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PROJECT REPORT

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TECHNICAL VIABILITY OF PARABOLIC DISH CONCENTRATING SOLAR POWER IN MALAYSIA ENVIRONMENT

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TECHNICAL VIABILITY OF PARABOLIC DISH CONCENTRATING SOLAR POWER IN MALAYSIA ENVIRONMENT

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A report submitted in partial fulfillment of the requirement for the Bachelor of Electrical Engineering (Industrial Power) With Honours.

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(JUNE / 2014)

"I hereby declare that I have read through this report entitle "**Technical Viability Of Parabolic Dish Concentrating Solar Power In Malaysia Environment**" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power) With Honours)".

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I declare that this report entitle "**Technical Viability Of Parabolic Dish Concentrating Solar Power In Malaysia Environment**" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any degree.

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Date : 16 JUNE 2014

Dedicated, in thankful appreciation for support, encouragement and understandings

To:

My supervisor Datuk Profesor Dr Ruddin Ab. Ghani;

Puan Hjh Rosnani Bt Hj Affandi;

My beloved father Romli Bin Saad;

My beloved mother Norisah Bt Saidin;

My family member;

My fellow classmate who have been together in four year;

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ABSRACT

Nowadays, the continuous usage of non-renewable such as fossil fuel combustion now and soon will cause of the negative effect in using which cause of global climate change. Another alternative that more reliable and abundant compared to fossil fuel is renewable energy such as solar. Solar Energy (SE) is by far, the most abundant energy source. Solar can be separated into two types that is Photovoltaic (PV) and Concentrating Solar Power (CSP) technology. CSP is a technology which solar radiation is concentrated as much as possible via a parabolic mirror to generate high temperature that then focusing to a receiver that is connected to the Stirling engine, the engine then will produce a mechanical output that then move the generator to generate electricity. However, Malaysia is only focusing to generate electricity using PV while using CSP technology still not be taking into consideration. Malaysia naturally has abundant sunshine and thus solar radiation. However, it is difficult to have a full day with the sky is really clear even in severe drought. The annual average daily solar irradiation for Malaysia has a magnitude of 4.21 – 5.56 $kWhm^{-2}$ and the sunshine duration is more than 2200 hours per years. The purpose of this project identify the potential using of CSP parabolic dish by taking into consideration of using this technology in Malaysia environment, which is by considering of climate change in Malaysia such as wind speed, rapid change of clouds, rain, temperature and relative humidity. There were two methods to analyze the potential of CSP, first by doing field measurement and collecting data from data logger. From the data analyze, the increasing relative humidity that can disturb to the changes ambient temperature and tilted irradiance. Therefore, it can concluded that to there is possible to implement the technology of CSP parabolic dish Stirling engine system in Malaysia.

ABSTRAK

Pada masa kini, penggunaan yang berterusan bahan mentah yang tidak boleh diperbaharui seperti pembakaran bahan api fossil dan arang batu. Ini akan menyebabkan kesan negatif terhadap perubahan iklim global. Salah satu lagi alternatif yang lebih dipercayai dan banyak jika dibandingkan dengan bahan api fosil adalah tenaga boleh diperbaharui adalah seperti solar. Tenaga Solar setakat ini , sumber tenaga yang paling banyak dan tidak akan habis. Pengunaan tenaga solar terbahagi kepada dua jenis iaitu Photovoltaic (PV) dan Penumpuan Kuasa Solar(CSP). CSP adalah teknologi yang radiasi solar tertumpu sebanyak mungkin melalui cermin parabola untuk menjana suhu tinggi yang kemudiannya memberi tumpuan kepada penerima yang disambungkan kepada engin Stirling. Engin ini bersambung kepada keluaran mekanikal yang kemudian bergerak penjana untuk menjana elektrik. Walaubagaimanapun, Malaysia hanya memberi tumpuan untuk menjana elektrik menggunakan PV pada masa sekarang, manakala teknologi CSP masih tidak mengambil kira. Malaysia secara semulajadi menerima cahaya matahari yang banyak. Walaubagaimanapun,, adalah sukar untuk mempunyai hari yang penuh dengan langit adalah benar-benar cerah tanpa awan walaupun dalam kemarau yang teruk. Purata penyinaran suria harian tahunan untuk Malaysia mempunyai magnitud 4,21 sehingga 5,56 kWhm^{-2} dan tempoh cahaya matahari yang menyinar adalah lebih daripada 2200 jam setiap tahun. Tujuan projek ini, adalah untuk mengenal pasti potensi menggunakan daripada CSP dengan mengambil kira menggunakan teknologi ini dalam persekitaran iklim Malaysia, yang mana perubahan iklim di Malaysia adalah seperti kelajuan angin, perubahan kedudukan awan , hujan, suhu dan kelembapan . Terdapat dua kaedah untuk menganalisis potensi CSP, pertama dengan melakukan pengukuran bidang dan mengumpul data dari “data logger”. Dari data yang diperolehi, tahap kelembapan yang bertambah boleh mengganggu kepada perubahan suhu sekitar dan sinaran cahaya solar. Oleh itu, kesimpulan dapat dibuat bahawa teknologi CSP parabola mampu untuk dilakukab di Malaysia tetapi perlu dipertihkatkn lagi tahap tumpuan cahaya matahari di atas cirmin parabola.

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LIST OF ABBREVIATIONS

PV	-	Photovoltaic.
CSP	-	Concentrating Solar Power
SE	-	Solar Energy
SREP	-	Small Renewable Energy Program
FIT	-	Malaysia Feed-in-Tariff
HP	-	Horse-Power
LFR	-	Linear Fresnel Reflector
DNI	-	Direct Normal Irradiance
PSM	-	Projek Sarjana Muda
MMD	-	Malaysian Meteorological Department
PCU	-	Power Concentrating Unit
D	-	Diameter
d	-	Depth
f	-	Focal Point
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.0 Overview

This chapter describes the research background, problem statement, project objectives, scope of the study, expected project outcome and project outline.

1.1 Research Background

Nowadays, with oil dominate over 40% of all worldwide energy, with the current continuous usage of non-renewable such as fossil fuel combustion now and soon will cause of the negative effect in using which cause of global climate change. In addition of increasing of oil price have made many countries to find another alternative that more reliable, cheaper and abundant of energy with environmentally friendly and ecological hazards associated with its production. The energy with environmental friendly is hydro, wind, geothermal and solar, as for solar it can be separated into two types that is Photovoltaic (PV) and Concentrating Solar Power (CSP) technology.

Concentrating Solar Power (CSP) is also one of 'green energy' or renewable energy technology that has a brighter future as the main source in generating electricity because the technology is abundant, clean and environment friendly. In addition no fossil fuel is used in this technology. Concentrating Solar Power (CSP) is a technology which solar radiation is concentrated as much as possible via a parabolic mirror to generate high temperature that then

focusing to a receiver that is connected to the Stirling engine, the engine then will produce a mechanical output that then move the generator to generate electricity.

The continuous development of Concentrating Solar Power (CSP) technologies have led to increases the ability to concentrate and harness solar energy for electricity production. There exist many techniques for effective concentration solar energy to produce solar thermal power such as Concentrating Solar Power (CSP). The amount of energy collected from concentration solar system depends on the amount of solar radiation in which concentrate to parabolic dish. As the position of the sun changes throughout day and throughout the year, it is necessary for the CSP system been adjusted so that it is always aimed at the Sun and as the result, will acquire the maximum solar radiation been focused to the parabolic dish receiver. Although, depends the configuration of the system, the most efficient system requires tracking the sun either in one or two axes, but in this project the position of sun been done by adjusting the position of parabolic dish mirror focal point to the brightest point and by installing using sighting rod in the middle of concentrator which functioning for orienting the dish toward the sun. When the concentrator receives the solar radiation on a parabolic dish surface it then will reflected the solar radiation to the focal point, where all the energy is concentrated, thus contribute to operating the Stirling-Engine system.

This study will be focuses on investigating the aspect of using different dimension of parabolic dish concentrator that will affect to solar radiation concentrated depending on the wet climate in Melaka. There are two difference type of parabolic dish which involved in this study, which are 11inches and 25inches in diameter. The 11 inch dish is having depth of 2.5 inch and focal point of 16inch. While the 25 inch dish is having depth of 3.6 inch and focal point of 2.1 inch length. The reflective material for these two dishes is the 11 inch dish is been coated aluminum as reflector and crystal clear acrylic parabolic mirror for 25 inch dish. The study will involve one month of data measurement and analysis.

1.2 Project Motivation

The main issue that motivated to explore this renewable source is that the world has a problem with the reduction of non-renewable energy such as oil and gases to generate electrical energy. Demand of renewable energy has become an important issue for global electricity generation. Specific high tendency towards renewable energy such as solar energy, as it does not diminish with use over time. With the use of renewable energy will reduce greenhouse gas emissions that harm the environment. Environmental issues and rising energy demand has increased interest in the use of renewable energy, especially in the use of solar energy in Melaka, Malaysia.

1.3 Problem Statement

In recent year, Malaysia only focusing on renewable energy such as solar PV, Biomass, Biogas and Mini Hydro generate electricity but even so the usage of Concentrating Solar Power (CSP) still not been given emphasis by government and investor. This is proven by the existence of Malaysia's production facilities on a large scale three leading Photovoltaic (PV) modules manufactures: SunPower, Q-Cells and First Solar [1].

Malaysia is a maritime country near the equator, so Malaysia will have naturally abundant solar radiation but it extremely rare to have a full day with a completely clear sky even in periods of severe drought. This due to Malaysia climate condition such as wind speed, a cloudy sky, rainfall and relative humidity, it usually considers CSP system not suitable be used in Malaysia, especially in Melaka environment but there no analysis had been done regarding the effect of climate condition on CSP system.

1.4 Objective of This Project

The objectives of this project are:

i. To identify the potential of using two sizes of parabolic dish Stirling engine beta-type in Melaka environment.
ii. To study the effect of environment factor in performing of Concentrating Solar Power (CSP) in Malaysia environment.
iii. To measure the temperature that can be produce at the parabolic dish receiver by using two type of parabolic dish concentrator.

This study will base on the technical viability of the possibility in using CSP technology as one alternative to generate electricity by using renewable energy by considering Melaka environment.

1.5 Scope of This Project

The scope of this project will be covering the case study through the literature review, journal finding and field measurement. This project will focus on three major scopes that are:

i. This study will be limited on measurement the temperature that can be concentrating to the parabolic receiver by two different type of parabolic dish concentrator as testing equipment.
ii. This research is by implementing the parabolic dish concentrator with Melaka environment for one month.
iii. This research is by analyzing the effectiveness of temperature that can be concentrated to receiver by considering environment changes in Melaka.

1.6 Expected Project Outcome

The expected project outcome in this study is to have an analysis related to the potential of using CSP technology by considering the Melaka environment such as solar radiation, ambient temperature, relative humidity, rainfall and wind speed complete this study. The result will appear in the form of table and graphs for further discussion. Hopefully this study can be used as reference for further study related to performing CSP in Malaysia.

1.7 Report outlines

The report consists of five chapters.

Chapter 1: Introduction

This chapter provides reader the overview of the research background, project motivation, problem statement, objectives, scopes and the expected project outcome of this project.

Chapter 2: Literature Review

This Chapter shows a review on the literature related to sustainable energy, solar energy, and CSP parabolic dish system. This chapter also reflects relevant previous researchers working related on a CSP parabolic dish system and the performance of parabolic concentrator under environment condition.

Chapter 3: Methodology

This chapter presents the methodology of the study that been used to achieve the objective and description of the flow chart of project activities. Two type of concentrator parabolic dish will be used of this study and the analysis be done from the field data measurement and data enquire from Data Logger system.

Chapter 4: Result and Discussion

This chapter shows all the data that have been recorded for one month in Melaka, that been shows in table and graphical display. The data that have been measure and enquire from Data Logger will be analyzed based on environment conditions that disturb the performance of reflective parabolic dish to receiver or focal point.

Chapter 5: Conclusion and Recommendation

This chapter consists of conclusions based on the entire work and results. This is followed by recommendations and suggestions for the work of future research.

CHAPTER 2

LITERATURE REVIEW

2.0 Overview

This chapter brief explains the Concentrating Solar Power (CSP) parabolic dish system in term of standalone systems. This paper also gives an overview from journals published and other researcher result.

2.1 Theory and Basic Principles

2.1.1 Solar Energy

Solar Energy (SE) is by far the most abundant energy source, solar is energy received by the earth from the sun, which it in the form of solar radiation. Solar radiation is closely related which the duration of sunshine that's been receiving by earth.

Malaysia is a maritime country near the equator, Malaysia naturally abundant sunshine and thus solar radiation. However, it is difficult to have a full day with the sky is really clear even in severe drought. The Cloud cover is usually one of the main factors to cut a large amount of sunlight and solar radiation. On average, Malaysia receives about 6 hours of solar radiation a day. However, the change of seasons effect the solar radiation received, for example Alor Setar and Kota Bharu receive about 7 hours a day of solar radiation while Kuching receives only 5 hours on average, with the average temperature of 27.5^{o}C [2][4]. The

annual average daily solar irradiation for Malaysia has a magnitude of 4.21 – 5.56 $kWhm^{-2}$, and the sunshine duration is more than 2200 hours per years [3]. This meaning Malaysia has a greater sunlight compare to German, in Table 2.1 shows the solar radiation thought the year.

Table 2.1: Solar Radiation in Malaysia (average value throughout the year) [15].

Location	Yearly Average Irradiance Value (kWh/m^2)
Kuching	1470
Bandar Baru Bangi	1487
Kuala Lumpur	1571
Petaling Jaya	1571
Seremban	1572
Kuantan	1601
Johor Bahru	1625
Senai	1629
Kota Bharu	1705
Kuala Terengganu	1714
Ipoh	1739
Taiping	1768
George Town	1785
Bayan Lepas	1809
Kota Kinabalu	1900

Solar energy has been identified and included in the Small Renewable Energy Program [5]. Regarding this issue the Malaysia government is further pursued in the 9th Malaysia Plan (2006 – 2010) which set a target of 5% renewable energy in the country's energy mix [1]. For this, the Malaysian Government has taken various measures to encourage individuals and companies to invest in solar PV projects [6]. But the technology from CSP still not been taken into consideration to develop as one of energy production by Malaysia government, this proven went power generation from solar power monopolized by solar PV [7]. This evidence reinforced by Malaysia FIT scheme where it only be focused only to four sources of renewable energy which is Biomass (including solid waste), Biogas (including landfill gas &

sewage), Small-hydro, and Solar PV [8]. Solar renewable energy can be separated into type which is photovoltaic (PV) technology and the other type is concentrating solar power (CSP) technology.

2.1.2 Concentrating Solar Power (CSP) Technology

Solar thermal power plants has barely considered by a wider public until a few years ago. This is all the more shocking because they not only offer the promise of lower energy costs (under mass production), but also has a significant advantage over the technology of large-scale energy [9]. CSP is one of reliable technology to generate electricity from solar power, this technology is which is solar power radiation is being concentrated to parabolic dish mirror to generate high temperature that point to the thermal receiver that is stirling engine, where it functioning as a converter that absorbed the thermal energy then by expanding then gas in a piston-cylinder to convert to mechanical power. The linear motion is converted to rotary motion to turn a generator to produce electricity [10]. CSP technology needed direct Normal Irradiance (DNI) in 1900-2000 kWh/m^2/year minimum for it to be economically feasible. DNI is the amount of solar radiation received per unit area from the direction of the sun, as in Malaysia is below than 1900kWh/m^2/y which is below than requirement for CSP technology to economically feasible. The model starts from solar energy to thermal, mechanical and electrical output (Figure 2.1).

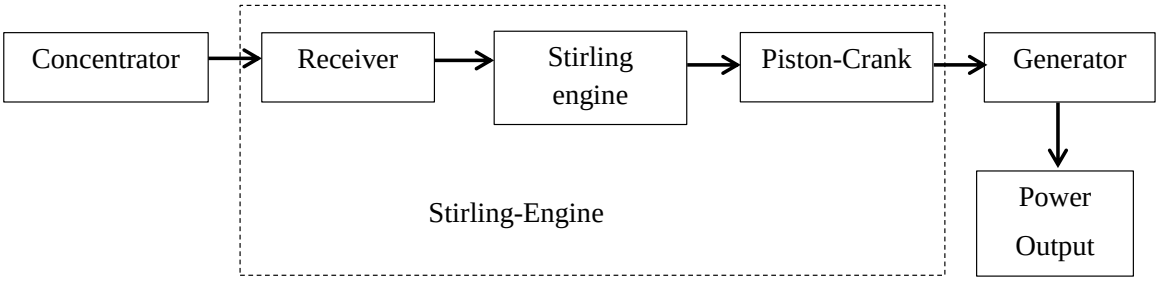


Figure 2.1: Block diagram CSP Parabolic Dish Stirling Engine.

The researches on so usage of solar power begin as seeing early of 1860's [4]. Historical development of solar power technology can be summarized in Table 2.2.

Table 2.2: Development of Solar Power Technology [4].

Year	Scientist/Engineers	Accomplishment
1767	Horace De Saussure	Created world first solar cooker which could reach temperatures of almost 190 degree F.
1816	Robert Stirling	Patent for his solar dish system which created electricity.
1866	Auguste Mouchout	Used parabolic trough to produce steam for the first solar steam engine.
1872	John Ericsson	Developed solar thermal Stirling Dish concentrating solar-powered devices for irrigation, refrigeration and locomotion.
1878	Augustine Mouchout	The first to combine the oven heat trap and burning mirrors concepts to create a solar oven.
1886	Alessandro Battaglia	First patent for a solar collector.
1901	Aubrey Eneas, John Ericsson	Construction of the world first solar thermal dish with dual access tracking.
1907	Frank Shuman	Completes construction of the "Direct acting solar engine" with maximum temperature output of 202^{o}F.
1913	Frank Shuman	Finished a 55HP "The No. 1 Sun Engine" parabolic solar thermal energy station.
1936	Charles G. Abbot	Created solar system comprised of three parabolic troughs with tracking system.
1968	Professor Giovanni Francia	Designed and build the first solar concentrated plant which entered in operation, able to produce 1MW with superheated Steam at 100 bars and 500^{o}C.
2004	Schaich Bergermann	Design and supervises the construction of a 10kW Stirling EuroDish System.
2009	Abengoe	The completion of PS20 20MW power tower.

CSP technologies are different from PV technologies where it does not produce electricity directly through solar radiation, but its use concentrating solar power to indirectly focusing heat and thus generating electricity. CSP also represents a powerful, clean, endless and reliable source of energy. The CSP plant produces no Carbon Dioxide (CO_2), thereby reducing carbon emissions from electricity generation by about 271.2 kg per megawatt-hour [11]. CSP technology consists four categorized of major solar concentrator that commonly used: i) Parabolic Trough, ii) Linear Fresnel Reflector (LFR), iii) Central Receivers and iv) Parabolic Dish.

2.3.2.1 Parabolic Trough

Parabolic Trough is a technology which used linear concentrator systems to collect the incoming solar radiation using long rectangular, curved (U-shaped) mirrors. The mirrors are tilted toward the sun, focusing solar radiation on receiver tube which consists heating the fluid inside. The tube receiver then placed at focal point length of the mirrors, because the small surface area compared to the trough capture area of the receiver tube, the temperatures can reach up to 400^{o}C without major heat loss.

