.4 |
| 7760 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7770 | | 23.7 | 23.3 | 23.6 | | 20.7 | 20 | 19.4 |
| 7780 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7790 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7800 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7810 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7820 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 7830 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7840 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7850 | | 23.7 | 23.3 | 23.6 | | 20.7 | 19.9 | 19.4 |
| 7860 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7870 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7880 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7890 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7900 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7910 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7920 | | 23.6 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7930 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7940 | | 23.6 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7950 | | 23.6 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7960 | | 23.7 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7970 | | 23.7 | 23.3 | 23.4 | | 20.7 | 19.9 | 19.4 |
| 7980 | | 23.6 | 23.3 | 23.5 | | 20.7 | 19.9 | 19.4 |
| 7990 | | 23.6 | 23.3 | 23.4 | | 20.7 | 19.9 | 19.4 |
| 8000 | | 23.7 | 23.3 | 23.4 | | 20.7 | 19.9 | 19.4 |
| 8010 | | 23.6 | 23.3 | 23.4 | | 20.7 | 19.9 | 19.4 |
| 8020 | | 23.6 | 23.2 | 23.3 | | 20.7 | 19.9 | 19.4 |
| 8030 | | 23.7 | 23.3 | 23.4 | | 20.7 | 19.9 | 19.4 |
| 8040 | | 23.6 | 23.2 | 23.4 | | 20.7 | 19.9 | 19.4 |
| 8050 | | 23.6 | 23.2 | 23.3 | | 20.7 | 19.9 | 19.4 |
| 8060 | | 23.6 | 23.2 | 23.3 | | 20.7 | 19.9 | 19.4 |
| 8070 | | 23.6 | 23.2 | 23.3 | | 20.7 | 19.9 | 19.4 |
| 8080 | | 23.6 | 23.2 | 23.3 | | 20.7 | 19.9 | 19.4 |
| 8090 | | 23.5 | 23.2 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8100 | | 23.5 | 23.2 | 23.4 | | 20.7 | 19.8 | 19.4 |

| Time (minutes) | Temperature ($^0$C) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 8110 | | 23.5 | 23.2 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8120 | | 23.5 | 23.2 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8130 | | 23.5 | 23.1 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8140 | | 23.5 | 23.2 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8150 | | 23.5 | 23.1 | 23.4 | | 20.7 | 19.8 | 19.4 |
| 8160 | | 23.5 | 23.2 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8170 | | 23.5 | 23.1 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8180 | | 23.5 | 23.1 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8190 | | 23.5 | 23.2 | 23.3 | | 20.7 | 19.8 | 19.4 |
| 8200 | | 23.5 | 23.2 | 23.2 | | | 19.8 | 19.4 |
| 8210 | | 23.5 | 23.2 | 23.2 | | | 19.8 | 19.4 |
| 8220 | | 23.5 | 23.1 | 23.2 | | | 19.8 | 19.4 |
| 8230 | | 23.5 | 23.2 | 23.2 | | | 19.8 | 19.4 |
| 8240 | | 23.5 | 23.2 | 23.2 | | | 19.8 | 19.4 |
| 8250 | | 23.5 | 23.2 | 23.2 | | | 19.8 | 19.4 |
| 8260 | | 23.5 | 23.1 | 23.2 | | | 19.8 | 19.4 |
| 8270 | | 23.5 | 23.1 | 23.2 | | | 19.8 | 19.4 |
| 8280 | | 23.5 | 23.1 | 23.2 | | | 19.8 | 19.4 |
| 8290 | | 23.5 | 23.1 | 23.2 | | | 19.8 | 19.4 |
| 8300 | | 23.5 | 23.1 | 23.2 | | | 19.8 | 19.4 |
| 8310 | | 23.5 | 23.1 | 23.2 | | | 19.8 | 19.4 |
| 8320 | | 23.5 | 23.2 | 23.2 | | | 19.8 | 19.3 |
| 8330 | | 23.5 | 23.2 | 23.2 | | | 19.8 | 19.3 |
| 8340 | | 23.5 | 23.1 | 23.2 | | | 19.7 | 19.3 |
| 8350 | | 23.5 | 23.1 | 23.2 | | | 19.7 | 19.3 |
| 8360 | | 23.4 | 23.1 | 23.2 | | | 19.7 | 19.3 |
| 8370 | | 23.5 | 23.1 | 23.2 | | | 19.7 | 19.3 |
| 8380 | | 23.5 | 23.1 | 23.2 | | | 19.7 | 19.3 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 8390 | | 23.4 | 23.1 | 23.1 | | | 19.6 | 19.3 |
| 8400 | | 23.5 | 23.1 | 23.1 | | | 19.7 | 19.3 |
| 8410 | | 23.4 | 23.1 | 23.1 | | | 19.7 | 19.3 |
| 8420 | | 23.3 | 23.1 | 23.1 | | | 19.7 | 19.3 |
| 8430 | | 23.4 | 23.2 | 23.1 | | | 19.7 | 19.3 |
| 8440 | | 23.4 | 23.2 | 23.1 | | | 19.7 | 19.3 |
| 8450 | | 23.4 | 23.2 | 23.2 | | | 19.7 | 19.3 |
| 8460 | | 23.3 | 23.3 | 23.2 | | | 19.7 | 19.3 |
| 8470 | | 23.3 | 23.3 | 23.2 | | | 19.7 | 19.3 |
| 8480 | | 23.3 | 23.3 | 23.2 | | | 19.7 | 19.3 |
| 8490 | | 23.3 | 23.3 | 23.2 | | | 19.7 | 19.3 |
| 8500 | | 23.3 | 23.3 | 23.2 | | | 19.7 | 19.3 |
| 8510 | | 23.4 | 23.3 | 23.2 | | | 19.7 | 19.3 |
| 8520 | | 23.3 | 23.4 | 23.2 | | | 19.6 | 19.3 |
| 8530 | | 23.3 | 23.3 | 23.2 | | | 19.7 | 19.4 |
| 8540 | | 23.3 | 23.4 | 23.1 | | | 19.7 | 19.3 |
| 8550 | | 23.3 | 23.5 | 23.2 | | | 19.6 | 19.3 |
| 8560 | | 23.3 | 23.4 | 23.2 | | | 19.6 | 19.3 |
| 8570 | | 23.3 | 23.4 | 23.2 | | | 19.6 | 19.3 |
| 8580 | | 23.3 | 23.4 | 23.2 | | | 19.6 | 19.3 |
| 8590 | | 23.3 | 23.4 | 23.2 | | | 19.6 | 19.4 |
| 8600 | | 23.3 | 23.4 | 23.1 | | | 19.6 | 19.4 |
| 8610 | | 23.3 | 23.5 | 23.1 | | | 19.7 | 19.4 |
| 8620 | | 23.3 | 23.6 | 23.1 | | | 19.7 | 19.4 |
| 8630 | | 23.3 | 23.6 | 23.1 | | | 19.7 | 19.4 |
| 8640 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.4 |
| 8650 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.4 |
| 8660 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 8670 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8680 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8690 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8700 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8710 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8720 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8730 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8740 | | 23.3 | 23.6 | 23.2 | | | 19.6 | 19.4 |
| 8750 | | 23.3 | 23.8 | 23.2 | | | 19.6 | 19.4 |
| 8760 | | 23.3 | 23.8 | 23.1 | | | 19.6 | 19.4 |
| 8770 | | 23.3 | 23.8 | 23.2 | | | 19.5 | 19.4 |
| 8780 | | 23.3 | 23.7 | 23.2 | | | 19.5 | 19.4 |
| 8790 | | 23.3 | 23.8 | 23.2 | | | 19.6 | 19.4 |
| 8800 | | 23.3 | 23.8 | 23.2 | | | 19.5 | 19.3 |
| 8810 | | 23.3 | 23.8 | 23.2 | | | 19.6 | 19.3 |
| 8820 | | 23.3 | 23.8 | 23.2 | | | 19.6 | 19.3 |
| 8830 | | 23.3 | 23.8 | 23.2 | | | 19.6 | 19.3 |
| 8840 | | 23.3 | 23.8 | 23.2 | | | 19.6 | 19.3 |
| 8850 | | 23.3 | 23.8 | 23.2 | | | 19.6 | 19.3 |
| 8860 | | 23.3 | 23.8 | 23.2 | | | 19.7 | 19.3 |
| 8870 | | 23.3 | 23.8 | 23.2 | | | 19.7 | 19.3 |
| 8880 | | 23.3 | 23.8 | 23.2 | | | 19.7 | 19.3 |
| 8890 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.3 |
| 8900 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.3 |
| 8910 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.4 |
| 8920 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.4 |
| 8930 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.4 |
| 8940 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.4 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 8950 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.4 |
| 8960 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.3 |
| 8970 | | 23.3 | 23.8 | 23.1 | | | 19.7 | 19.3 |
| 8980 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 8990 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9000 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9010 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9020 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9030 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9040 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9050 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9060 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9070 | | 23.3 | 23.7 | 23.1 | | | 19.7 | 19.3 |
| 9080 | | 23.3 | 23.7 | 23.2 | | | 19.7 | 19.3 |
| 9090 | | 23.3 | 23.7 | 23.2 | | | 19.7 | 19.3 |
| 9100 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9110 | | 23.3 | 23.6 | 23.1 | | | 19.7 | 19.3 |
| 9120 | | 23.3 | 23.6 | 23.1 | | | 19.7 | 19.3 |
| 9130 | | 23.3 | 23.6 | 23.1 | | | 19.7 | 19.3 |