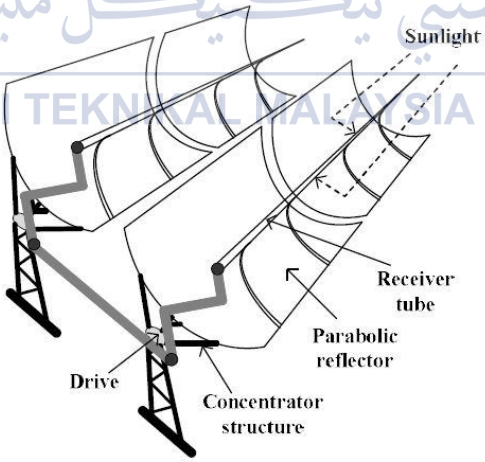


Figure 2.2: Parabolic trough systems [12].

2.3.2.2 Linear Fresnel Reflector (LFR)

The concept of Linear Fresnel Reflector (LFR) is similar with parabolic trough system which collects solar energy using a long rectangular mirror. LFR technology uses refraction rather than reflection to concentrate the solar energy by a group of flat reflector as in Figure 2.3. As parabolic dish system, the point focus LFR must track the sun about two axes [7].

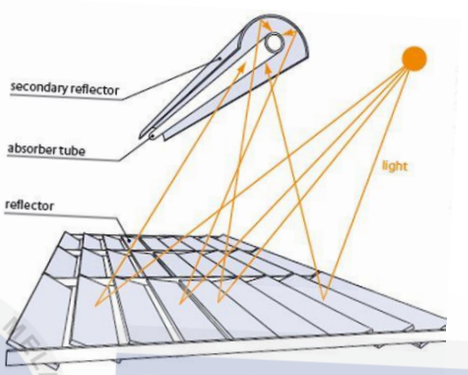


Figure 2.3: Fresnel reflector systems.

2.3.2.3 Central Receivers

A Central Receiver or Solar Tower is a system that use a large field of individually movable flat mirrors called heliostats and has a receiver located at the top of a tower. Each heliostat moves about two axes, it's functioning to keep the sun's image reflected onto the receiver at the top of the tower full day. The receiver, usually vertical tube bundle is heated by insolation reflected, thereby heating the heat transfer fluid passing through the tube as shown in Figure 2.4. The main difference between parabolic trough and central receivers is the process where heat is accumulated from the sun.

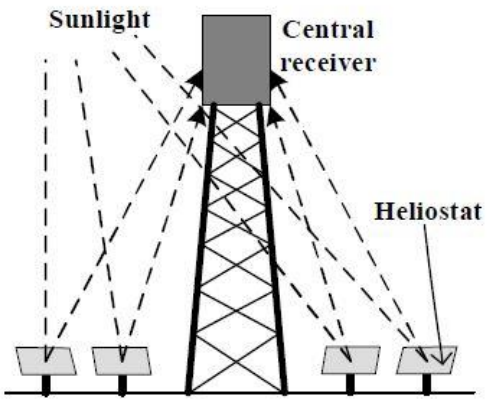


Figure 2.4: Central Receiver Systems [12].

2.3.2.4 Parabolic Dish

The parabolic dish system uses a parabolic dish shaped reflecting mirror that concentrates the sunlight radiation into the receiver (stirling engine) as in Figure 2.5. The stirling engine is placed at the focal point of the dish reflector. The solar radiations then concentrated to a receiver at the focal point parabolic dish to absorb the heat and then expend the gas to move a piston then generate electricity.

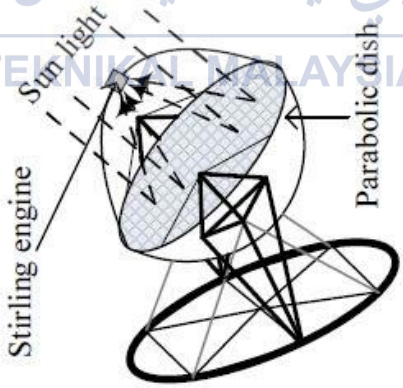


Figure 2.5: Parabolic Dish [12].

But compared to this four technology CSP parabolic dish has the most efficiency in generating electricity and suitable for small and large scale to generate electricity. This difference can be referring from Table 2.3. Therefore parabolic dish system has the potential to be one of the cheapest sources of renewable energy.

Table 2.3: Different CSP Technology [7] [12].

Technology	Focus	Temperature	Hybrid Operation	Cost ($/kW)	Efficiency
Parabolic Trough	Line	400^{o}C	Possible	4156	10-15%
Linear Fresnel	Line	270^{o}C	Possible	2200	9-15%
Central Receiver	Point	1000^{o}C	Possible	4500	14-17%
Parabolic Dish	Point	750^{o}C	Still in R&D phase	6000	18-25%

2.1.3 Stirling Engine

The stirling engine is one of the important parts in parabolic dish stirling system as in Figure 2.1, it's functioning as a receiver that will absorb as much of the solar energy that has been reflected by concentrator and this energy act as to heat up the working gas in the stirling engine. A stirling engine will be working at 200-250^{o}C heat of end temperature [19] [20]. Expansion and compression is achieved by heating and cooling of gas in cylinder chamber and moving the gas between them through the system. Figure 2.6 shows the main component in stirling engine.

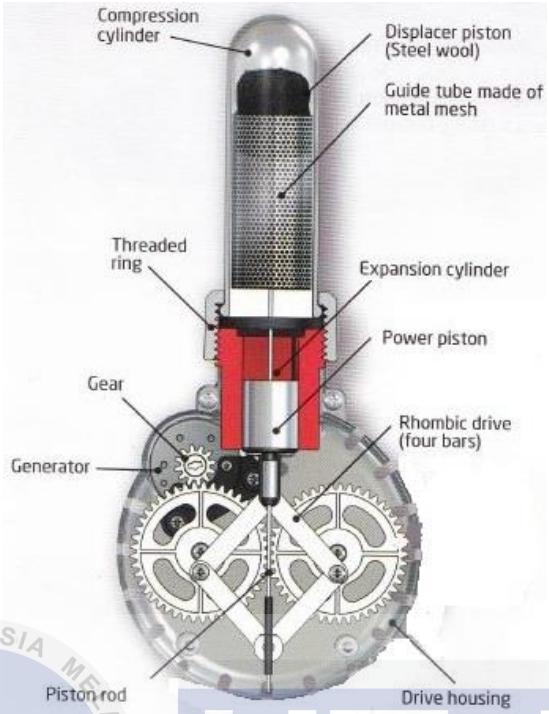


Figure 2.6: The Beta-type Stirling Engine Unit [13].

By referring the Stirling cycle of pressure-volume diagram in Figure 2.7, the Stirling cycle consists of two constant-volume processes and two isothermal processes. Changeover 1-2 is an isothermal compression of the working gas because process uses the flywheel momentum concept. Changeover 2-3 is a constant volume process where the working gas is transferred to the hot space by the movement of the piston. Changeover 3-4 is an isothermal expansion of the working gas can accomplished by heating the working gas. Changeover 4-1 is a constant volume process where the working gas is moved from hot space to cold space. The net work generated during each cycle is equal to the area of the enclosed curve.

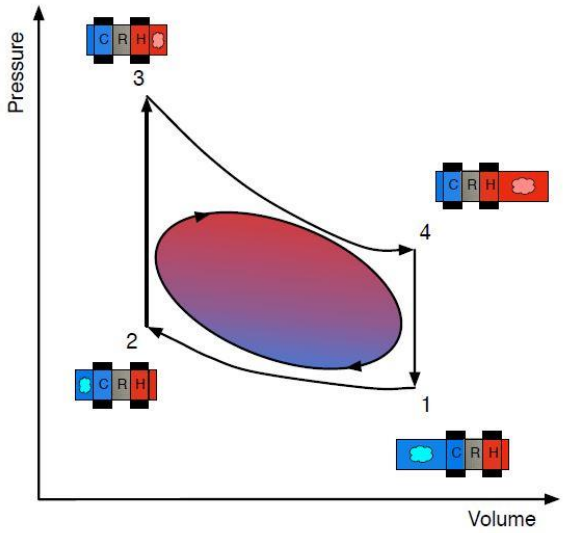


Figure 2.7: Overview of Stirling Cycle [14].

An ideal Stirling engine cycle has an efficiency that equal to the Carnot cycle [14], which given by an equation $\mu = 1 - T_3/T_1$ where T_1 refer to the point 1 in Figure 2.7.

2.1.4 Parabolic Concentrator

For CSP parabolic dish concentrator stirling system uses parabolic mirrors to concentrate solar direct normal radiation reflected to the receiver. Concentrator size depends on how much power the unit power input focus (PCU) can handle and efficiency concentrator itself, for example diameter parabolic concentrator required for systems 25 kW is about 10 meters [14]. Without considering the efficiency concentrator solar tracking and weather effects are determined by the reflection surface and the shape of the dish. Figure 2.8 is a schematic diagram of dish concentrator.

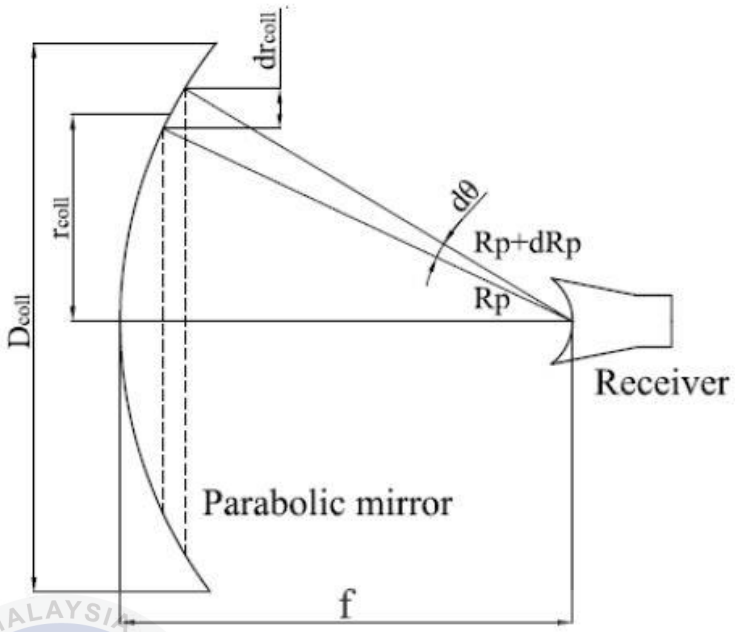


Figure 2.8: Schematic Diagram of Dish Concentrator [10].

As shown in Figure 2.8, D_{coll} concentrator diameter and focal length f of two important structural parameters, this relationship shows in the equation below

$$\frac{f}{D_{coll}} = \frac{1}{4\tan(\varphi_{rim}/2)} \quad (2.2.4.1)$$

$$R_p = \frac{2f}{1+\cos\theta} \quad (2.2.4.2)$$

If φ_{rim} is the rim angle, $R_{p\,is}$ the distance from the concentrator to focal point, θ is the angle of polar axis,

2.1.5 Power Concentrating Unit (PCU)

In PCU, solar energy power conversion into mechanical energy is done by a stirling engine. stirling engine drive shaft connected to a generator that converts the energy into electricity.

2.1.6 Parabolic Dish Focal Point Calculation

Parabolic dish focal point is one of important criteria because solar irradiance will be reflected to focal point, so in order to require an accurate result went taken the measurement, it necessary to correctly calculate focal point. Although the dish is standard manufactured unit, it still will have difference from dish to dish due to tolerance.

The parameter needed in calculate focal point (f) of concentrator parabolic dish, the diameter (D) and depth (d) as shown in Figure 2.9. The equation below can be used to calculate a correct focal point.

$$f = \frac{D^2}{16d} \tag{2.1.6.1}$$

Figure 2.9: Parabolic Shape [16]

Calculation focal point for concentrating parabolic dish 25inches is as follow:

Where:

Diameter, D = 25.25 inches

Depth, d = 2.5 inches

$$f = \frac{D^2}{16d} = \frac{25.25^2}{16(2.5)} = 15.93 \text{ inches} \quad (2.1.6.2)$$

Calculation focal point for concentrating parabolic dish 11inches is as follow:

Where:

Diameter, D = 11 inches

Depth, d = 3.6 inches

$$f = \frac{D^2}{16d} = \frac{11^2}{16(3.6)} = 2.1 \text{ inches} \quad (2.1.6.3)$$

2.1.7 Tracking Mechanism

The present of sun position during the day is different depending to the time and it shifting from the morning to evening. Therefore, to enquire an accurate data and to ensure that is concentrator is perpendicular toward the sun, it is necessary for the parabolic dish to be pointed directly to the sun, to achieved the highest solar irradiance been reflected to focal point. There are two type of sun tracking system that is single-axis and two-axis system, the most common configuration for two-axis tracking system are azimuth-elevation and tilt azimuth-roll tracking system [17].

Although in this project, it did not use any tracking devices. The position of sun tracking by adjusting the position of parabolic dish mirror focal point to the brightest point as in Figure 2.10 and by installing using sighting rod in the middle of concentrator which functioning for orienting the dish toward the sun as shown in Figure 2.11.

Figure 2.10: Brightest point at focal point

Figure 2.11: Sighting Rod

2.4 Review of Previous Related Works

There is several paper works that are related to this project title have been studied but only three are going to be highlighted in this subtopic

2.3.1 Development Assessment of Solar Concentrating Power System for Green Generation

From a technical paper National Conference in Mechanical Engineering Research (NCMER) in 2010 in Development Assessment of Solar Concentrating Power System for Green Generation. Studies have shown that concentrating solar power (CSP) system provide environmentally benign source of energy, produces almost no emissions, and uses no fuel other than sunlight [4]. CSP only need one square kilometre of land is enough to produce 100 - 120GWh of electricity per year using solar thermal technology. This is equivalent to the annual output of a conventional coal power plant of 50MW or gas-fired intermediate load [4]. Energy from the sun varies from place and very dependent on weather conditions. Without the atmosphere 1.4 kW/m^2 per hour is available, but the atmosphere can only count to 1.0 kW/m^2 per hour in the presence of clouds [4].

In theory, the amount of solar energy received by the earth's surface can calculate using the Stefan-Boltzmann law, where

$$\text{Thermal Flux, } S = \sigma \times T^4 \qquad (2.3.1.1)$$

Where

σ = Stefan's constant (5.6703×10^{-8} watt/m^2K^4)

T = Temperature of radiator

The output power of CSP technology can be calculated as solar input Q_{solar}, solar power multiplied by the efficiency of each collector, reflector and engine

$$P = Q_{solar}.\eta_{coll}.\eta_{ref}.\eta_{eng} = Q_{solar}.\eta_{plant} \quad (2.3.1.2)$$

Where

Q_{solar} = Solar Input

η_{coll} = Collector Efficiency

η_{ref} = Reflector Efficiency

η_{eng} = Engine Efficiency

The solar power input Q_{solar} into system can be written as the global horizontal radiation G_h and collector area $A_{collector}$

$$Q_{solar} = G_h . A_{collector}$$

Where

G_h = Global Horizontal

$A_{collector}$ = Collector Area

2.3.2 Concentrating Solar Power (CSP) in Malaysia environment

From a technical paper Energy Conversion Power Symposium (PECs) in 2012 in Concentrating Solar Power (CSP) In Malaysia environment. Studies have shown that Malaysia has a lot of solar energy with a magnitude of about 4.21 to 5.56 kWh/m^2 [7] for the average daily solar radiation and sunshine duration is more than 2200 hours per year. CSP technologies require direct Normal Irradiance (DNI) at least from 1900 to 2000 kWh/m^2/year to be economically feasible. Ideal location for CSP solutions are those that are exposed to high sunlight and low cloud cover, southern states such as the United States, Mexico, the Mediterranean, South Africa, parts of China, Pakistan, India, Australia and parts of South America [7]. Malaysia and other countries in the tropics are not in high insolation zone with

less than 1900 kWh/m^2/year. Clouds reduce annual production CSP plant so that the plants may not be viable in the tropics [7].

Due to weather conditions, it is believed that CSP systems cannot be used in tropical areas with relatively high diffuse fraction of the global radiation. However, no systematic study or research on the development of the CSP plant in Malaysia to prove that faith. CSP plants are located in areas with good solar resources with DNI higher than 1900 kWh/m^2/year. Thailand became the first country in the tropics have CSP plants themselves. On January 25, 2012, Thailand's first CSP plant called TSE1 5MW of electrical power supplied to the public power grid Thailand for the first time. Therefore, this proves that CSP plants can work even in areas with lower DNI than 1900 kWh/m^2/year. Although, German is one of the countries that located in the area where it receive DNI of 902 kWh/m^2/year which also lower than 1900 kWh/m^2/year but still be able to produce capacity of 1.5MW using Tower system[7]. Malaysia still has the potential to develop CSP plant itself, taking into account the size of the collector field or design a new CSP technology to provide the same amount of heat or electricity in the region with solar energy resources are very good [7].

2.3.3 Factor for Maximizing Solar Fraction Under Wet Climate Environment in Malaysia

From this journal, the writer been focusing in the design and method to increasing the efficiency of solar radiation can be transmitted to the focal point of parabolic dish concentrator by considering the wet climate in Malaysia environment and to be able to reduce the cost of manufacturing to less than $1/W.

Parabolic dish concentrator main function is to concentrate the direct solar radiation from large area to receiver of the low density of the small area, which will increases the density of solar radiation to several hundred times[16]. The parabolic dish will focus the solar radiation rays parallel to the axis of the focal point, but solar radiations are not always parallel. Therefore a good approximation they can be considered to originate in the dish subtends angle

θ = 0.0093 radians / 0.532 degre [16]. When perfect parabolic dish shape reflection and angle focal length f and rim angle Φ_{rim} is aligned to the sun, reflect radiation at focal plane forming a circular image centered on the focal point of the diameter d, as shown in Figure 2.12. It has a diameter,

$$d = \frac{f \times \theta}{\cos \Phi_{rim}(1 + \cos \Phi_{rim})} \tag{2.3.3.1}$$

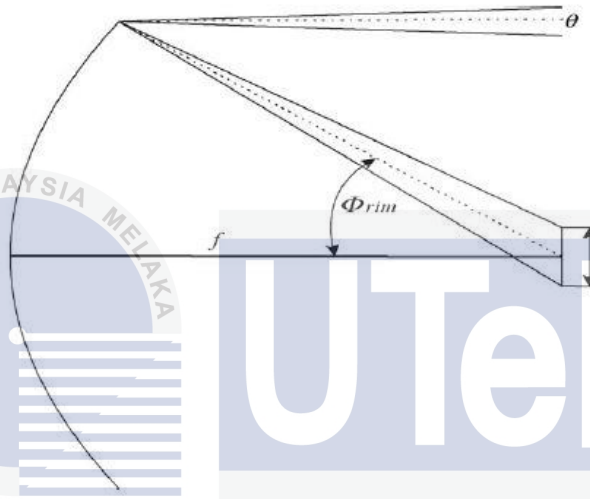


Figure 2.12: Concentration of solar radiation by parabolic dish of focal length and rim angle [16]

By referring to the Seinfeld and Palumbo [18], intensity of solar radiation flux on the circle is a maximum and uniform in paraxial solar image (hot spot). It reduces to a diameter larger than fxθ as a result of forming an elliptical image [16]. Theoretical concentration ratio in C is defined as the ratio of the intensity of radiation in a hot spot for normal beam insolation which approximately

$$C \sim \frac{4}{\theta^2} \sin^2 \Phi_{rim} \tag{2.3.3.2}$$

It can defined as, it a rim angle 45^o, the concentration ratio will exceed 2300 suns, this can be refer that the normal beam insolation of 1kW/m^2 is per 1sun.