| 9140 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9150 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9160 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9170 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9180 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9190 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9200 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9210 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |
| 9220 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.3 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 9230 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.2 |
| 9240 | | 23.3 | 23.6 | 23.2 | | | 19.7 | 19.2 |
| 9250 | | 23.3 | 23.6 | 23.3 | | | 19.7 | 19.2 |
| 9260 | | 23.3 | 23.6 | 23.3 | | | 19.7 | 19.2 |
| 9270 | | 23.3 | 23.6 | 23.3 | | | 19.7 | 19.2 |
| 9280 | | 23.3 | 23.6 | 23.3 | | | 19.7 | 19.2 |
| 9290 | | 23.3 | 23.5 | 23.3 | | | 19.7 | 19.2 |
| 9300 | | 23.3 | 23.5 | 23.4 | | | 19.7 | 19.2 |
| 9310 | | 23.3 | 23.5 | 23.3 | | | 19.7 | 19.2 |
| 9320 | | 23.3 | 23.5 | 23.4 | | | 19.7 | 19.2 |
| 9330 | | 23.3 | 23.5 | 23.3 | | | 19.7 | 19.3 |
| 9340 | | 23.3 | 23.5 | 23.3 | | | 19.7 | 19.3 |
| 9350 | | 23.3 | 23.5 | 23.3 | | | 19.7 | 19.3 |
| 9360 | | 23.3 | 23.5 | 23.3 | | | 19.7 | 19.3 |
| 9370 | | 23.3 | 23.4 | 23.3 | | | 19.7 | 19.3 |
| 9380 | | 23.3 | 23.5 | 23.3 | | | 19.7 | 19.3 |
| 9390 | | 23.3 | 23.4 | 23.3 | | | 19.7 | 19.2 |
| 9400 | | 23.3 | 23.4 | 23.3 | | | 19.7 | 19.2 |
| 9410 | | 23.3 | 23.5 | 23.4 | | | 19.7 | 19.2 |
| 9420 | | 23.3 | 23.4 | 23.3 | | | 19.7 | 19.2 |
| 9430 | | 23.3 | 23.4 | 23.3 | | | 19.7 | 19.2 |
| 9440 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9450 | | 23.3 | 23.4 | 23.3 | | | 19.7 | 19.2 |
| 9460 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9470 | | 23.3 | 23.5 | 23.4 | | | 19.7 | 19.2 |
| 9480 | | 23.3 | 23.4 | 23.3 | | | 19.7 | 19.2 |
| 9490 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9500 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 9510 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9520 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9530 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9540 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9550 | | 23.3 | 23.4 | 23.4 | | | 19.7 | 19.2 |
| 9560 | | 23.2 | 23.4 | 23.4 | | | 19.6 | 19.2 |
| 9570 | | 23.2 | 23.4 | 23.4 | | | 19.6 | 19.2 |
| 9580 | | 23.3 | 23.3 | 23.4 | | | 19.7 | 19.2 |
| 9590 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.2 |
| 9600 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.2 |
| 9610 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.2 |
| 9620 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.2 |
| 9630 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.2 |
| 9640 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9650 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9660 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9670 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9680 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9690 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9700 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9710 | | 23.2 | 23.3 | 23.5 | | | 19.6 | 19.1 |
| 9720 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9730 | | 23.1 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9740 | | 23.2 | 23.3 | 23.5 | | | 19.6 | 19.1 |
| 9750 | | 23.1 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9760 | | 23.1 | 23.3 | 23.4 | | | 19.6 | 19.1 |
| 9770 | | 23.2 | 23.2 | 23.4 | | | 19.6 | 19.1 |
| 9780 | | 23.2 | 23.3 | 23.4 | | | 19.6 | 19.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 9790 | | 23.1 | 23.3 | 23.3 | | | 19.6 | 19.1 |
| 9800 | | 23.1 | 23.3 | 23.3 | | | 19.6 | 19 |
| 9810 | | 23.1 | 23.3 | 23.3 | | | 19.6 | 19 |
| 9820 | | 23.2 | 23.3 | 23.3 | | | 19.6 | 19 |
| 9830 | | 23.2 | 23.4 | 23.3 | | | 19.6 | 19 |
| 9840 | | 23.2 | 23.4 | 23.2 | | | 19.6 | 19 |
| 9850 | | 23.2 | 23.4 | 23.2 | | | 19.6 | 19 |
| 9860 | | 23.2 | 23.4 | 23.2 | | | 19.6 | 19 |
| 9870 | | 23.2 | 23.5 | 23.2 | | | 19.6 | 19 |
| 9880 | | 23.3 | 23.4 | 23.2 | | | 19.6 | 19 |
| 9890 | | 23.3 | 23.4 | 23.2 | | | 19.5 | 19 |
| 9900 | | 23.3 | 23.4 | 23.2 | | | 19.5 | 19 |
| 9910 | | 23.3 | 23.5 | 23.2 | | | 19.5 | 19 |
| 9920 | | 23.3 | 23.5 | 23.2 | | | 19.5 | 19 |
| 9930 | | 23.3 | 23.5 | 23.2 | | | 19.6 | 19 |
| 9940 | | 23.3 | 23.5 | 23.2 | | | 19.6 | 19.1 |
| 9950 | | 23.3 | 23.5 | 23.2 | | | 19.5 | 19.1 |
| 9960 | | 23.3 | 23.5 | 23.2 | | | 19.5 | 19 |
| 9970 | | 23.3 | 23.6 | 23.2 | | | 19.5 | 19 |
| 9980 | | 23.3 | 23.6 | 23.2 | | | 19.5 | 19 |
| 9990 | | 23.4 | 23.6 | 23.2 | | | 19.5 | 19.1 |
| 10000 | | 23.4 | 23.6 | 23.2 | | | 19.5 | 19 |
| 10010 | | 23.4 | 23.6 | 23.2 | | | 19.5 | 19.1 |
| 10020 | | 23.4 | 23.6 | 23.2 | | | 19.5 | 19 |
| 10030 | | 23.4 | 23.6 | 23.2 | | | 19.5 | 19 |
| 10040 | | 23.4 | 23.7 | 23.2 | | | 19.5 | 19 |
| 10050 | | 23.4 | 23.7 | 23.2 | | | 19.5 | 19 |
| 10060 | | 23.4 | 23.7 | 23.2 | | | 19.5 | 19 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 10070 | | 23.4 | 23.7 | 23.1 | | | 19.5 | 19 |
| 10080 | | 23.4 | 23.7 | 23.2 | | | 19.5 | 19 |
| 10090 | | 23.4 | 23.7 | 23.1 | | | 19.5 | 19 |
| 10100 | | 23.4 | 23.7 | 23.2 | | | 19.5 | 19 |
| 10110 | | 23.4 | 23.8 | 23.1 | | | 19.5 | 19 |
| 10120 | | 23.4 | 23.8 | 23.2 | | | 19.5 | 19 |
| 10130 | | 23.4 | 23.8 | 23.1 | | | 19.5 | 19 |
| 10140 | | 23.4 | 23.8 | 23.1 | | | 19.6 | 19 |
| 10150 | | 23.5 | 23.9 | 23.2 | | | 19.6 | 19 |
| 10160 | | 23.5 | 23.9 | 23.2 | | | 19.5 | 19 |
| 10170 | | 23.5 | 23.8 | 23.2 | | | 19.5 | 19 |
| 10180 | | 23.5 | 23.9 | 23.2 | | | 19.5 | 19 |
| 10190 | | 23.5 | 23.9 | 23.2 | | | 19.5 | 19.1 |
| 10200 | | 23.5 | 23.9 | 23.2 | | | 19.5 | 19.1 |
| 10210 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10220 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10230 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10240 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10250 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10260 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10270 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10280 | | 23.5 | 23.9 | 23.3 | | | 19.5 | 19.1 |
| 10290 | | 23.5 | 23.9 | 23.2 | | | 19.5 | 19.1 |
| 10300 | | 23.5 | 23.9 | 23.2 | | | 19.5 | 19.1 |
| 10310 | | 23.5 | 23.9 | 23.3 | | | 19.6 | 19 |
| 10320 | | 23.5 | 23.9 | 23.2 | | | 19.5 | 19.1 |
| 10330 | | 23.5 | 23.9 | 23.3 | | | 19.6 | 19.1 |
| 10340 | | 23.5 | 23.9 | 23.3 | | | 19.6 | 19.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 10350 | | 23.5 | 23.8 | 23.3 | | | 19.6 | 19.1 |
| 10360 | | 23.5 | 23.8 | 23.3 | | | 19.6 | 19.1 |
| 10370 | | 23.6 | 23.8 | 23.3 | | | 19.6 | 19.1 |
| 10380 | | 23.6 | 23.9 | 23.3 | | | 19.6 | 19.1 |
| 10390 | | 23.6 | 23.9 | 23.3 | | | 19.6 | 19.1 |
| 10400 | | 23.6 | 23.9 | 23.3 | | | 19.6 | 19.1 |
| 10410 | | 23.6 | 23.9 | 23.3 | | | 19.6 | 19.1 |
| 10420 | | 23.6 | 23.9 | 23.2 | | | 19.6 | 19.1 |
| 10430 | | 23.5 | 23.9 | 23.2 | | | 19.6 | 19.1 |
| 10440 | | 23.5 | 23.8 | 23.2 | | | 19.6 | 19.1 |
| 10450 | | 23.5 | 23.8 | 23.2 | | | 19.6 | 19.1 |
| 10460 | | 23.6 | 23.8 | 23.1 | | | 19.6 | 19.1 |
| 10470 | | 23.5 | 23.8 | 23.2 | | | 19.5 | 19.1 |
| 10480 | | 23.6 | 23.8 | 23.2 | | | 19.5 | 19.1 |
| 10490 | | 23.5 | 23.8 | 23.2 | | | 19.5 | 19.2 |
| 10500 | | 23.5 | 23.8 | 23.2 | | | 19.5 | 19.2 |
| 10510 | | 23.6 | 23.8 | 23.2 | | | 19.5 | 19.1 |
| 10520 | | 23.5 | 23.8 | 23.2 | | | 19.5 | 19.2 |
| 10530 | | 23.6 | 23.8 | 23.2 | | | 19.5 | 19.2 |
| 10540 | | 23.5 | 23.8 | 23.2 | | | 19.5 | 19.2 |
| 10550 | | 23.5 | 23.8 | 23.2 | | | 19.5 | 19.2 |
| 10560 | | 23.5 | 23.7 | 23.2 | | | 19.5 | 19.2 |
| 10570 | | 23.5 | 23.7 | 23.2 | | | 19.5 | 19.2 |
| 10580 | | 23.4 | 23.7 | 23.3 | | | 19.5 | 19.2 |
| 10590 | | 23.5 | 23.7 | 23.3 | | | 19.5 | 19.2 |
| 10600 | | 23.4 | 23.7 | 23.3 | | | 19.5 | 19.2 |
| 10610 | | 23.4 | 23.7 | 23.3 | | | 19.5 | 19.2 |
| 10620 | | 23.4 | 23.7 | 23.3 | | | 19.5 | 19.2 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 10630 | | 23.4 | 23.7 | 23.3 | | | 19.5 | 19.1 |