This journal also state the most important parameters that increase the quantity and density of the energy concentrated in the focus of the reflector is projected concentrator area, a reflection of secular and accuracy make the reflector. In practical the other parameters that need to be taken consideration is weight, material strength and stiffness and limit the size of the construction of the concentrator [16]. The bigger the mirror, the more weight will be, so the strain in the material will be greater than that allowed in the case of strong wind. Figure 2.13 the potential error in developing the parabolic dish.

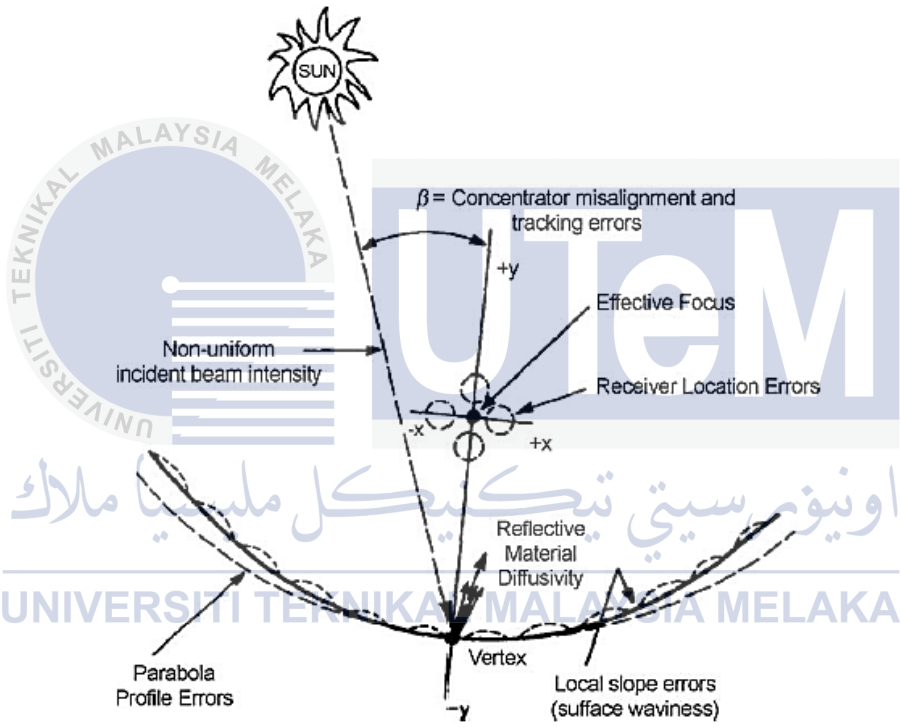


Figure 2.13: The potential errors in the parabolic dish concentrator [16].

CHAPTER 3

METHODOLOGY

3.0 Overview

This project will study the technical viability of parabolic dish concentrating solar power (CSP) in Malaysia environment. Where in this chapter, there will be describing about the method used to achieve the objective of the project.

3.1 Introduction

This project will study the technical viability of parabolic dish concentrating solar power in Melaka environment. Where in this chapter, there will be describing about the method used to achieve the objective of the project. This project will identify the potential and technical aspect of concentrating parabolic dish and the effect of environment in Melaka environment.

This chapter also contain the flow chart of the project where it illustrates the overall method that has been used to carry out in this project. This chapter also cover on data enquire from data logger and measured. Methodology of project is important to ensure the flow of project will be done in systematic to gather the good data collecting result, so in order to possess a good data, measurement and gathering data is been done at the appropriate weather in mid-day which around 10.00 am until 4.00 pm, for one month which is from 3rd March to

2nd April 2014. This set of time where chosen because it has the higher solar irradiation and most abundant.

This project is mainly focused on aspect of the effective of the parabolic dish concentrator to concentrated solar radiation to focus point in Melaka environment using different dimensions of solar dish concentrator. Parabolic dish concentrator functioning to collect and direct the solar irradiation of low density to focus point, which it will increase the several times of the density of solar radiation, this will prerequisite to efficient conservation into electricity.

3.2 Methodology Chart

Figure 3.1 will shows the flow chart of the project methodology from start until end of the task for this project. At the beginning of this study it is important understand and study any related information about this research, a study from articles, books, thesis and journal that related to "Technical Viability of Parabolic Dish Concentrating Solar Power in Malaysia Environment" from previous researches are being used. The flow chart can be simply a guide line to reach the main target and make sure all objective will be achieved.

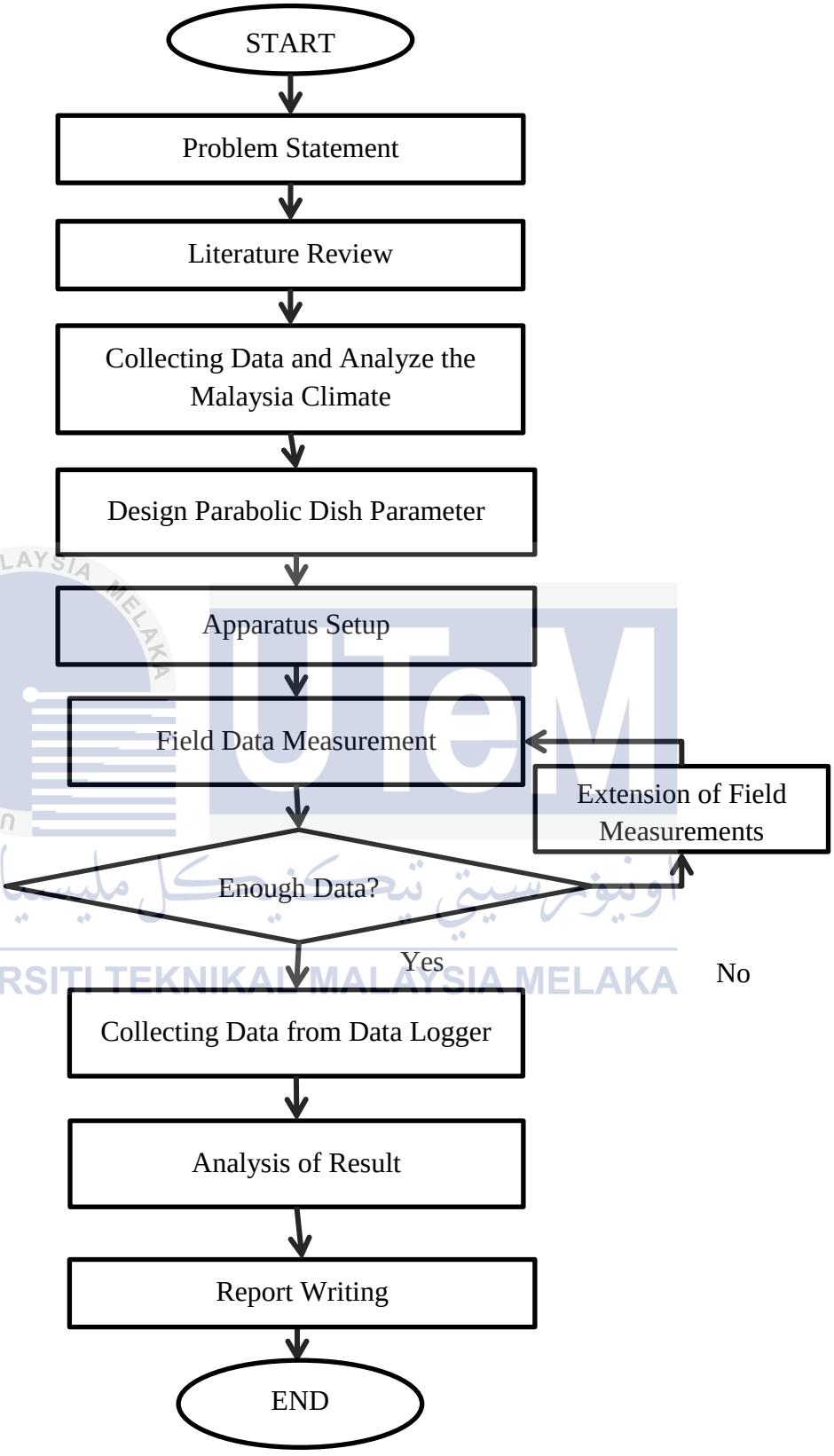


Figure 3.1: Flow Chart of Project Activities.

3.3 Design Parameter and Apparatus Setup

The aims of this project is to analyse the effect of environment condition on solar irradiation and thermal performance of solar parabolic dish concentrator, there is two type of parabolic dish which involves in this project, first is 25inches diameter crystal clear acrylic parabolic mirror and the second dish is 11inches diameter aluminium film parabolic mirror. Figure 3.2 shows the flow chart that need to be taken as consideration in selecting an effective parabolic mirror and Table 3.1 shows the parabolic dish concentrator parameters.

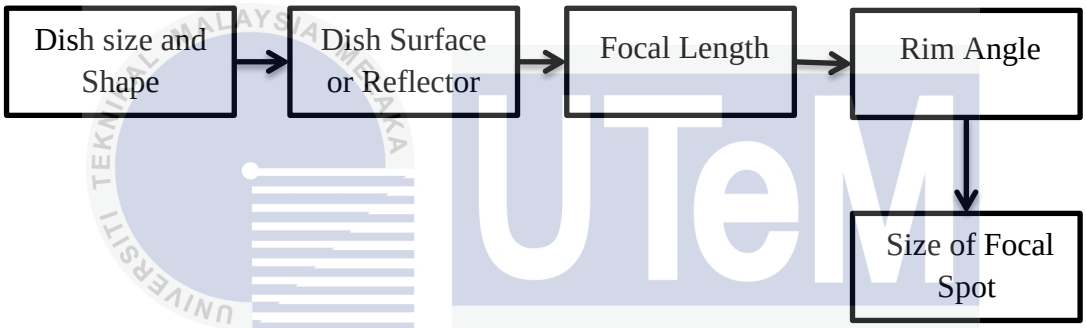
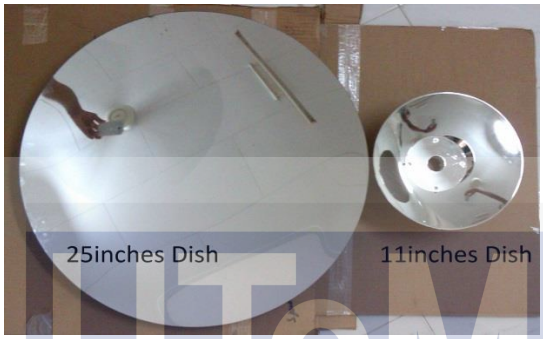


Figure 3.2: Flow chart in designing solar collector

Table 3.1: Dish concentrator parameter

Parameter	Parabolic Dish 1	Parabolic Dish 2
Diameter, D	25.25 inches	11 inches
Depth, d	2.5 inches	3.6 inches
Focal point, f	16 inches from outer rim 18 inches from centre rim	2.1 inches from outer rim
Rim Angle, Φ_{rim}	38.65^{o}	158.38^{o}
Tracking	Manual	Manual
Graphical Picture		

3.4 Field Data Measurement

Related to this topic studies about the effect of environment factor in performing of concentrating solar power (CSP) in Malaysia environment, the location of data measurement is been focused in Melaka. Data collecting had been done after all the setup finish. The temperature at the receiver and at the surface of parabolic been recorded by using digital material thermometer by placing the tip of thermometer at the focal point. The data been recorded for one month which is from 3rd March to 2nd April 2014. The experiment procedure in completing this field data measurement, are as shows in Appendices A.

The temperature been recorded from 10.00 am to 4.00 pm daily, this range of time frame chosen because it has the highest direct solar irradiance and most abundance sunshine daily. The parameter been measure and recorded daily is temperature at receiver (focal point) and temperature on the surface of parabolic dish, as shows in Table 3.2. The full data that have

been recorded for one month will shows in Chapter 4. This field data measurement also will be consideration of the environment condition during data been recorded such as haze and a cloudy sky.

Table 3.2: Data Recorded Table

Date										
Environment condition										
Data Collection	Field Data Measurement				Data Logger					
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)	
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)						
10.00 am										
11.00 am										
12.00 pm										
01.00 pm										
02.00 pm										
03.00 pm										
04.00 pm										

3.5 Collecting Data from Data Logger

A data logger is an electronic device that has ability to records data automatically for daily 24-hours, it that specific devices for measuring the environment as shown in Figure 3.3. The data that been recorded by data logger been enquire in range of one month which is the same as field data measurement from 3rd March to 2nd April 2014. All the data enquired been chosen and been represented in Table 3.2. Full list of data enquired from data logger been display in Appendices B.

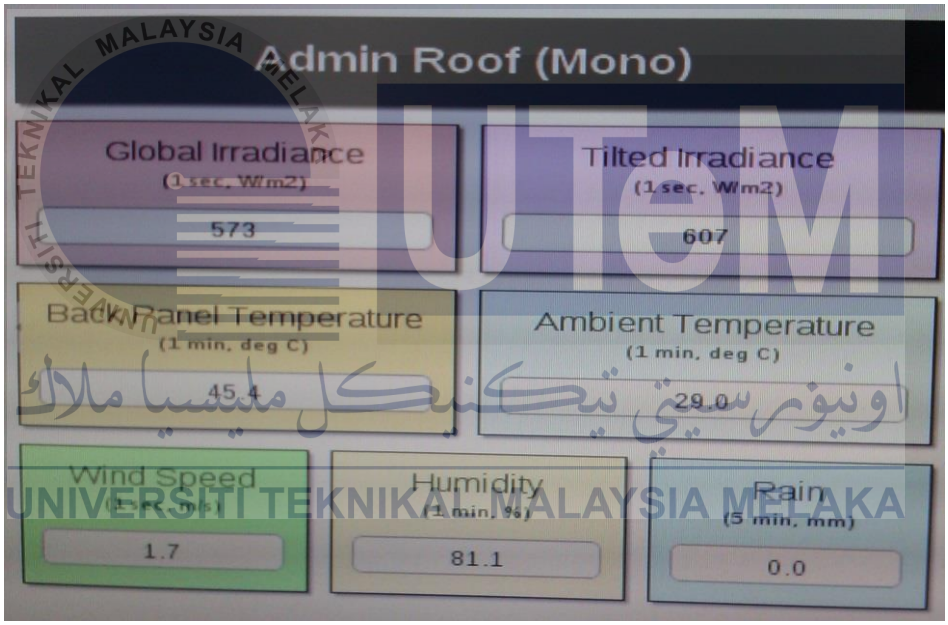


Figure 3.3: Parameter in Data Logger

3.6 Project Gantt chart and Key Milestones

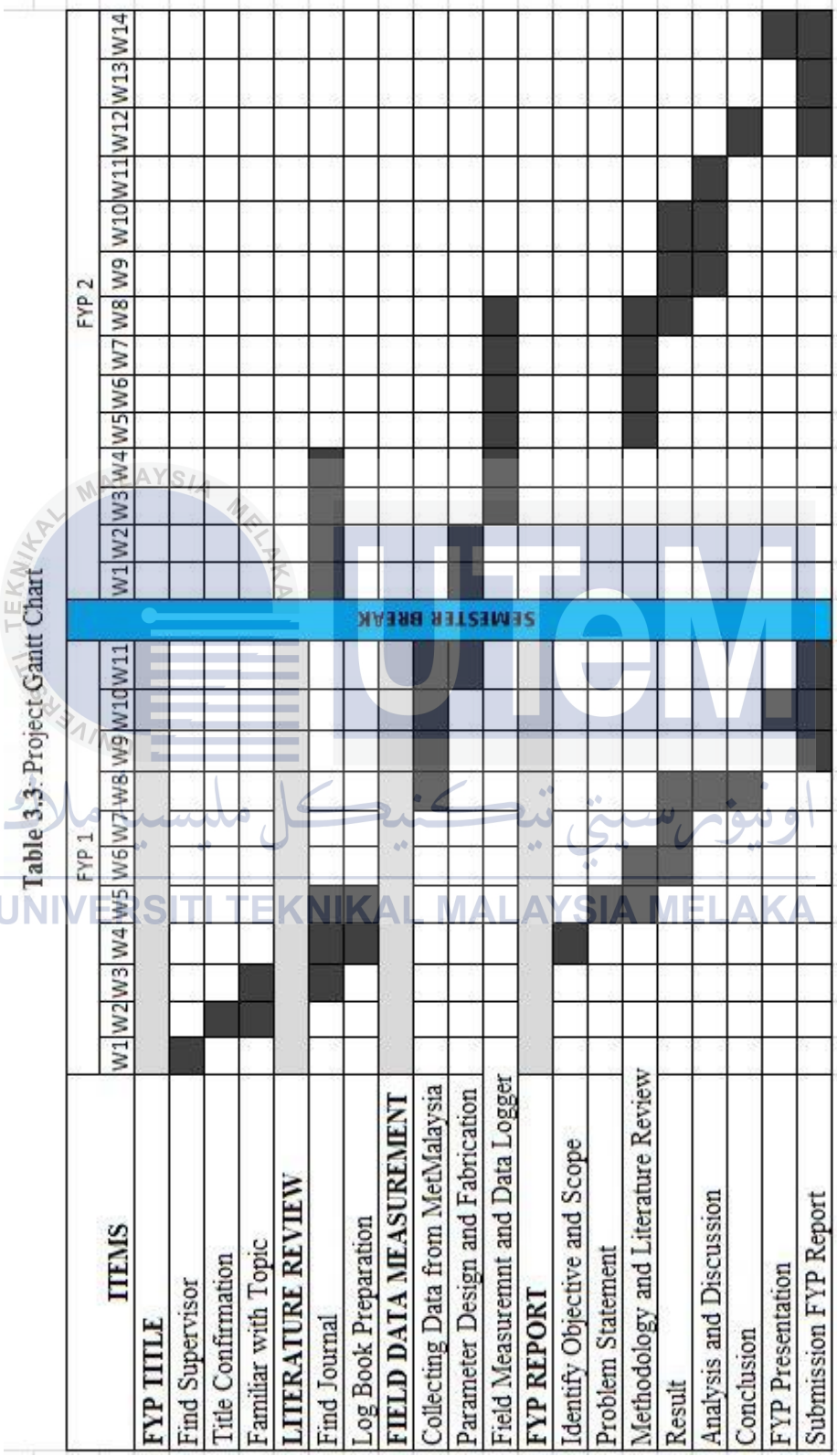


Table 3.3: Project Gantt Chart

ITEMS	FYP 1											SEMESTER BREAK	FYP 2														
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
FYP TITLE																										
Find Supervisor																										
Title Confirmation																										
Familiar with Topic																										
LITERATURE REVIEW																										
Find Journal																										
Log Book Preparation																										
FIELD DATA MEASUREMENT																										
Collecting Data from MetMalaysia																										
Parameter Design and Fabrication																										
Field Measuremnt and Data Logger																										
FYP REPORT																										
Identify Objective and Scope																										
Problem Statement																										
Methodology and Literature Review																										
Result																										
Analysis and Discussion																										
Conclusion																										
FYP Presentation																										
Submission FYP Report																										

The framework in this report will be covered in a period of one year which includes FYP 1 and FYP 2, the key milestones that will be shown in Table 3.4.