| 10640 | | 23.4 | 23.7 | 23.3 | | | 19.5 | 19.2 |
| 10650 | | 23.4 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10660 | | 23.4 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10670 | | 23.4 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10680 | | 23.5 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10690 | | 23.4 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10700 | | 23.4 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10710 | | 23.4 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10720 | | 23.4 | 23.6 | 23.3 | | | 19.6 | 19.1 |
| 10730 | | 23.4 | 23.7 | 23.3 | | | 19.6 | 19.1 |
| 10740 | | 23.4 | 23.6 | 23.3 | | | 19.6 | 19.1 |
| 10750 | | 23.4 | 23.6 | 23.3 | | | 19.6 | 19.1 |
| 10760 | | 23.4 | 23.5 | 23.3 | | | 19.6 | 19.1 |
| 10770 | | 23.4 | 23.6 | 23.4 | | | 19.6 | 19.1 |
| 10780 | | 23.4 | 23.6 | 23.4 | | | 19.6 | 19.1 |
| 10790 | | 23.4 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10800 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10810 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10820 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10830 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10840 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10850 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10860 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10870 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10880 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10890 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10900 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 10910 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10920 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10930 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10940 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10950 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10960 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10970 | | 23.3 | 23.5 | 23.5 | | | 19.6 | 19.1 |
| 10980 | | 23.3 | 23.5 | 23.4 | | | 19.6 | 19.1 |
| 10990 | | 23.3 | 23.4 | 23.4 | | | 19.6 | 19.1 |
| 11000 | | 23.2 | 23.4 | 23.5 | | | 19.6 | 19.1 |
| 11010 | | 23.2 | 23.4 | 23.4 | | | 19.6 | 19.1 |
| 11020 | | 23.2 | 23.4 | 23.5 | | | 19.6 | 19.1 |
| 11030 | | 23.2 | 23.4 | 23.5 | | | 19.6 | 19.1 |
| 11040 | | 23.2 | 23.4 | 23.5 | | | 19.6 | 19.1 |
| 11050 | | 23.2 | 23.4 | 23.5 | | | 19.5 | 19.1 |
| 11060 | | 23.2 | 23.4 | 23.5 | | | 19.5 | 19.1 |
| 11070 | | 23.2 | 23.4 | 23.5 | | | 19.5 | 19.1 |
| 11080 | | 23.2 | 23.4 | 23.5 | | | 19.5 | 19.1 |
| 11090 | | 23.1 | 23.4 | 23.4 | | | 19.5 | 19.1 |
| 11100 | | 23.1 | 23.4 | 23.4 | | | 19.5 | 19.1 |
| 11110 | | 23.1 | 23.4 | 23.4 | | | 19.5 | 19.1 |
| 11120 | | 23.1 | 23.4 | 23.4 | | | 19.5 | 19.1 |
| 11130 | | 23.1 | 23.4 | 23.4 | | | 19.5 | 19.1 |
| 11140 | | 23.1 | 23.4 | 23.4 | | | 19.5 | 19.1 |
| 11150 | | 23.1 | 23.4 | 23.3 | | | 19.5 | 19.1 |
| 11160 | | 23.2 | 23.4 | 23.3 | | | 19.5 | 19.1 |
| 11170 | | 23.1 | 23.3 | 23.4 | | | 19.5 | 19.1 |
| 11180 | | 23.1 | 23.3 | 23.3 | | | 19.5 | 19.1 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 11190 | | 23.1 | 23.3 | 23.3 | | | 19.5 | 19.1 |
| 11200 | | 23.2 | 23.3 | 23.3 | | | 19.5 | 19.1 |
| 11210 | | 23.2 | 23.3 | 23.3 | | | 19.5 | 19.1 |
| 11220 | | 23.2 | 23.3 | 23.3 | | | 19.5 | 19.1 |
| 11230 | | 23.2 | 23.4 | 23.2 | | | 19.5 | 19.1 |
| 11240 | | 23.2 | 23.3 | 23.2 | | | 19.5 | 19.1 |
| 11250 | | 23.2 | 23.3 | 23.2 | | | 19.5 | 19.1 |
| 11260 | | 23.2 | 23.4 | 23.2 | | | 19.5 | 19.1 |
| 11270 | | 23.2 | 23.4 | 23.2 | | | 19.5 | 19.1 |
| 11280 | | 23.2 | 23.4 | 23.2 | | | 19.5 | 19.1 |
| 11290 | | 23.3 | 23.4 | 23.2 | | | 19.5 | 19.1 |
| 11300 | | 23.2 | 23.4 | 23.2 | | | 19.4 | 19.1 |
| 11310 | | 23.2 | 23.4 | 23.2 | | | 19.4 | 19.2 |
| 11320 | | 23.3 | 23.5 | 23.1 | | | 19.4 | 19.2 |
| 11330 | | 23.3 | 23.5 | 23.2 | | | 19.4 | 19.2 |
| 11340 | | 23.4 | 23.5 | 23.1 | | | 19.4 | 19.2 |
| 11350 | | 23.4 | 23.5 | 23.1 | | | 19.5 | 19.2 |
| 11360 | | 23.4 | 23.5 | 23.1 | | | 19.5 | 19.2 |
| 11370 | | 23.4 | 23.5 | 23.1 | | | 19.5 | 19.2 |
| 11380 | | 23.4 | 23.6 | 23.1 | | | 19.4 | 19.2 |
| 11390 | | 23.4 | 23.6 | 23.1 | | | 19.4 | 19.2 |
| 11400 | | 23.4 | | 23.1 | | | 19.4 | 19.2 |
| 11410 | | 23.4 | | 23.1 | | | 19.4 | 19.2 |
| 11420 | | 23.4 | | 23.1 | | | 19.4 | 19.2 |
| 11430 | | 23.4 | | 23.2 | | | 19.4 | 19.2 |
| 11440 | | 23.4 | | 23.1 | | | 19.4 | 19.2 |
| 11450 | | 23.4 | | 23.1 | | | 19.4 | 19.2 |
| 11460 | | 23.4 | | 23.1 | | | 19.4 | 19.2 |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 11470 | | 23.4 | | 23.1 | | | 19.4 | 19.2 |
| 11480 | | 23.4 | | 23.1 | | | 19.5 | 19.2 |
| 11490 | | 23.4 | | 23.1 | | | 19.5 | 19.2 |
| 11500 | | 23.4 | | 23.2 | | | 19.5 | 19.3 |
| 11510 | | 23.4 | | 23.2 | | | 19.5 | |
| 11520 | | 23.4 | | 23.2 | | | 19.5 | |
| 11530 | | 23.4 | | 23.2 | | | 19.5 | |
| 11540 | | 23.5 | | 23.3 | | | 19.5 | |
| 11550 | | 23.5 | | 23.2 | | | 19.5 | |
| 11560 | | 23.5 | | 23.3 | | | 19.5 | |
| 11570 | | 23.5 | | 23.3 | | | 19.5 | |
| 11580 | | 23.6 | | 23.3 | | | 19.5 | |
| 11590 | | 23.6 | | 23.3 | | | 19.5 | |
| 11600 | | 23.5 | | 23.3 | | | 19.5 | |
| 11610 | | 23.5 | | 23.3 | | | 19.5 | |
| 11620 | | 23.5 | | 23.3 | | | 19.5 | |
| 11630 | | 23.6 | | 23.3 | | | 19.5 | |
| 11640 | | 23.6 | | 23.4 | | | 19.5 | |
| 11650 | | 23.6 | | 23.4 | | | 19.5 | |
| 11660 | | 23.6 | | 23.3 | | | 19.5 | |
| 11670 | | 23.6 | | 23.3 | | | 19.5 | |
| 11680 | | 23.6 | | 23.3 | | | 19.5 | |
| 11690 | | 23.6 | | 23.4 | | | 19.5 | |
| 11700 | | 23.6 | | 23.4 | | | 19.5 | |
| 11710 | | 23.6 | | 23.3 | | | 19.5 | |
| 11720 | | 23.6 | | 23.3 | | | 19.5 | |
| 11730 | | 23.7 | | 23.3 | | | 19.5 | |
| 11740 | | 23.7 | | 23.3 | | | 19.6 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 11750 | | 23.7 | | 23.3 | | | 19.6 | |
| 11760 | | 23.7 | | 23.3 | | | 19.5 | |
| 11770 | | 23.7 | | 23.2 | | | 19.5 | |
| 11780 | | 23.7 | | 23.3 | | | 19.5 | |
| 11790 | | 23.7 | | 23.3 | | | 19.5 | |
| 11800 | | 23.7 | | 23.3 | | | 19.5 | |
| 11810 | | 23.7 | | 23.3 | | | 19.5 | |
| 11820 | | 23.7 | | 23.3 | | | 19.6 | |
| 11830 | | 23.6 | | 23.3 | | | 19.6 | |
| 11840 | | 23.6 | | 23.3 | | | 19.6 | |
| 11850 | | 23.6 | | 23.3 | | | 19.6 | |
| 11860 | | 23.6 | | 23.3 | | | 19.6 | |
| 11870 | | 23.6 | | 23.2 | | | 19.6 | |
| 11880 | | 23.6 | | 23.2 | | | 19.6 | |
| 11890 | | 23.6 | | 23.2 | | | 19.6 | |
| 11900 | | 23.6 | | 23.2 | | | 19.6 | |
| 11910 | | 23.6 | | 23.2 | | | 19.6 | |
| 11920 | | 23.6 | | 23.2 | | | 19.6 | |
| 11930 | | 23.6 | | 23.2 | | | 19.6 | |
| 11940 | | 23.6 | | 23.2 | | | 19.6 | |
| 11950 | | 23.6 | | 23.2 | | | 19.6 | |
| 11960 | | 23.6 | | 23.1 | | | 19.6 | |
| 11970 | | 23.6 | | 23.1 | | | 19.6 | |
| 11980 | | 23.6 | | 23.1 | | | 19.6 | |
| 11990 | | 23.6 | | 23.1 | | | 19.6 | |
| 12000 | | 23.6 | | 23.1 | | | 19.6 | |
| 12010 | | 23.5 | | 23.1 | | | 19.6 | |
| 12020 | | 23.6 | | 23.1 | | | 19.6 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 12030 | | 23.5 | | 23.1 | | | 19.6 | |
| 12040 | | 23.5 | | 23.1 | | | 19.6 | |
| 12050 | | 23.5 | | 23 | | | 19.6 | |
| 12060 | | 23.6 | | 23 | | | 19.6 | |
| 12070 | | 23.5 | | 23.1 | | | 19.5 | |
| 12080 | | 23.5 | | 23 | | | 19.5 | |
| 12090 | | 23.5 | | 23 | | | 19.5 | |
| 12100 | | 23.6 | | 23 | | | 19.5 | |
| 12110 | | 23.5 | | 23 | | | 19.5 | |
| 12120 | | 23.5 | | 23.1 | | | 19.5 | |
| 12130 | | 23.5 | | 23.1 | | | 19.5 | |
| 12140 | | 23.5 | | 23.1 | | | 19.5 | |
| 12150 | | 23.5 | | 23 | | | 19.5 | |
| 12160 | | 23.5 | | 23 | | | 19.5 | |
| 12170 | | 23.5 | | 23 | | | 19.5 | |
| 12180 | | 23.5 | | 23 | | | 19.5 | |
| 12190 | | 23.5 | | 23 | | | 19.5 | |
| 12200 | | 23.5 | | 23 | | | 19.5 | |
| 12210 | | 23.5 | | 23 | | | 19.5 | |
| 12220 | | 23.4 | | 23 | | | 19.5 | |
| 12230 | | 23.4 | | 23 | | | 19.5 | |
| 12240 | | 23.4 | | 23 | | | 19.5 | |
| 12250 | | 23.4 | | 23 | | | 19.5 | |
| 12260 | | 23.4 | | 22.9 | | | 19.5 | |
| 12270 | | 23.4 | | 22.9 | | | 19.5 | |