Table 3.4: The Key Milestones in this project

Number	Milestone	Date
1	i. Literature Review. ii. Study on the potential and technical aspects of the CSP parabolic dish system. iii. Investigate on environment effect in performing CSP in Malaysia. iv. Initial parabolic dish design and component finding for experiment implementation.	September-December 2013
2	i. Parameter design for parabolic dish mirror ii. Apparatus setup	January-February 2014
3	i. Field data measurement ii. Data Collection from Data Logger. iii. Result Analysis.	March-April 2014
4	i. Report Writing and Presentation.	May-June 2014

CHAPTER 4

RESULT AND DISCUSSION

4.0 Overview

This chapter will include the result and discussion of the project. On top of that, the results were directly corresponding to the objective of the project which has been stated in the introduction before.

4.3 Introduction

Concentration Solar Power (CSP) is the systems that depend from direct solar irradiation from the sun to the parabolic dish concentrator. Solar irradiation then was focus from concentrator to Stirling engine. In this project, the data were recorded for one month which is from 3rd March to 2nd April 2014.

4.4 Project Result

The data recorded are used for analysis the impact of weather environment in Melaka that will contribute to effectiveness of CSP parabolic dish, in order to preforms the Dish Stirling engine in Melaka environment. The range of time frame to measurement the temperature efficiency from 10.00 am until 4.00 pm for one month that been stated before. The temperature measured used the digital material thermometer as shown in Figure 4.1.

Figure 4.1: Digital Material Thermometer

4.4.1 Result from Data Logger

For this part the data been analysis of the changes of environment condition for 24-hours in one month by using data from Data Logger that been measured at Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka (UTeM) in Durian Tunggal, Melaka. The data been recorded with the interval of one hour daily. Full list of data enquired from data logger been display in Appendices B.

The graph below is shows the gradient changes of Melaka environment in one month that has been recorded before and been display in graphical forms in Figure 4.2, Figure 4.3, Figure 4.4, Figure 4.5 and Figure 4.6.

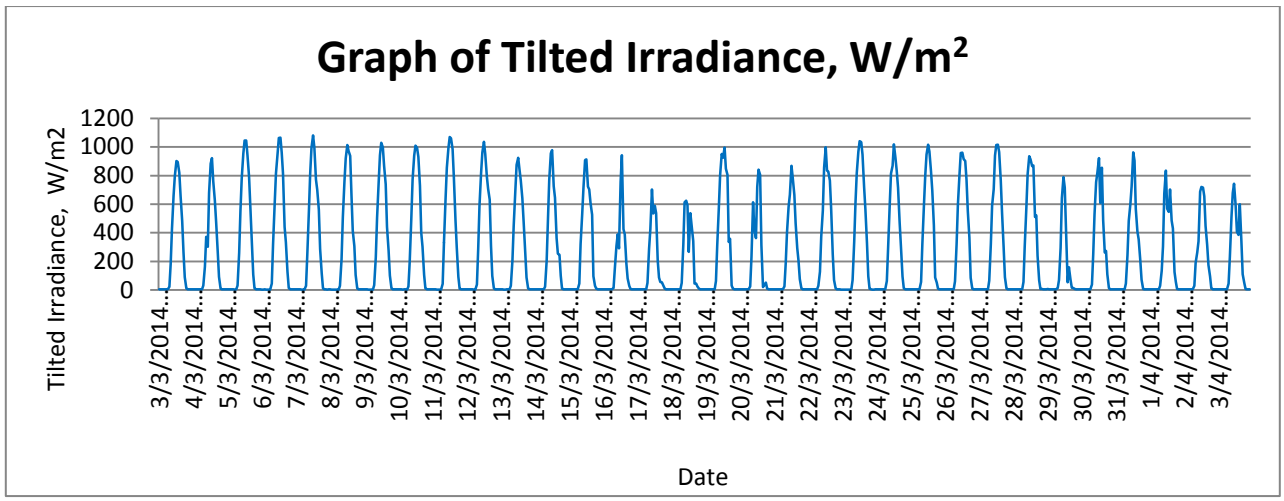


Figure 4.2: Graph of Tilted Irradiance for one month

Based on the Tilted Irradiance graph in Figure 4.2 above the solar irradiance begin increase higher staring 10.00am and reach to peak during 1.00 pm until 2.00pm which is above 1000W/m^2. In this 31days graph also shows that there is 12days which reach the solar irradiance above 1000W/m^2 and the other 15days indicate the solar irradiance reach between ranges of 800W/m^2 until 1000W/m^2. In this there still has the possibility to perform the CSP parabolic dish, because from the previous researches has been stated that Stirling-Engine will be able to operate in DNI above 1000W/m^2 [7]. The higher and consistent of solar irradiance will contribute to a better solar reflection to the receiver.

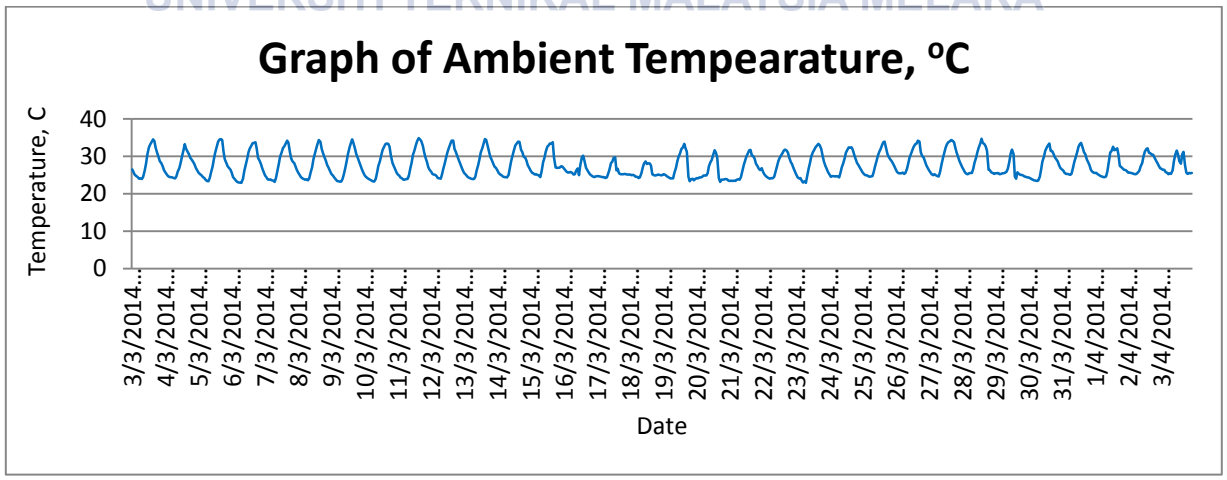


Figure 4.3: Graph of Ambient Temperature for one month

Based on the Ambient Temperature graph in Figure 4.3, the higher ambient temperature record is 34.8°C which is on 11 March 2014 at 4.00pm and the lowest ambient temperature is 22.9°C which is on 6 March 2014 at 8.00 am. The relation between ambient temperature and relative humidity it can be say it directly proportional, by referring Figure 4.3 and Figure 4.4, as the humidity increase it will affect the changes of ambient temperature, thus will disrupt the reliability of heat reflection to receiver. For graph of Relative Humidity in Figure 4.4 it can be say the humidity level at UTeM is quite high, which is above 80% for the whole month and the humidity level will be increasing a lot higher during rainy day that up to 99.2% which been shows in Figure 4.4 and Figure 4.5.

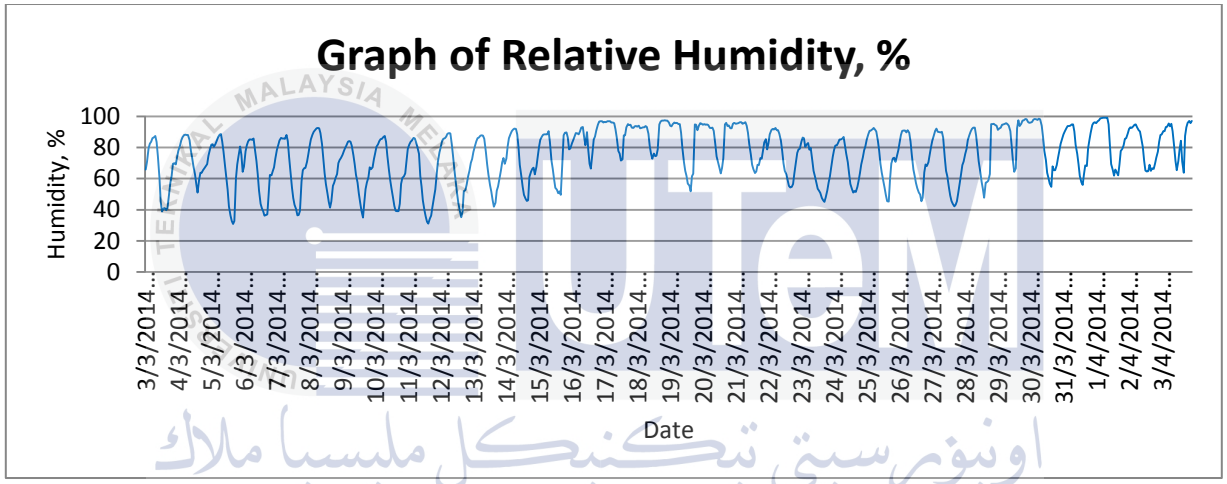


Figure 4.4: Graph of Relative Humidity for one month

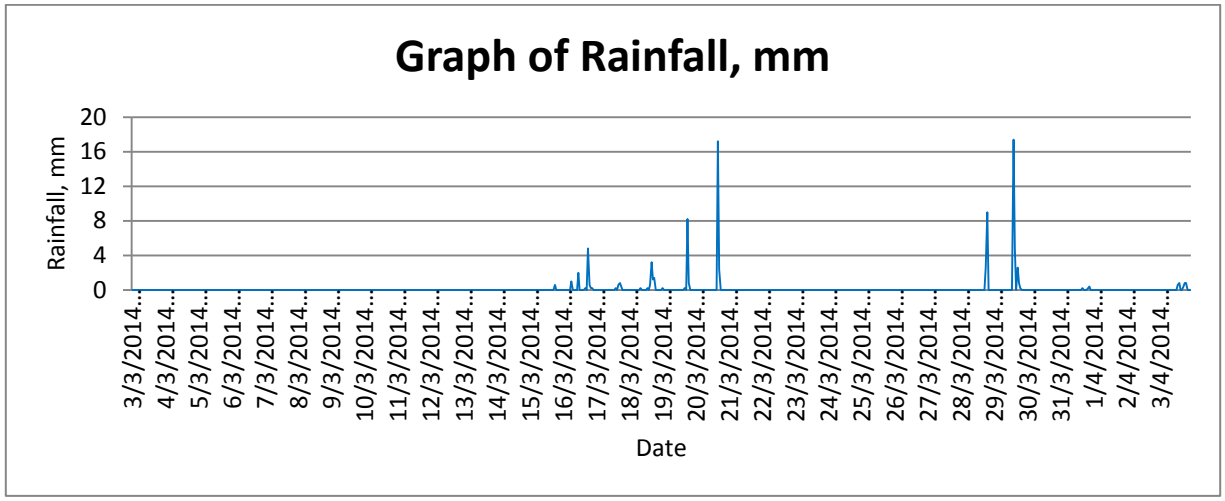


Figure 4.5: Graph of Total Rainfall for one month

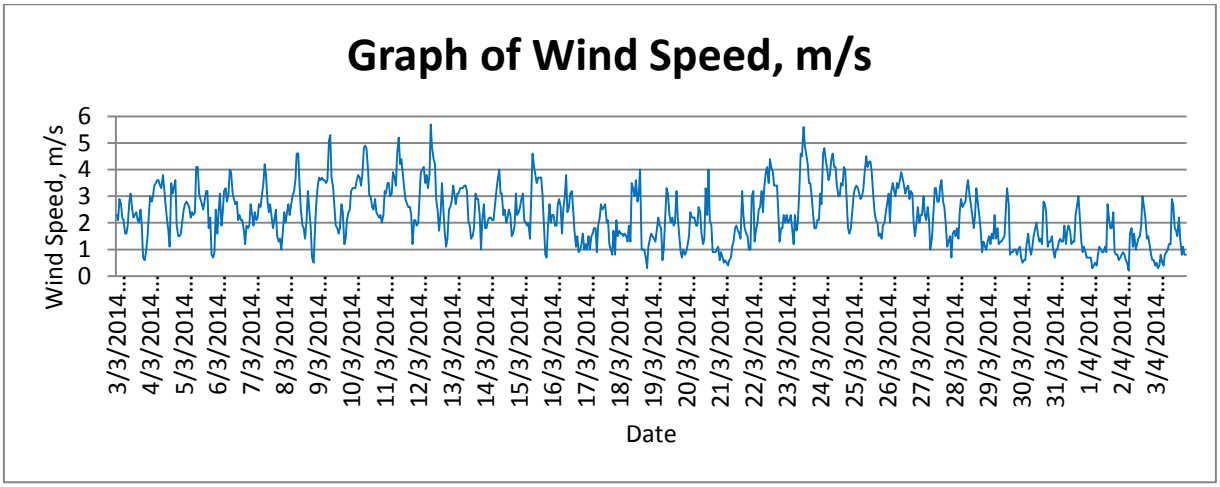


Figure 4.6: Graph of Wind Speed changes for one month

In average the wind speed from the Figure 4.6 it was rather low, the higher wind speed recorded is only 5.7m/s and the lowest wind speed that have been recorded is 0.4m/s, which will not affect the performance of the heat that been concentrate to focal point.

From the graphical display in Figure 4.2, Figure 4.3, Figure 4.4, Figure 4.5 and Figure 4.6, the changes environment condition also affect to solar irradiation which contribute to the temperature of concentrator parabolic dish, although there are also partially rain in one month measured but the irradiance also effect the by the relative humidity, ambient temperature and wind speed. This shows where as the increasing of relative humidity in the environment this cause in decreasing of the ambient temperature that later on will affect the temperature that been focus to the receiver.

4.4.2 Field Data Measurement Result

For this part the field data measurement that been recorded manually from 10.00am to 4.00pm for one month is been compared with the Data Logger that been measured automatically 24-hours for one month at Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka (UTeM) in Durian Tunggal, Melaka

Table below shows all the data that have been recorded previously into a table and graphical display in daily for one month data.

Table 4.1: Table recorded on 3 March 2014

Date	3/3/2014								
Environment condition	Haze and cloudy								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	71	54.2	99.2	41.2	26.2	425	74.5	2.8	0
11.00 am	67	47.2	98.1	40.9	28	659	60.3	3.1	0
12.00 pm	70	50.2	107.4	43	30.4	796	44.6	2.5	0
01.00 pm	68.1	47.9	115.1	44.6	32.4	902	39	2.2	0
02.00 pm	97.2	55.5	138.5	55.5	33.1	896	41	2.3	0
03.00 pm	53.2	47.2	90.3	44.3	33.7	819	41	2.4	0
04.00 pm	50.1	47.9	104.9	47.9	34.5	656	39.7	2.1	0

From the Table 4.1, the effect of environment such as the decreasing of the relative humidity will affect the increasing of ambient temperature and thus cause the increasing in the solar radiance. The environment wind speed for this day, are rather consistent. As the increase of the solar radiance this will affect the temperature at the dish receiver. The best possible for Stirling-Engine to operate is at 250^{o}C at the receiver[19], so based on the data recorded on 3 march 2014, the temperature at receiver will not contribute for the Stirling-Engine to operate. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.7.

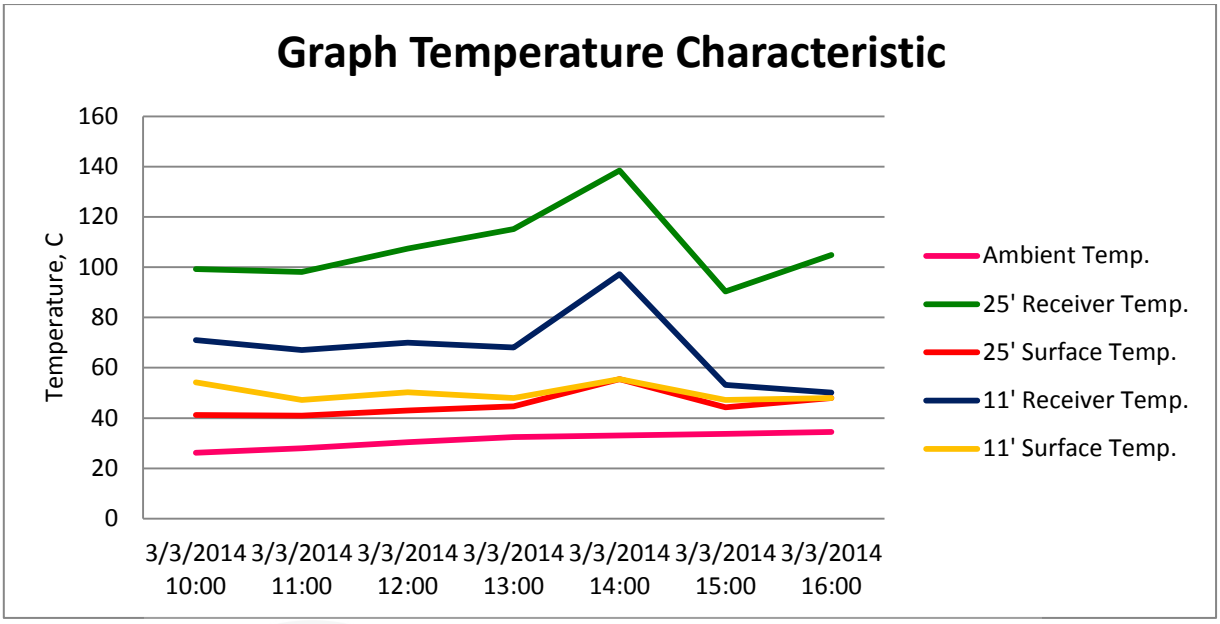


Figure 4.7: Graph of Temperature Characteristic on 3 March 2014

Table 4.2: Table recorded on 4 March 2014

Date	4/3/2014								
Environment condition	Haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	70	50.1	110.3	40	25.9	372	78.2	3.8	0
11.00 am	55.7	35.1	198.2	38.1	26.8	302	73.5	3.3	0
12.00 pm	150.5	34.3	259.3	40.2	28.2	681	68.1	2.7	0
01.00 pm	161.3	41.1	269.3	50.9	29.8	884	62.7	2.1	0
02.00 pm	239.7	35.9	270.2	36.1	31.6	923	56.6	1.7	0
03.00 pm	142.9	36.8	155.9	40.1	33.2	761	51.1	1.1	0
04.00 pm	97.8	35.1	44.5	38.9	32	627	59.5	3.5	0

From the Table 4.2, the effect of environment such as the decreasing of the relative humidity will affect the increasing of ambient temperature and thus cause the increasing in the solar radiance. The environment wind speed for this day, are rather higher at the morning and decreasing in speed in the evening. As the increase of the solar radiance this will affect the temperature at the dish receiver. It shows that during tilted irradiance 923W/m^2 the temperature reach up to 239.7^{o}C on 11inch dish and 270.2^{o}C on 25inch dish. The best possible for Stirling-Engine to operate is at 250^{o}C [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for three hour that is from 12.00pm to 2.00pm, meanwhile for 11inch parabolic dish don't reach the requirement for stirling-engine to operate. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.8.