| 12280 | | 23.4 | | 22.9 | | | 19.5 | |
| 12290 | | 23.4 | | 22.9 | | | 19.5 | |
| 12300 | | 23.4 | | 22.9 | | | 19.5 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 12310 | | 23.4 | | 22.9 | | | 19.5 | |
| 12320 | | 23.4 | | 22.9 | | | 19.5 | |
| 12330 | | 23.4 | | 22.9 | | | 19.5 | |
| 12340 | | 23.4 | | 22.9 | | | 19.5 | |
| 12350 | | 23.4 | | 22.9 | | | 19.5 | |
| 12360 | | 23.4 | | 22.9 | | | 19.5 | |
| 12370 | | 23.3 | | 22.9 | | | 19.5 | |
| 12380 | | 23.3 | | 22.9 | | | 19.5 | |
| 12390 | | 23.3 | | 22.9 | | | 19.5 | |
| 12400 | | 23.3 | | 22.9 | | | 19.5 | |
| 12410 | | 23.3 | | 22.9 | | | 19.5 | |
| 12420 | | 23.3 | | 22.9 | | | 19.5 | |
| 12430 | | 23.3 | | 22.9 | | | 19.5 | |
| 12440 | | 23.3 | | 22.9 | | | 19.5 | |
| 12450 | | 23.3 | | 22.8 | | | 19.4 | |
| 12460 | | 23.3 | | 22.8 | | | 19.4 | |
| 12470 | | 23.3 | | 22.8 | | | 19.4 | |
| 12480 | | 23.3 | | 22.8 | | | 19.4 | |
| 12490 | | 23.3 | | 22.8 | | | 19.4 | |
| 12500 | | 23.3 | | 22.8 | | | 19.4 | |
| 12510 | | 23.3 | | 22.8 | | | 19.4 | |
| 12520 | | 23.3 | | 22.8 | | | 19.4 | |
| 12530 | | 23.3 | | 22.8 | | | 19.4 | |
| 12540 | | 23.3 | | 22.8 | | | 19.4 | |
| 12550 | | 23.3 | | 22.8 | | | 19.4 | |
| 12560 | | 23.3 | | 22.8 | | | 19.4 | |
| 12570 | | 23.3 | | 22.8 | | | 19.4 | |
| 12580 | | 23.3 | | 22.8 | | | 19.4 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 12590 | | 23.3 | | 22.8 | | | 19.4 | |
| 12600 | | 23.3 | | 22.8 | | | 19.4 | |
| 12610 | | 23.2 | | 22.8 | | | 19.4 | |
| 12620 | | 23.2 | | 22.8 | | | 19.4 | |
| 12630 | | 23.2 | | 22.8 | | | 19.4 | |
| 12640 | | 23.2 | | 22.8 | | | 19.3 | |
| 12650 | | 23.2 | | 22.8 | | | 19.3 | |
| 12660 | | 23.2 | | 22.8 | | | 19.4 | |
| 12670 | | 23.2 | | 22.8 | | | 19.4 | |
| 12680 | | 23.2 | | 22.8 | | | 19.3 | |
| 12690 | | | | 22.8 | | | 19.3 | |
| 12700 | | | | 22.7 | | | 19.3 | |
| 12710 | | | | 22.8 | | | 19.3 | |
| 12720 | | | | 22.7 | | | 19.3 | |
| 12730 | | | | 22.7 | | | 19.3 | |
| 12740 | | | | 22.7 | | | 19.3 | |
| 12750 | | | | 22.7 | | | 19.4 | |
| 12760 | | | | 22.7 | | | 19.4 | |
| 12770 | | | | 22.7 | | | 19.4 | |
| 12780 | | | | 22.7 | | | 19.4 | |
| 12790 | | | | 22.7 | | | 19.4 | |
| 12800 | | | | 22.7 | | | 19.4 | |
| 12810 | | | | 22.7 | | | 19.4 | |
| 12820 | | | | 22.7 | | | 19.4 | |
| 12830 | | | | 22.7 | | | 19.4 | |
| 12840 | | | | 22.7 | | | 19.4 | |
| 12850 | | | | 22.7 | | | 19.4 | |
| 12860 | | | | 22.7 | | | 19.4 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 12870 | | | | 22.7 | | | 19.4 | |
| 12880 | | | | 22.7 | | | 19.4 | |
| 12890 | | | | 22.7 | | | 19.4 | |
| 12900 | | | | 22.6 | | | 19.4 | |
| 12910 | | | | 22.6 | | | 19.4 | |
| 12920 | | | | 22.6 | | | 19.5 | |
| 12930 | | | | 22.6 | | | 19.5 | |
| 12940 | | | | 22.6 | | | 19.5 | |
| 12950 | | | | 22.6 | | | 19.5 | |
| 12960 | | | | 22.6 | | | 19.5 | |
| 12970 | | | | 22.6 | | | 19.5 | |
| 12980 | | | | 22.6 | | | 19.5 | |
| 12990 | | | | 22.6 | | | 19.5 | |
| 13000 | | | | 22.6 | | | 19.5 | |
| 13010 | | | | 22.6 | | | 19.5 | |
| 13020 | | | | 22.6 | | | 19.5 | |
| 13030 | | | | 22.6 | | | 19.5 | |
| 13040 | | | | 22.6 | | | 19.4 | |
| 13050 | | | | 22.6 | | | 19.4 | |
| 13060 | | | | 22.6 | | | 19.5 | |
| 13070 | | | | 22.6 | | | 19.5 | |
| 13080 | | | | 22.6 | | | 19.5 | |
| 13090 | | | | 22.6 | | | 19.5 | |
| 13100 | | | | 22.6 | | | 19.5 | |
| 13110 | | | | 22.6 | | | 19.5 | |
| 13120 | | | | 22.6 | | | 19.5 | |
| 13130 | | | | 22.6 | | | 19.5 | |
| 13140 | | | | 22.6 | | | 19.6 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 13150 | | | | 22.6 | | | 19.6 | |
| 13160 | | | | 22.6 | | | 19.6 | |
| 13170 | | | | 22.6 | | | 19.6 | |
| 13180 | | | | 22.6 | | | 19.6 | |
| 13190 | | | | 22.6 | | | 19.6 | |
| 13200 | | | | 22.6 | | | 19.6 | |
| 13210 | | | | 22.6 | | | 19.6 | |
| 13220 | | | | 22.6 | | | 19.6 | |
| 13230 | | | | 22.6 | | | 19.6 | |
| 13240 | | | | 22.6 | | | 19.6 | |
| 13250 | | | | 22.6 | | | 19.6 | |
| 13260 | | | | 22.6 | | | 19.6 | |
| 13270 | | | | 22.6 | | | 19.6 | |