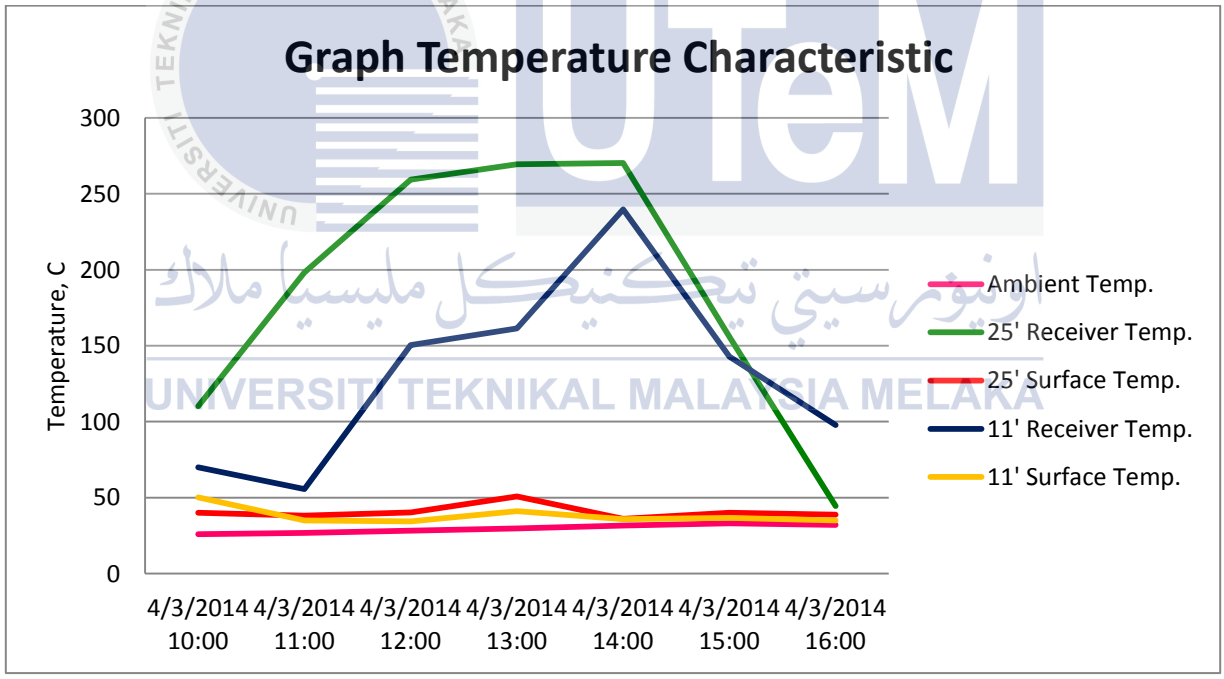


Figure 4.8: Graph of Temperature Characteristic on 4 March 2014

Table 4.3: Table recorded on 5 March 2014

Date	5/3/2014								
Environment condition	Haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	115.2	38.3	135.3	40.1	25.6	554	77.6	4.1	0
11.00 am	180.7	39.5	240.9	43.9	27.2	779	67.9	4.1	0
12.00 pm	197.2	47.7	277.3	45.8	29.2	953	60.5	3.1	0
01.00 pm	220.8	60.1	280.3	55.6	30.9	1046	52.8	2.9	0
02.00 pm	270.9	47	260.3	52.1	32.5	1045	42.2	2.7	0
03.00 pm	268.2	47	150.1	45	33.8	943	36.2	2.5	0
04.00 pm	50.1	39.1	88.2	40.4	34.4	789	32.7	2.8	0

From the Table 4.3, the effect of environment such as the decreasing of the relative humidity will affect the increasing of ambient temperature and thus cause the increasing in the solar radiance. The environment wind speed for this day, are rather higher at the morning and decreasing in speed in the evening. As the increase of the solar radiance this will affect the temperature at the dish receiver. It shows that during tilted irradiance $923W/m^2$ the temperature reach up to 239.7^oC on 11inch dish and 270.2^oC on 25inch dish. The best possible for Stirling-Engine to operate is at 250^oC [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^oC for three hour that is from 12.00pm to 2.00pm, meanwhile for 11inch parabolic dish don't reach the requirement for stirling-engine to operate. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.9.

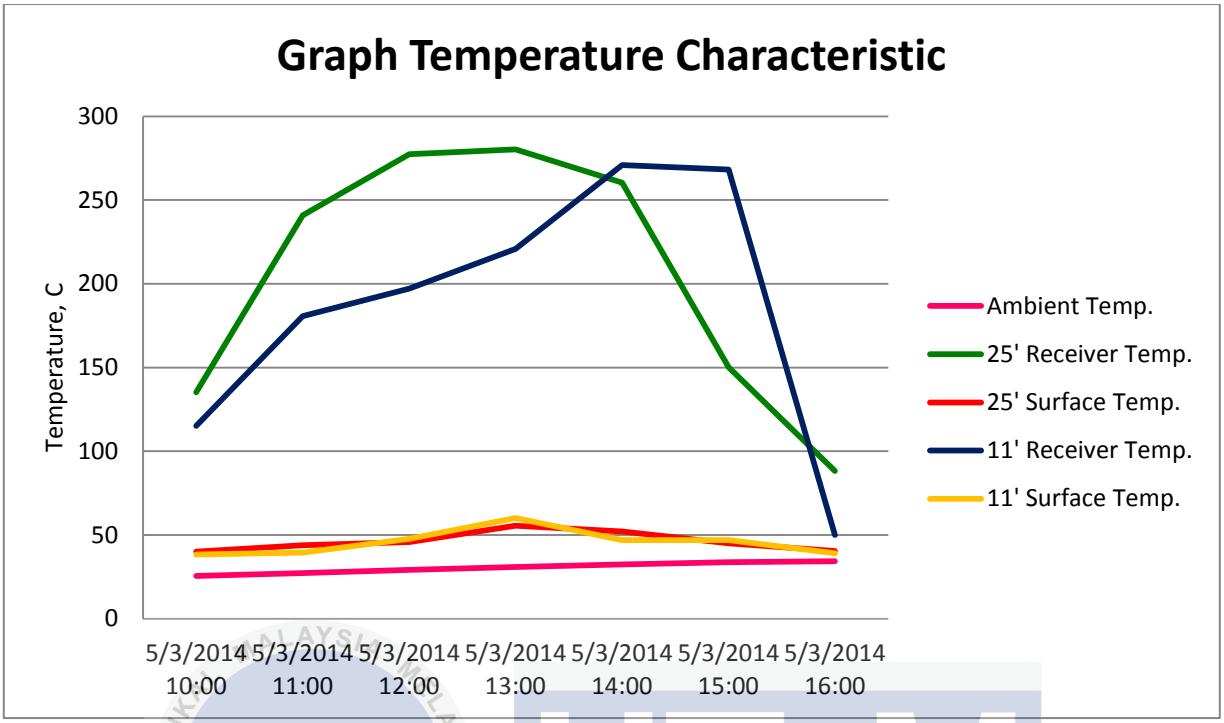


Figure 4.9: Graph of Temperature Characteristic on 5 March 2014

Table 4.4: Table recorded on 6 March 2014

Date	6/3/2014								
Environment condition	Clear Sky								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (°C)	Tilted Irradiance (W/m²)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (°C)	Surface Temp. (°C)	Temp. at receiver (°C)	Surface Temp. (°C)					
10.00 am	100.3	40	130	40.2	26	603	71.3	4	0
11.00 am	98.6	40.1	199.8	40.5	27.5	815	63	3.9	0
12.00 pm	110.7	43.2	267.2	52.6	29.3	950	52.5	3.1	0
01.00 pm	265.9	43.9	290.3	55.7	31	1062	43.8	2.9	0
02.00 pm	270.6	42.5	335.3	54.6	32	1064	41	2.7	0
03.00 pm	291.7	41.6	263.7	50.1	32.8	961	39.1	2.8	0
04.00 pm	171.1	38.1	190.7	45.2	33.5	814	36.2	2.1	0

From the Table 4.4, the effect of environment such as the decreasing of the relative humidity will affect the increasing of ambient temperature and thus cause the increasing in the solar radiance. The environment wind speed for this day, are rather higher at the morning and decreasing in speed in the evening. As the increase of the solar radiance this will affect the temperature at the dish receiver. It shows that during tilted irradiance 950 W/m^2 the temperature reach up to 110.7^{o}C on 11inch dish and 267.2^{o}C on 25inch dish. The best possible for Stirling-Engine to operate is at 250^{o}C [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for four hour that is from 12.00pm to 3.00pm, meanwhile for 11inch parabolic dish reach higher than 250^{o}C for three hours that is from 1.00pm to 3.00pm. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.10.

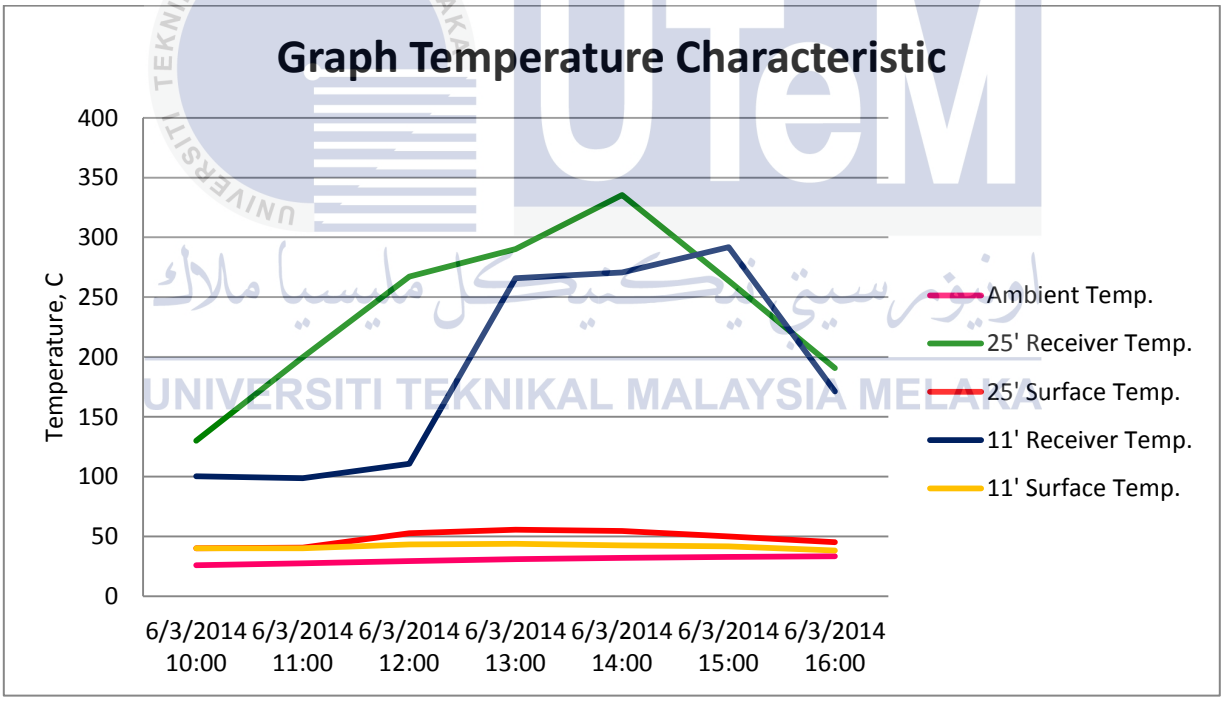


Figure 4.10: Graph of Temperature Characteristic on 6 March 2014

Table 4.5: Table recorded on 7 March 2014

Date	7/3/2014								
Environment condition	Clear Sky								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	110.4	45.6	161.2	60.3	26.3	555	74	3.5	0
11.00 am	145.3	46	263.1	60.9	28	817	65.2	4.2	0
12.00 pm	181.9	44.9	291.2	65.7	29.9	993	54.3	3.8	0
01.00 pm	280	50.1	304.3	69.8	31.1	1081	47.5	2.8	0
02.00 pm	267.1	50	269.7	69	32.2	995	43.2	2.4	0
03.00 pm	190.3	44.4	188.1	61.2	32.6	772	40.4	2.7	0
04.00 pm	90.6	45.3	70.1	44.2	33.5	701	36.5	2.2	0

From the Table 4.5, temperature at receiver is increase as the tilted irradiance increase for both parabolic dishes, it also recorded that the tilted irradiance this day is the highest for the whole month that is 1081W/m^2, from the data also shows that the changes of receiver temperature for both were rather the same, although the temperature for 25inch dish is higher than 11inch dish. The changes for temperature in for both dish surface temperature and the ambient temperature show almost also the same. From the Table 4.5, it also shows that the ambient temperature changes are directly proportional to the changes of the relative humidity in atmosphere and it also recorded during solar irradiance reach 555 W/m^2 of the relative humidity 74%. The wind speed it can be say the movement of wind speed is rather slow for the whole day. From the data also shows that this day during tilted irradiance 817 W/m^2 the receiver temperature reach up to 145.3^{o}C on 11inch dish and 263.1^{o}C on 25inch dish. The best possible for Stirling-Engine to operate is at 250^{o}C [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for four hours that is from 11.00m to 2.00pm, meanwhile for 11inch parabolic dish reach higher than 250^{o}C for two hour that is from 1.00pm to 2.00pm. The data also shows that

25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.11. From the Figure 4.12, the higher direct solar irradiance that been recorded from Data Logger is 1081W/m^2 at 1.00pm, if it been compared to the data that been measured as shown in Figure 4.11, the increasing of solar irradiance also affect the increasing in efficient of reflecting solar to the focal point, where it indicate the increasing up to 304.3^{o}C for 25 inches parabolic dish and 280.0^{o}C for 11inch parabolic dish, this higher recorded temperature also affect because of other environment condition such as clear sky, low wind speed, and low humidity level as shown in Figure 4.13 and Figure 4.14. This can be say that on this day environment condition it a suitable environment for the stirling-Engine to operate.

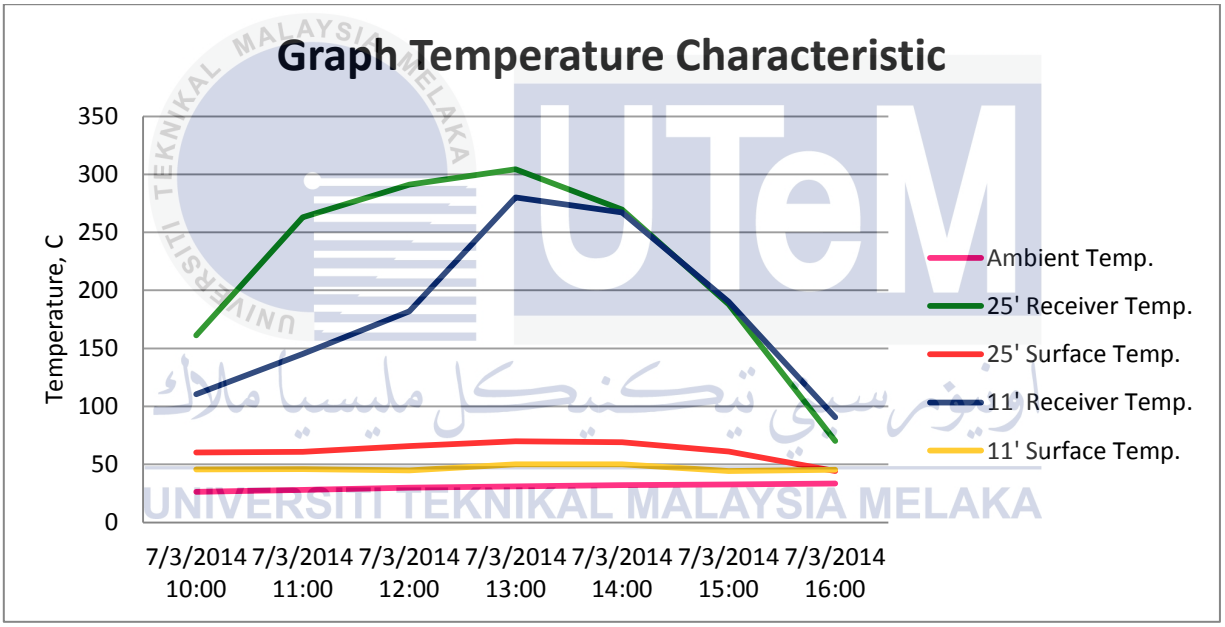


Figure 4.11: Graph of Temperature Characteristic on 7 March 2014

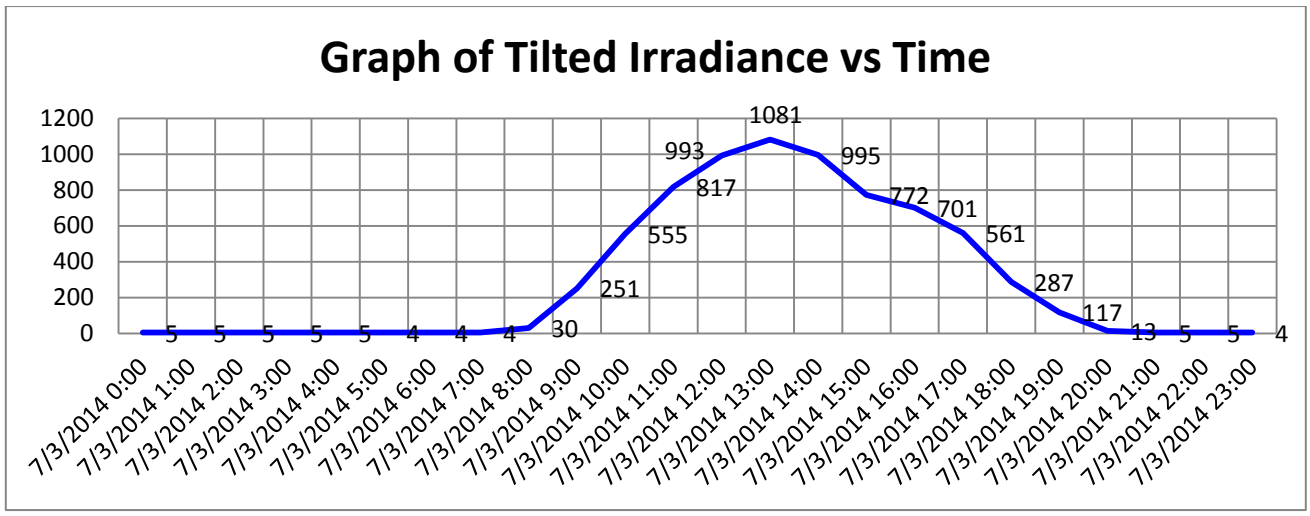


Figure 4.12: Plot of Higher Tilted Irradiance on 7 March 2014

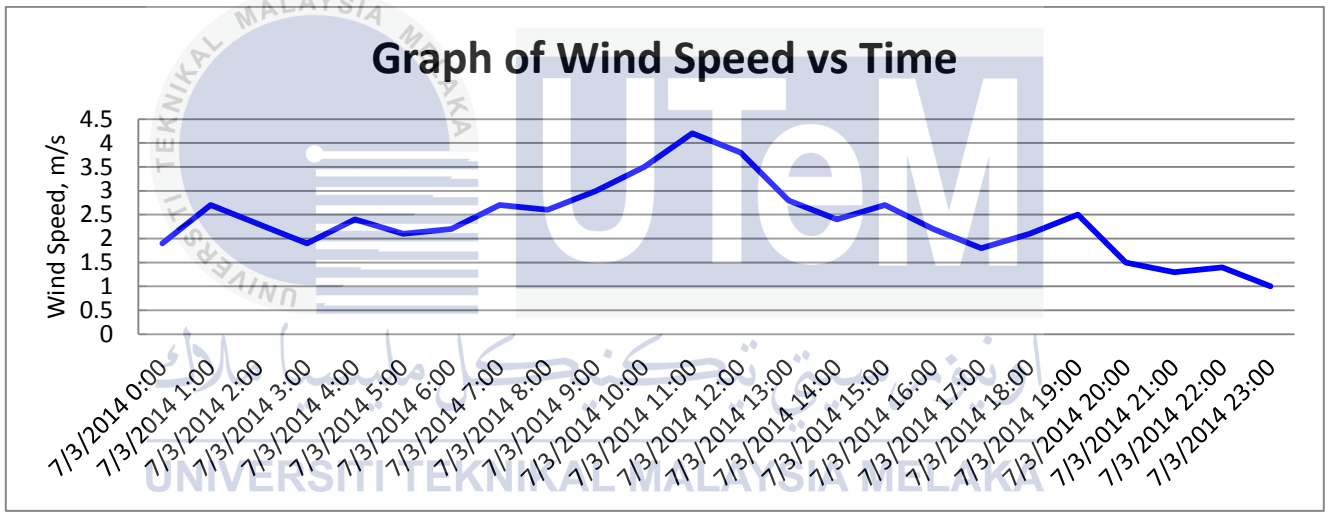


Figure 4.13: Plot of Wind Speed changes on 7 March 2014

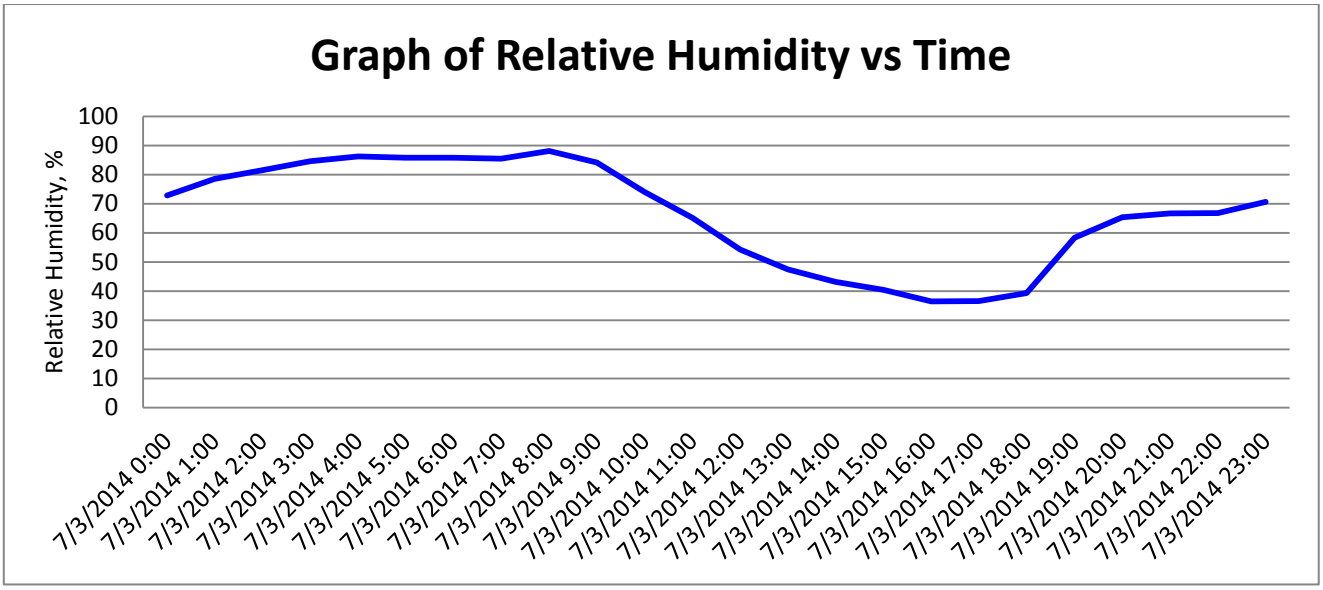


Figure 4.14: Plot of Humidity Level changes on 7 March 2014

Table 4.6: Table recorded on 8 March 2014

Date	8/3/2014								
Environment condition	Haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror / Time	11 inch size		25 inch size		Ambient Temp. (°C)	Tilted Irradiance (W/m²)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
	Temp. at receiver (°C)	Surface Temp. (°C)	Temp. at receiver (°C)	Surface Temp. (°C)					
10.00 am	120.4	40.6	150.3	60.3	25.5	508	82.1	4.6	0
11.00 am	109.7	40.4	240.9	59.4	27.1	756	72.9	4.6	0
12.00 pm	235.8	48.5	284.7	60.5	29.1	919	63.5	3.4	0
01.00 pm	261.3	47.7	340.1	45.7	30.5	1014	56.6	2.5	0
02.00 pm	296.7	43.1	292.3	44.9	32.1	972	50.4	1.9	0
03.00 pm	197.5	47.3	250.1	45	33.3	938	45	1.8	0
04.00 pm	70.2	40.1	82.2	40.6	34.3	663	41.3	1.4	0

From the Table 4.6, it is recorded the relative humidity is higher in the morning and continuous to decrease over time, on the other hand, ambient temperature continuous to raise up to 34.3^{o}C during 4.00pm, due to this two environment effect that increase the tilted irradiance. It is recorded tilted irradiance higher during 12.00pm until 3.00pm, which from 919W/m^2 to 1014W/m^2. The recorded data also shows that the tilted irradiance for this day is quite consistent. The best possible for stirling-Engine to operate is at 250^{o}C [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for four hour that is from 12.00pm to 3.00pm, which the same as the increasing of tilted irradiance, meanwhile for 11inch parabolic dish, it only be able to reach temperature at the receiver for only two hour that is from 1.00pm until 2.00pm. The movement of wind is rather quite slow during evening for this day. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.15.

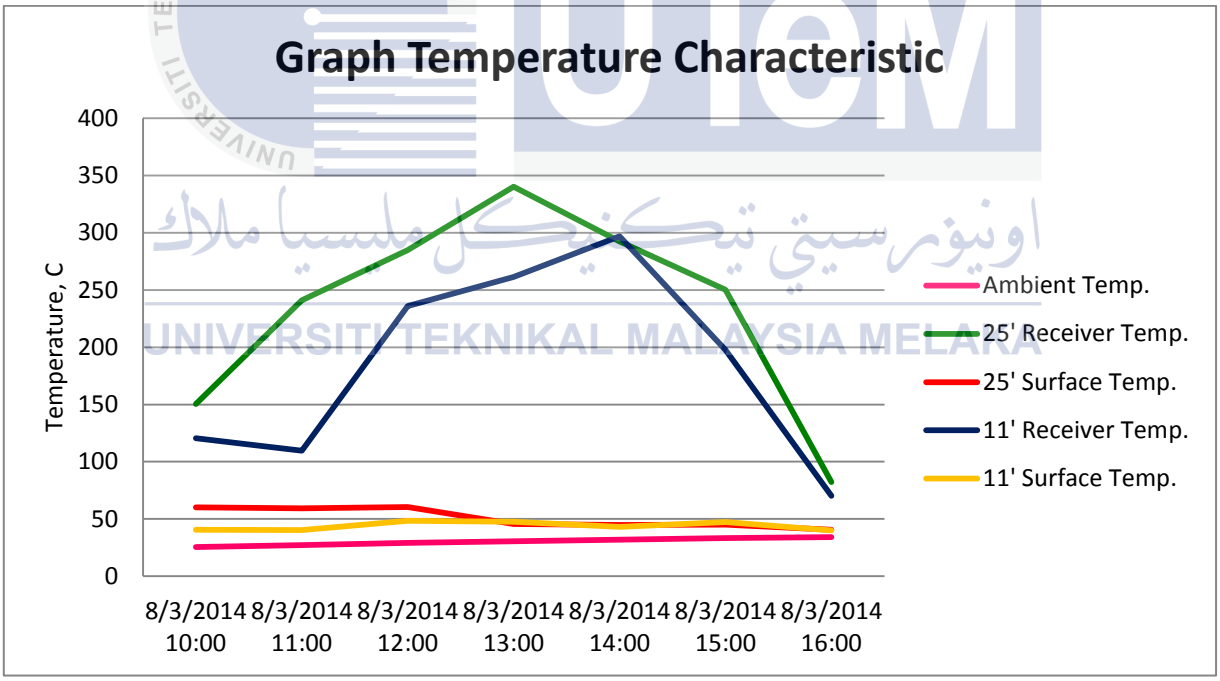


Figure 4.15: Graph of Temperature Characteristic on 8 March 2014

Table 4.7: Table recorded on 9 March 2014

Date	9/3/2014								
Environment condition	cloudy								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	70.2	40.2	98.2	50.1	25.1	507	69.4	5.3	0
11.00 am	75.2	40.3	110.1	51.2	27	755	62.6	3.7	0
12.00 pm	230.1	56.2	250	49.9	28.7	943	57.3	3.3	0
01.00 pm	190.2	55.2	260.2	48.9	30.6	1030	50.5	2.6	0
02.00 pm	158.1	35.5	267.1	47.8	32.4	998	44.9	1.9	0
03.00 pm	83.4	33.2	188.5	44.9	33.5	866	39.5	1.8	0
04.00 pm	55.2	37.1	49.8	42.1	34.5	739	35.1	1.6	0

From the Table 4.7, it is recorded the relative humidity is high in the morning and continuous to decrease over time, on the other hand, ambient temperature continuous to raise up to 34.5^{o}C during 4.00pm, due to this two environment effect that increase the tilted irradiance. It is recorded tilted irradiance higher during 12.00pm until 2.00pm, which from 943W/m^2 to 1030W/m^2. In average the tilted irradiance for this day is rather low this is due to the clouds that cover the solar irradiance. The recorded data also shows that the tilted irradiance for this day is quite consistent. The best possible for stirling-Engine to operate is at 250^{o}C at the receiver [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for three hour that is from 12.00pm to 2.00pm, which the same as the increasing of tilted irradiance, meanwhile for 11inch parabolic dish, it only be able to reach higher temperature at 230.1^{o}C at 12.00pm, the data for 11inch also shows that the temperature at receiver drop significantly after 12.00pm, it due to the could that cover 11inch dish. The movement of wind is rather quite slow during evening for this day. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.16.

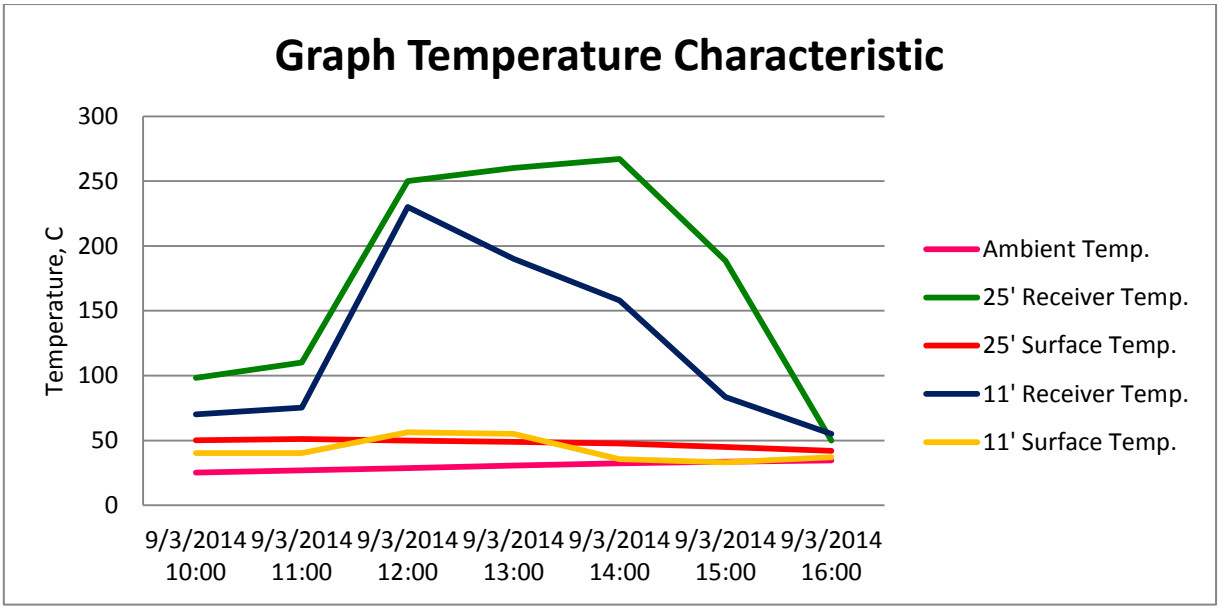


Figure 4.16: Graph of Temperature Characteristic on 9 March 2014

Table 4.8: Table recorded on 10 March 2014

Date	10/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	115.2	40.7	180.1	47.9	25.6	502	74.9	4.8	0
11.00 am	110.3	39.8	187.2	48	27.4	773	65.6	4.9	0
12.00 pm	145.7	45.6	240.1	48.1	28.7	939	59.1	4.8	0
01.00 pm	230.3	43.7	271.2	48.3	30.2	1009	53.7	4	0
02.00 pm	250.6	45	310.3	48.2	31.6	993	47.5	3	0
03.00 pm	120.6	42	261.3	47.8	32.5	931	42.4	3	0
04.00 pm	80.1	41.2	167.1	46.7	33.2	730	39.3	2.6	0

From the Table 4.8, it is recorded the relative humidity is high in the morning which is 74.9% and continuous to decrease over time, on the other hand, ambient temperature continuous to raise up to 32.5^{o}C during 4.00pm, this environment changes cause of increasing the tilted irradiance. It is recorded tilted irradiance higher during 12.00pm until 3.00pm, which from 931W/m^2 to 1009W/m^2. In average the tilted irradiance for this day is rather low this is due to the clouds and haze that cover the solar irradiance. The recorded data also shows that the tilted irradiance for this day is quite consistent from 12.00pm until 3.00pm. The best possible for Stirling-Engine to operate is at 250^{o}C at the receiver [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for three hour that is from 1.00pm to 3.00pm, which the same as the increasing of tilted irradiance, meanwhile for 11inch parabolic dish, it only be able to reach higher temperature at 250.6^{o}C at 2.00pm for one hour, the data for 11inch also shows that the temperature at receiver drop significantly after 2.00pm. The movement of wind speed is rather quite high during evening that cause the drop of temperature at 11inch parabolic dish. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.17.

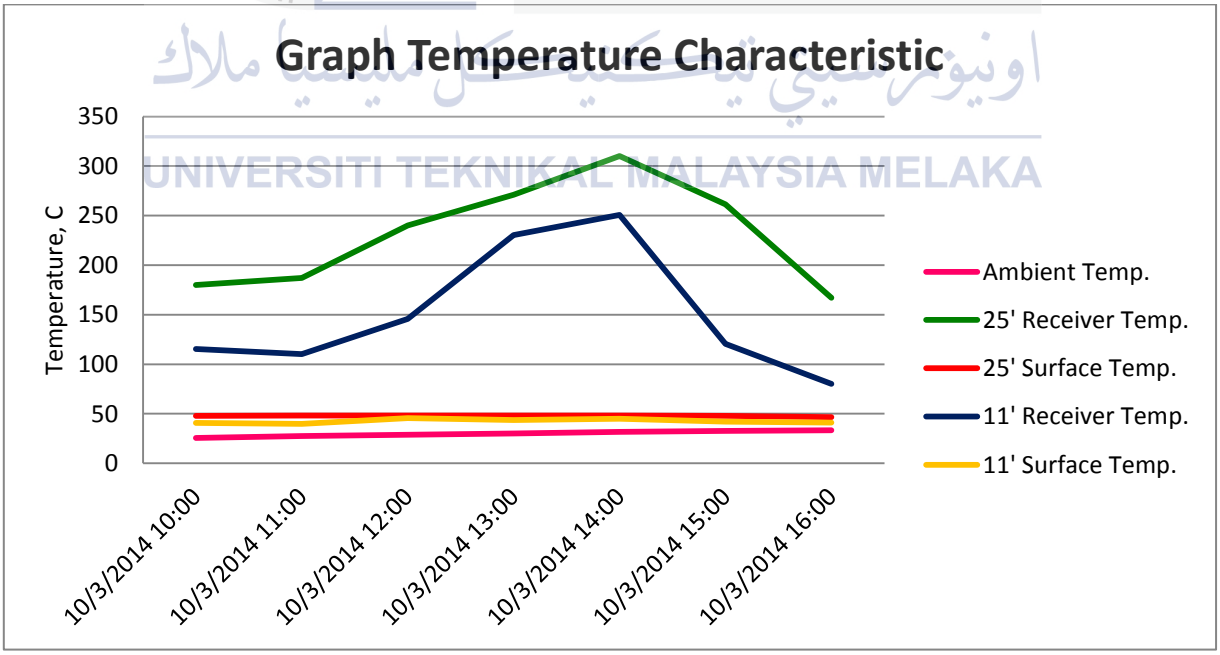


Figure 4.17: Graph of Temperature Characteristic on 10 March 2014

Table 4.9: Table recorded on 11 March 2014

Date	11/3/2014								
Environment condition	Clear sky								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	120.2	40.7	171.3	45.6	26.8	635	61.7	4.6	0
11.00 am	131.3	39.7	193.2	46.8	28.3	855	54.9	5.2	0
12.00 pm	135.6	46.5	200.9	46.7	30.3	993	46.2	4.2	0
01.00 pm	247.3	47.3	310.4	47.2	31.6	1069	39.8	4.4	0
02.00 pm	261.2	45.3	303.6	46.9	32.9	1060	35.7	3.8	0
03.00 pm	159.6	46.7	211.3	46	34	985	32.3	3.3	0
04.00 pm	110.3	40.6	181.3	40.7	34.8	785	31.1	2.9	0

From the Table 4.9, it is recorded the relative humidity is high in the morning which is 61.7% and continuous to decrease over time, on the other hand, ambient temperature continuous to raise up to 34.4^{o}C during 4.00pm, this environment changes cause of increasing the tilted irradiance. It is recorded tilted irradiance higher during 12.00pm until 3.00pm, which from 985W/m^2 to 1069W/m^2. In average the tilted irradiance for this day is rather high due to clear sky. The recorded data also shows that the tilted irradiance for this day is quite consistent from 12.00pm until 3.00pm. The best possible for Stirling-Engine to operate is at 250^{o}C at the receiver [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for two hour that is from 1.00pm to 2.00pm, meanwhile for 11inch parabolic dish, it only be able to reach higher temperature at 261.2^{o}C at 2.00pm for one hour. The movement of wind speed is rather quite high during evening that cause the drop of temperature at 11inch parabolic dish. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.18.