| 13280 | | | | 22.6 | | | 19.6 | |
| 13290 | | | | 22.6 | | | 19.6 | |
| 13300 | | | | 22.6 | | | 19.6 | |
| 13310 | | | | 22.6 | | | 19.6 | |
| 13320 | | | | 22.6 | | | 19.6 | |
| 13330 | | | | 22.6 | | | 19.6 | |
| 13340 | | | | 22.6 | | | 19.6 | |
| 13350 | | | | 22.6 | | | 19.6 | |
| 13360 | | | | 22.6 | | | 19.6 | |
| 13370 | | | | 22.6 | | | 19.6 | |
| 13380 | | | | 22.6 | | | 19.5 | |
| 13390 | | | | 22.6 | | | 19.5 | |
| 13400 | | | | 22.6 | | | 19.5 | |
| 13410 | | | | 22.6 | | | 19.5 | |
| 13420 | | | | 22.6 | | | 19.5 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 13430 | | | | 22.6 | | | 19.5 | |
| 13440 | | | | 22.6 | | | 19.5 | |
| 13450 | | | | 22.6 | | | 19.5 | |
| 13460 | | | | 22.6 | | | 19.5 | |
| 13470 | | | | 22.6 | | | 19.5 | |
| 13480 | | | | 22.6 | | | 19.5 | |
| 13490 | | | | 22.6 | | | 19.5 | |
| 13500 | | | | 22.6 | | | 19.5 | |
| 13510 | | | | 22.6 | | | 19.5 | |
| 13520 | | | | 22.6 | | | 19.5 | |
| 13530 | | | | 22.6 | | | 19.5 | |
| 13540 | | | | 22.6 | | | 19.5 | |
| 13550 | | | | 22.6 | | | 19.5 | |
| 13560 | | | | 22.6 | | | 19.5 | |
| 13570 | | | | 22.6 | | | 19.5 | |
| 13580 | | | | 22.6 | | | 19.5 | |
| 13590 | | | | 22.6 | | | 19.5 | |
| 13600 | | | | 22.6 | | | 19.5 | |
| 13610 | | | | 22.6 | | | 19.5 | |
| 13620 | | | | 22.6 | | | 19.5 | |
| 13630 | | | | 22.6 | | | 19.5 | |
| 13640 | | | | 22.6 | | | 19.5 | |
| 13650 | | | | 22.6 | | | 19.5 | |
| 13660 | | | | 22.6 | | | 19.5 | |
| 13670 | | | | 22.6 | | | 19.5 | |
| 13680 | | | | 22.6 | | | 19.5 | |
| 13690 | | | | 22.6 | | | 19.5 | |
| 13700 | | | | 22.6 | | | 19.5 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 13710 | | | | 22.6 | | | 19.5 | |
| 13720 | | | | 22.6 | | | 19.5 | |
| 13730 | | | | 22.6 | | | 19.5 | |
| 13740 | | | | 22.6 | | | 19.5 | |
| 13750 | | | | 22.6 | | | 19.5 | |
| 13760 | | | | 22.6 | | | 19.5 | |
| 13770 | | | | 22.6 | | | 19.5 | |
| 13780 | | | | 22.6 | | | 19.5 | |
| 13790 | | | | 22.6 | | | 19.5 | |
| 13800 | | | | 22.6 | | | 19.5 | |
| 13810 | | | | 22.6 | | | 19.5 | |
| 13820 | | | | 22.6 | | | 19.5 | |
| 13830 | | | | 22.6 | | | 19.5 | |
| 13840 | | | | 22.6 | | | 19.5 | |
| 13850 | | | | 22.6 | | | 19.5 | |
| 13860 | | | | 22.6 | | | 19.5 | |
| 13870 | | | | 22.6 | | | 19.5 | |
| 13880 | | | | 22.5 | | | 19.5 | |
| 13890 | | | | 22.6 | | | 19.5 | |
| 13900 | | | | 22.6 | | | 19.5 | |
| 13910 | | | | 22.6 | | | 19.5 | |
| 13920 | | | | 22.6 | | | 19.5 | |
| 13930 | | | | 22.6 | | | 19.5 | |
| 13940 | | | | 22.5 | | | 19.5 | |
| 13950 | | | | 22.6 | | | 19.5 | |
| 13960 | | | | 22.5 | | | 19.5 | |
| 13970 | | | | 22.5 | | | 19.5 | |
| 13980 | | | | 22.5 | | | 19.5 | |

| Time (minutes) | Temperature ($^0C$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 13990 | | | | 22.5 | | | 19.5 | |
| 14000 | | | | 22.5 | | | 19.5 | |
| 14010 | | | | 22.5 | | | 19.5 | |
| 14020 | | | | 22.5 | | | 19.5 | |
| 14030 | | | | 22.5 | | | 19.5 | |
| 14040 | | | | 22.5 | | | 19.5 | |
| 14050 | | | | 22.5 | | | 19.5 | |
| 14060 | | | | 22.5 | | | 19.5 | |
| 14070 | | | | 22.5 | | | 19.5 | |
| 14080 | | | | 22.5 | | | 19.5 | |
| 14090 | | | | 22.6 | | | 19.5 | |
| 14100 | | | | 22.6 | | | 19.4 | |
| 14110 | | | | 22.5 | | | 19.4 | |
| 14120 | | | | 22.5 | | | 19.4 | |
| 14130 | | | | 22.5 | | | 19.4 | |
| 14140 | | | | 22.5 | | | 19.4 | |
| 14150 | | | | 22.5 | | | 19.4 | |
| 14160 | | | | 22.6 | | | 19.4 | |
| 14170 | | | | 22.6 | | | 19.3 | |
| 14180 | | | | 22.6 | | | | |
| 14190 | | | | 22.6 | | | | |
| 14200 | | | | 22.6 | | | | |
| 14210 | | | | 22.6 | | | | |
| 14220 | | | | 22.6 | | | | |
| 14230 | | | | 22.6 | | | | |
| 14240 | | | | 22.6 | | | | |
| 14250 | | | | 22.6 | | | | |
| 14260 | | | | 22.6 | | | | |

| Time (minutes) | Temperature ($^0$C) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sample one | Sample two | Sample three | Sample four | Sample five | Sample six | Sample seven | Sample eight |
| 14270 | | | | 22.6 | | | | |
| 14280 | | | | 22.6 | | | | |
| 14290 | | | | 22.9 | | | | |