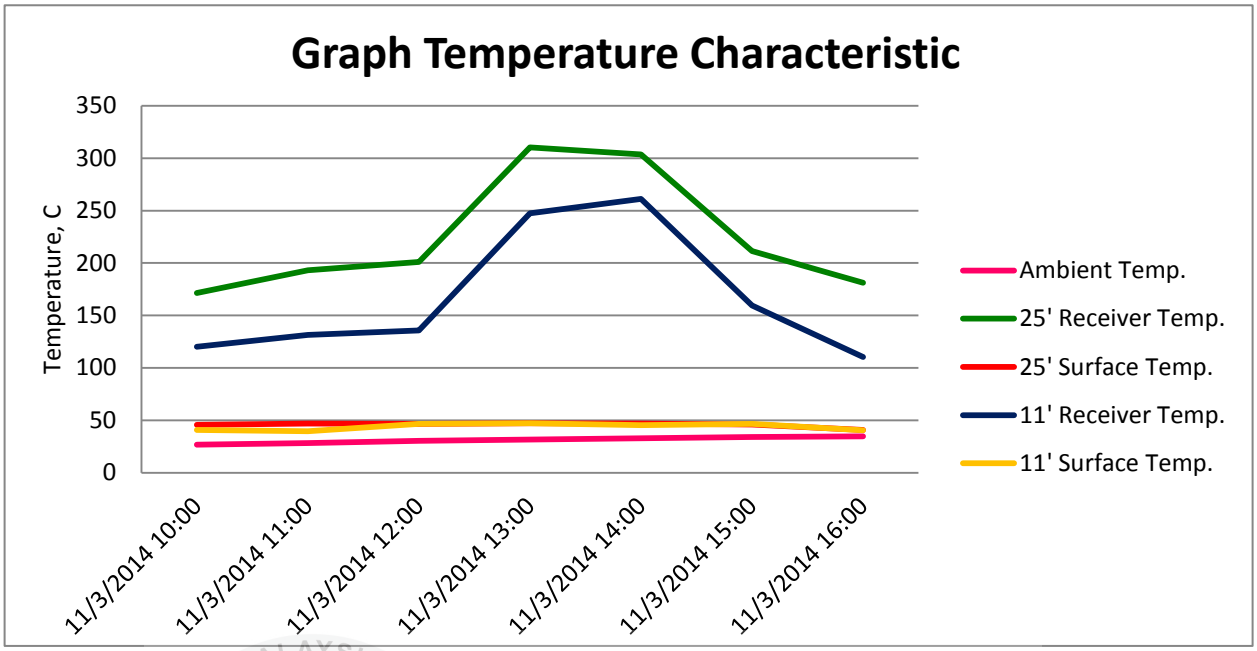


Figure 4.18: Graph of Temperature Characteristic on 11 March 2014

Table 4.10: Table recorded on 12 March 2014

Date	12/3/2014								
Environment condition	Clear sky								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	160.2	46.3	180.3	45.3	26.6	589	75.2	5.7	0
11.00 am	131.3	36.9	240.1	47.3	28.3	816	65	4.8	0
12.00 pm	141.2	47.8	273.3	47.9	29.7	963	57.7	4.4	0
01.00 pm	271.9	55.1	301.1	54.2	31.1	1035	50.5	4.2	0
02.00 pm	260.3	51.2	322.3	55.3	32.4	952	44.3	2.9	0
03.00 pm	240.3	47.7	303.9	49.7	33.3	794	38.9	2.4	0
04.00 pm	143.2	47	220.4	47.3	34.2	708	35.2	1.7	0

From the Table 4.10, it is recorded the relative humidity is high in the morning which is 75.2% and continuous to decrease over time, on the other hand, ambient temperature continuous to raise up to 34.2^{o}C during 4.00pm, this environment changes cause of increasing the tilted irradiance. It is recorded tilted irradiance higher during 12.00pm until 2.00pm, which from 963W/m^2 to 1035W/m^2. The increasing of tilted irradiance in environment will increase the temperature at receiver. The from previous research best possible for stirling-engine to operate is at 250^{o}C at the receiver [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for four hour that is from 12.00pm to 3.00pm, due to clear sky and low relative humidity, temperature at receiver 25inch dish reach higher than 300^{o}C for three hour, meanwhile for 11inch parabolic dish, it only be able to reach higher temperature at 250.6^{o}C at 1.00pm to 2.00pm for two hour, the data for 11inch also shows that the temperature at receiver drop at 11.00am by the cause of wind speed at 5.7m/s. The movement of wind speed for this day is the highest for this month as shows in Figure 4.19. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.20.

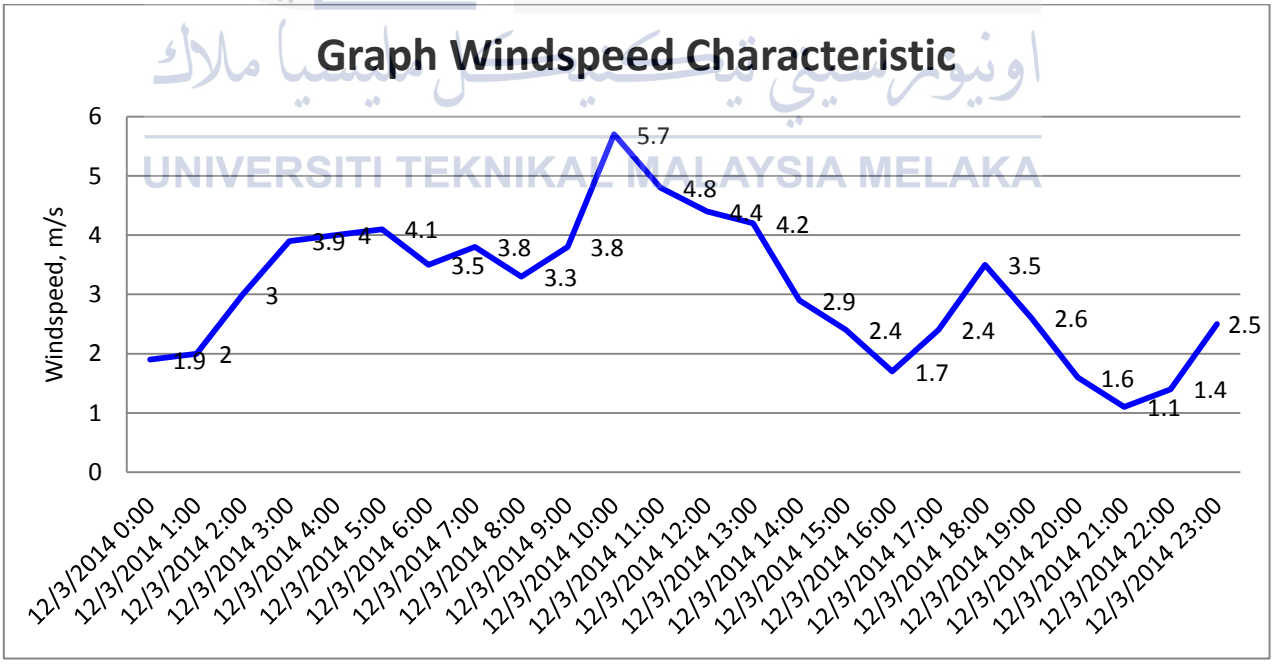


Figure 4.19: Graph of Windspeed Characteristic on 11 March 2014

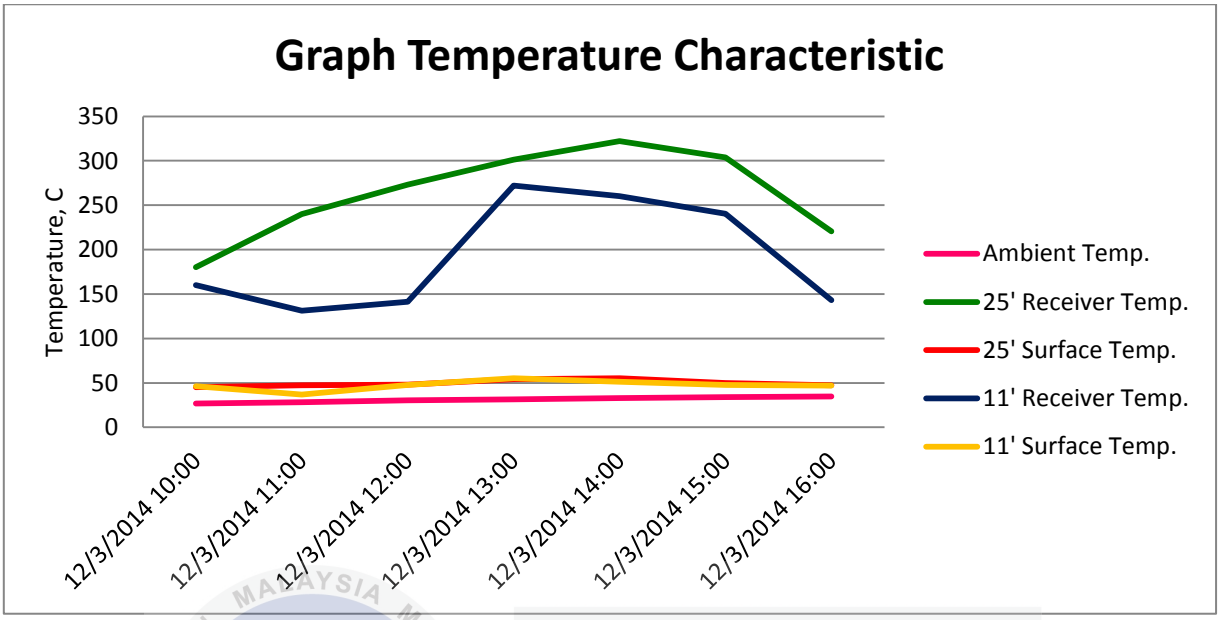


Figure 4.20: Graph of Temperature Characteristic on 12 March 2014

Table 4.11: Table recorded on 13 March 2014

Date	13/3/2014								
Environment condition	Cloudy								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (°C)	Surface Temp. (°C)	Temp. at receiver (°C)	Surface Temp. (°C)	Ambient Temp. (°C)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	141.3	45.2	170	45.9	26.1	452	77.1	3.4	0
11.00 am	161.3	46.3	234.7	47.4	27.7	692	69.1	3.4	0
12.00 pm	170.3	45.8	268.7	46.3	29.2	874	62.5	3.2	0
01.00 pm	220.3	47.3	301.1	49.4	31	925	55.8	2	0
02.00 pm	280.4	49.8	230.3	48.3	32.2	844	51.6	1.9	0
03.00 pm	150.7	44.3	160.4	44.6	33.4	768	46.4	1.4	0
04.00 pm	90	40.3	110.3	41.2	34.6	641	41.9	1.5	0

From the Table 4.11, it is recorded the relative humidity is high in the morning which is 77.1% and continuous to decrease over time, on the other hand, ambient temperature continuous to raise up to 34.6^{o}C during 4.00pm, this environment changes cause of increasing the tilted irradiance. It is recorded tilted irradiance higher during 1.00pm, which is 925W/m^{2}. The increasing of tilted irradiance in environment will increase the temperature at receiver. The from previous research best possible for Stirling-Engine to operate is at 250^{o}C at the receiver [19], so based on the data recorded the temperature at 25inch parabolic dish shows that the temperature at the receiver reach higher than 250^{o}C for four hour that is from 12.00pm to 3.00pm, meanwhile for 11inch parabolic dish, it only be able to reach receiver temperature higher than 250^{o}C for one hour at 2.00pm. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.21.

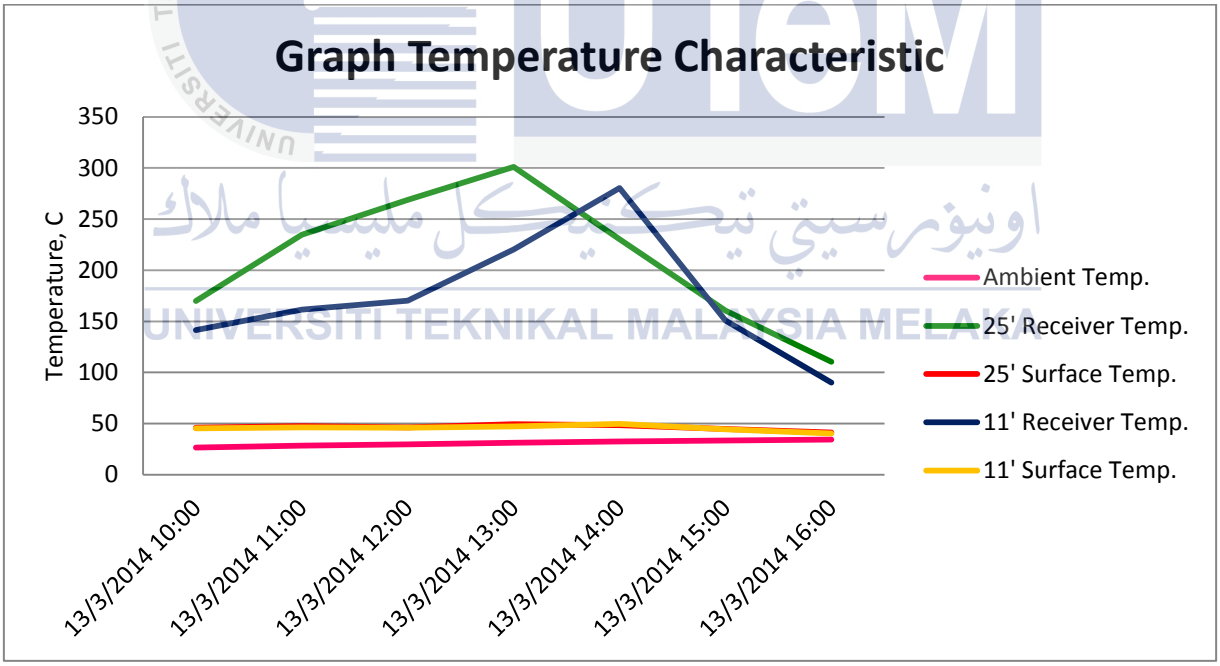


Figure 4.21: Graph of Temperature Characteristic on 13 March 2014

Table 4.12: Table recorded on 14 March 2014

Date	14/3/2014								
Environment condition	Haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	120.2	40.7	171.3	45.6	26.8	635	61.7	4.6	0
11.00 am	131.3	39.7	193.2	46.8	28.3	855	54.9	5.2	0
12.00 pm	135.6	46.5	200.9	46.7	30.3	993	46.2	4.2	0
01.00 pm	247.3	47.3	310.4	47.2	31.6	1069	39.8	4.4	0
02.00 pm	261.2	45.3	303.6	46.9	32.9	1060	35.7	3.8	0
03.00 pm	159.6	46.7	211.3	46	34	985	32.3	3.3	0
04.00 pm	110.3	40.6	181.3	40.7	34.8	785	31.1	2.9	0

From the Table 4.12, it is recorded the relative humidity is high in the morning which is 61.7% and continuous to decrease over time, while ambient temperature continuous to raise up to 34.8^{o}C during 4.00pm, this environment changes cause of increasing the tilted irradiance. It is recorded tilted irradiance rather high although there a haze, it is recorded the higher solar irradiance high than 1000W/m^2 for two hour, that cause increase the receiver temperature to higher than 300^{o}C from 1.00pm to 2.00pm. From the previous researcher best possible for stirling-engine to operate is at 250^{o}C at the receiver [19], so based on the data recorded the temperature at 25inch parabolic dish shows will be able to working from 1.00pm to 2.00pm, meanwhile for 11inch parabolic dish, it only be able to reach higher temperature receiver higher than 250^{o}C for only one hours. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.22.

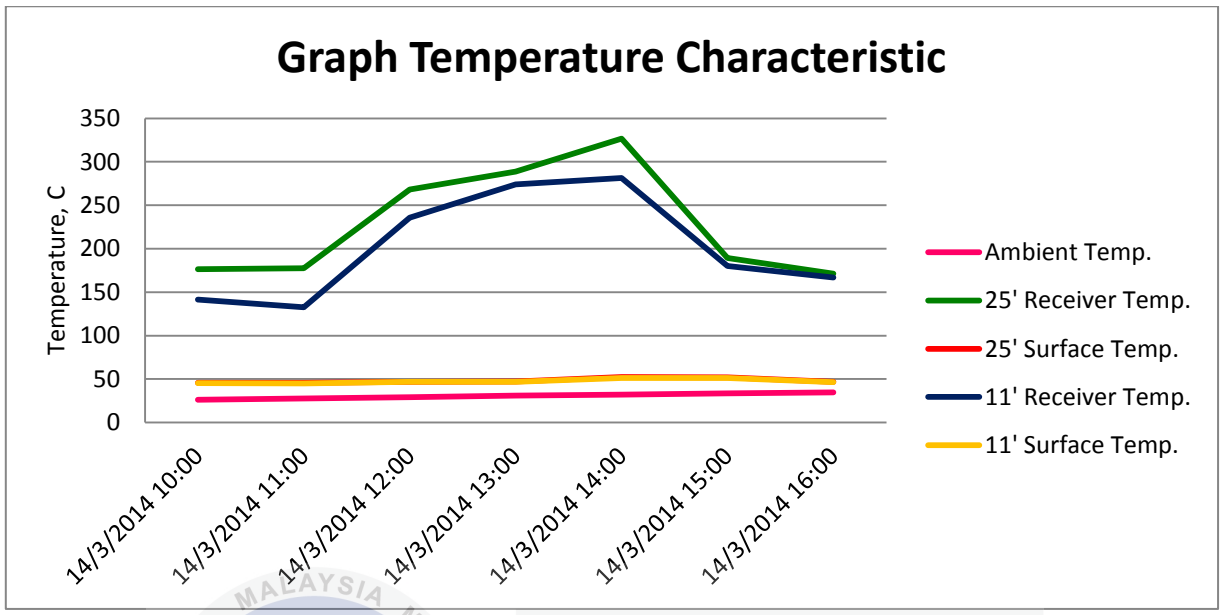


Figure 4.22: Graph of Temperature Characteristic on 14 March 2014

Table 4.13: Table recorded on 15 March 2014

Date	15/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	156	45.1	180.2	46.7	28.4	530	71.5	3	0
11.00 am	175.3	47.3	248.6	49.8	29.5	717	66.2	4.6	0
12.00 pm	174.1	46.6	246.7	49.7	31.2	909	59.9	4.1	0
01.00 pm	201.9	48.2	265.3	49.9	32.5	914	54.2	3.8	0
02.00 pm	251.1	51.3	309	50.3	32.9	724	52.8	3.5	0
03.00 pm	198.2	54.3	199.1	48.1	33.4	702	50.6	3.7	0
04.00 pm	120.3	49	124.2	45.1	33.4	610	51.8	3.7	0

From the Table 4.13, it is recorded the relative humidity is high in the morning which is 71.5% and continuous to decrease over time, while ambient temperature continuous to raise up to 33.4^{o}C during 4.00pm, this environment changes cause of increasing the tilted irradiance. It is recorded tilted irradiance rather low this will affect the solar irradiance that been focused to receiver. The data also shows that the wind speed in quite high at the evening, that may disrupt the reliability of heat reflection to the receiver. From the previous researcher best possible for stirling-engine to operate is at 250^{o}C at the receiver [19], so based on the data recorded the temperature at 25inch parabolic dish shows will be able to working from 1.00pm to 2.00pm, meanwhile for 11inch parabolic dish, it only be able to reach higher temperature receiver higher than 250^{o}C for only one hours. The data also shows that 25inch parabolic dish have higher heat reflection to the receiver compared to 11inch parabolic dish, as shows in Figure 4.23.

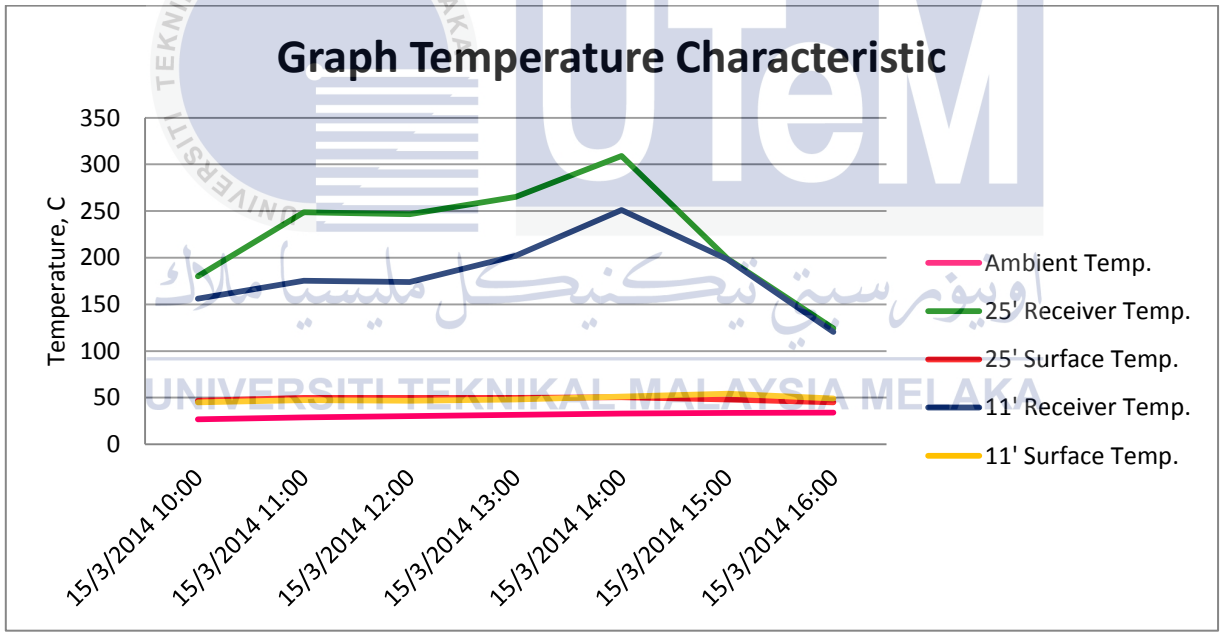


Figure 4.23: Graph of Temperature Characteristic on 15 March 2014

Table 4.14: Table recorded on 16 March 2014

Date	16/3/2014								
Environment condition	haze and light rainfall								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	Rain	Rain	Rain	Rain	26.1	307	86.7	3	0
11.00 am	Rain	Rain	Rain	Rain	26.7	390	81.4	3.8	0
12.00 pm	131.2	40.2	141.3	41.2	24.9	291	89.8	2.4	2
01.00 pm	138.3	40.1	142.4	42.3	27.6	754	78.4	2.6	0
02.00 pm	145.2	42.2	151.9	43.9	29.7	941	69.5	3.1	0
03.00 pm	88.2	35.1	170.4	37.2	30.1	425	66.5	3.2	0
04.00 pm	70.2	31.2	75.1	32.2	28.8	390	76.2	2.5	0

From the Table 4.14, it is recorded the relative humidity is high in the morning, which due to raining and continuous to decrease over time, while ambient temperature recorded drop while raining, this environment changes thus cause the decreasing of tilted irradiance. The relationship can been seen from table where at 12.00pm, the rainfall recorded 2mm, relative humidity increase to 89.9% and ambient temperature recorded drop to 24.9^oC, this changes of environment then cause the limitation of solar irradiance to 291W/m^2. The minimum of solar irradiance will disrupt the reliability of heat reflection to the receiver. Based on the data recorded at 25inch and 11inch parabolic dish, this whole day are not suitable for Stirling engine to operate as the receiver temperature cannot reach higher than 250^oC. The data also shows that 25inch parabolic dish have slightly increasing of temperature at 3.00pm, as shows in Figure 4.24 while the changes of rainfall shows in Figure 4.25.

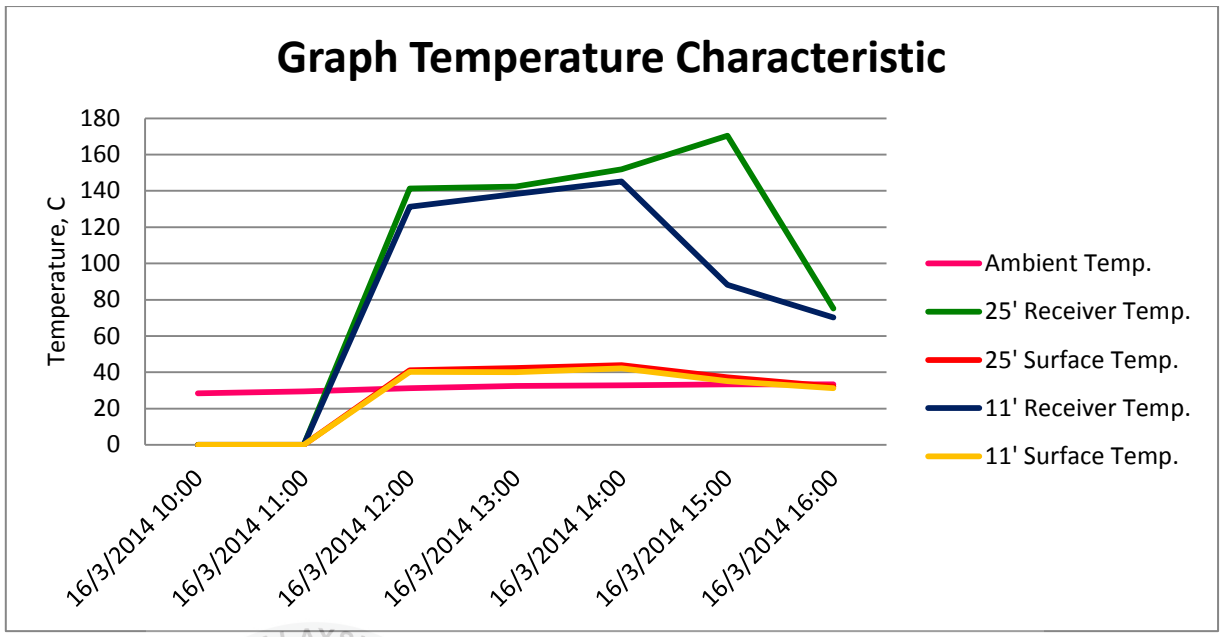


Figure 4.24: Graph of Temperature Characteristic on 16 March 2014

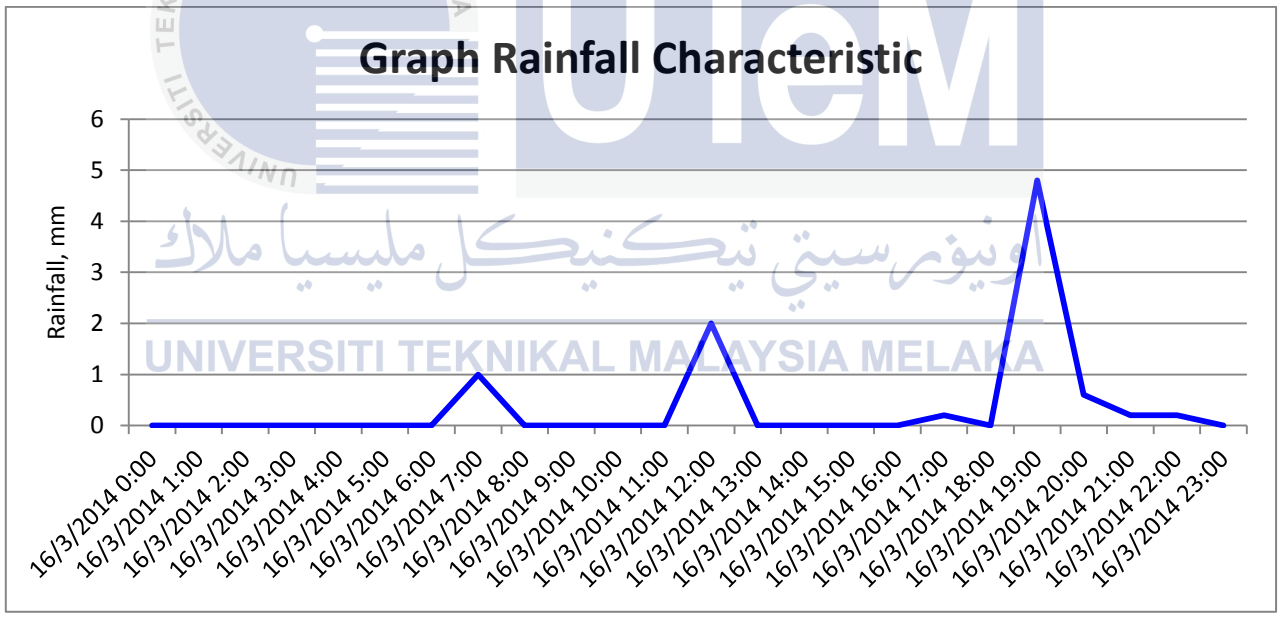


Figure 4.25: Graph of Rainfall Characteristic on 16 March 2014

Table 4.15: Table recorded on 17 March 2014

Date	17/3/2014								
Environment condition	haze and light rainfall								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	81	35.4	89.2	35.6	26.4	425	86.4	1.9	0
11.00 am	73.2	35.1	98.3	39.1	28.2	704	77.8	2.2	0
12.00 pm	118.1	34.4	137.2	36.9	28.5	536	76.1	2.7	0
01.00 pm	57.9	34.7	88	35.5	29.5	589	71.6	2.5	0
02.00 pm	rain	rain	rain	rain	29.7	537	72.3	2.6	0
03.00 pm	rain	rain	rain	rain	26.2	206	87.9	2.7	0.2
04.00 pm	rain	rain	rain	rain	26.6	88	87.8	2	0

From the Table 4.15, it is recorded the relative humidity is high early in the morning and late in the evening, which due to raining from previous day, while ambient temperature recorded drop while raining, this environment changes thus cause the decreasing of tilted irradiance. The relationship can been seen from table where at 3.00pm, the rainfall recorded 0.2mm, relative humidity increase to 87.9% and ambient temperature recorded drop to 26.2^{o}C, this changes of environment then cause the decreasing of solar irradiance from 537W/m^2 to 88W/m^2. The minimum of solar irradiance will disrupt the reliability of heat reflection to the receiver. Based on the data recorded at 25inch and 11inch parabolic dish, this whole day are not suitable for Stirling engine to operate as the receiver temperature cannot reach higher than 250^{o}C. The data also shows that 25inch and 11inch parabolic dish the receiving temperature drop from 12.00pm due to environment effect, as shows in Figure 4.26 while the changes of rainfall shows in Figure 4.27.

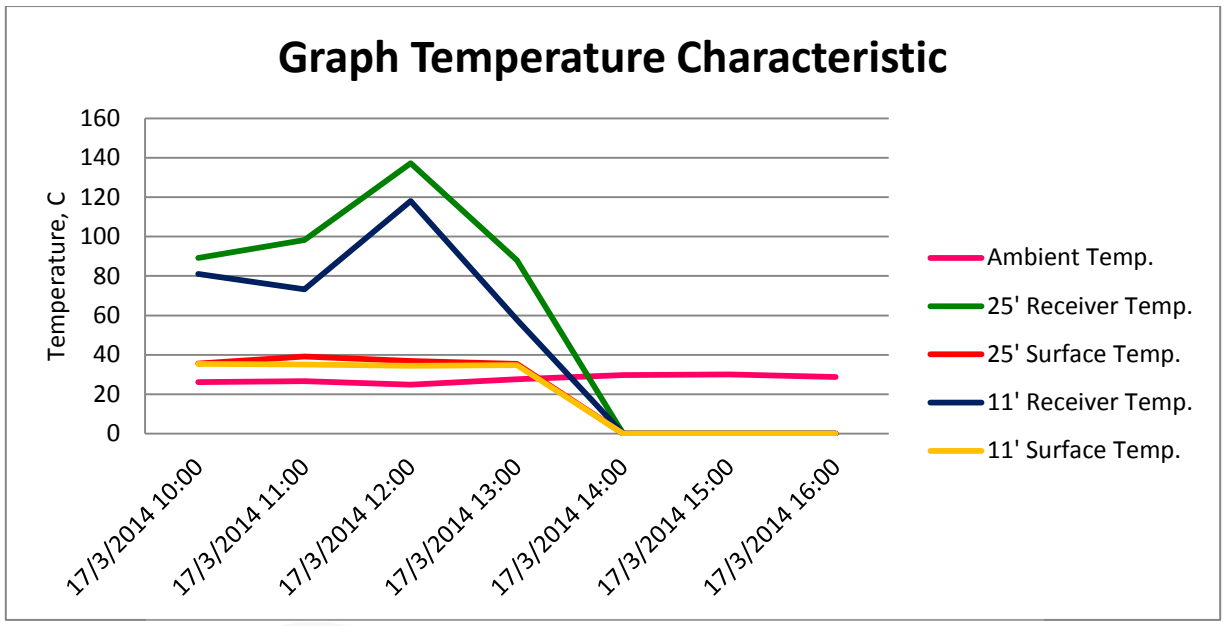


Figure 4.26: Graph of Temperature Characteristic on 17 March 2014

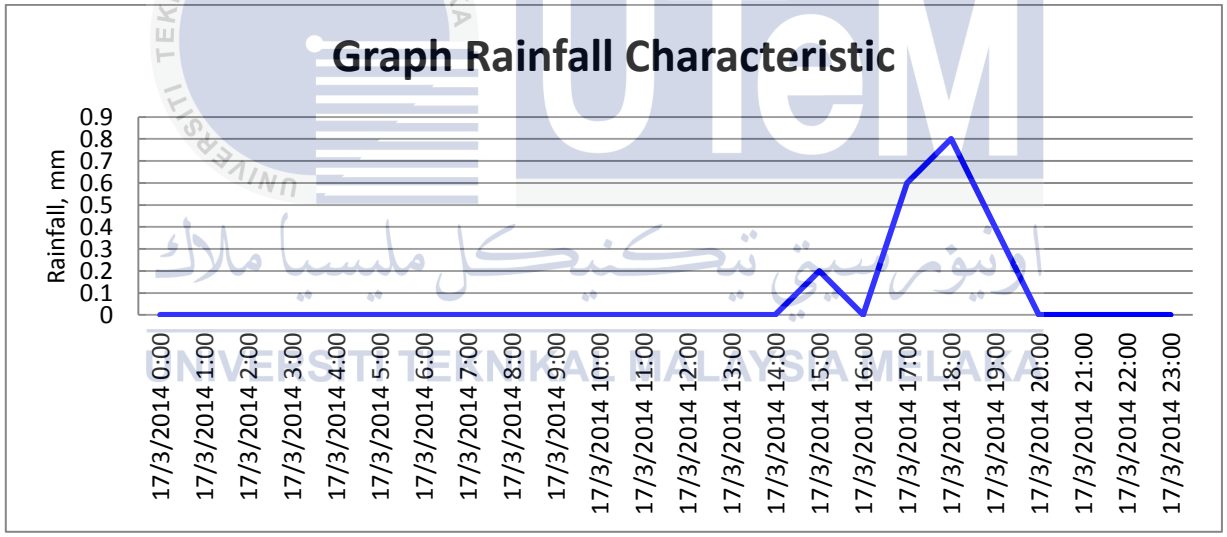


Figure 4.27: Graph of Rainfall Characteristic on 17 March 2014

Table 4.16: Table recorded on 18 March 2014

Date	18/3/2014								
Environment condition	Drizzly rain								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	71.2	40.2	99.7	42.7	26.9	613	81.1	3.5	0
11.00 am	72.4	38.9	97.6	42.3	28	624	76	3.3	0
12.00 pm	178.3	41.2	198.5	43	28.6	594	72.8	3	0
01.00 pm	199	42.6	220.6	45.6	27.9	267	76.1	3.6	0
02.00 pm	197.6	42.5	231.7	45.7	28.1	538	74.5	2.8	0.2
03.00 pm	110.6	49.1	230.6	46.8	28.1	451	74.7	3.1	0
04.00 pm	100.3	48.3	116.7	44.9	27.5	342	78.8	4	0.6

From the Table 4.16, temperature at receiver is increase as the tilted irradiance increase for both parabolic dishes, it also recorded that the tilted irradiance this day is the lowest for the average whole day, from the data also shows that the changes of receiver temperature for both were rather the same, although the temperature for 25inch dish is higher at 2.00 pm than 11inch dish. The changes for temperature in for both dish surface temperature and the ambient temperature show almost also the same. From the Table 4.16, it also shows that the ambient temperature changes are directly proportional to the changes of the relative humidity in atmosphere and it also recorded during solar irradiance reach 613 W/m^2 of the relative humidity 81.1%. The wind speed it can be say the movement of wind speed is rather intermediate for the whole day. From the data also shows that this day during the higher temperature can be reach is only 231.7^oC at tilted irradiance 538 W/m^2. The best possible for Stirling-Engine to operate is at 250^oC, so based on the data recorded the temperature at 25inch parabolic dish and 11inch parabolic dish are not suitable to operate the Stirling engine to working. The data also shows that 25inch parabolic dish have almost the same heat reflection to the receiver with 11inch parabolic dish, as shows in Figure 4.28. From the Figure 4.29, the

higher direct solar irradiance that been recorded from Data Logger is 0nly 624W/m^2 at 12.00pm, if it been compared to the data that been measured as shown in Figure 4.28, the decreasing of solar irradiance also affect the increasing in efficient of reflecting solar to the focal point, from environment condition as shown in Figure 4.30, Figure 4.31 and Figure 4.32, each changes of environment condition will a factor to measure the effective of using CSP parabolic dish in Melaka.

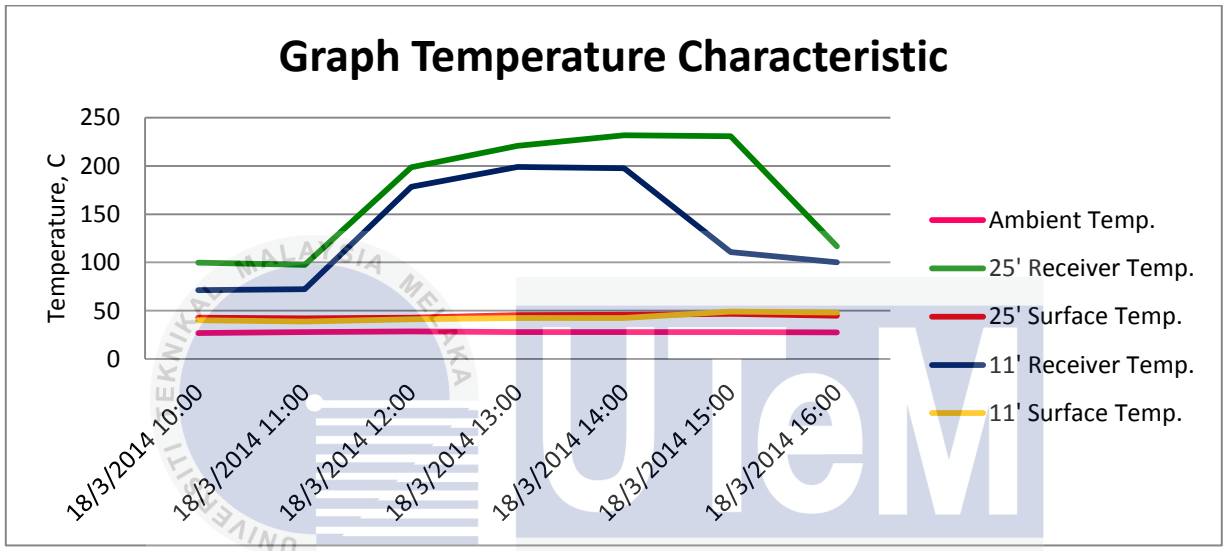


Figure 4.28: Graph of Temperature Characteristic on 18 March 2014

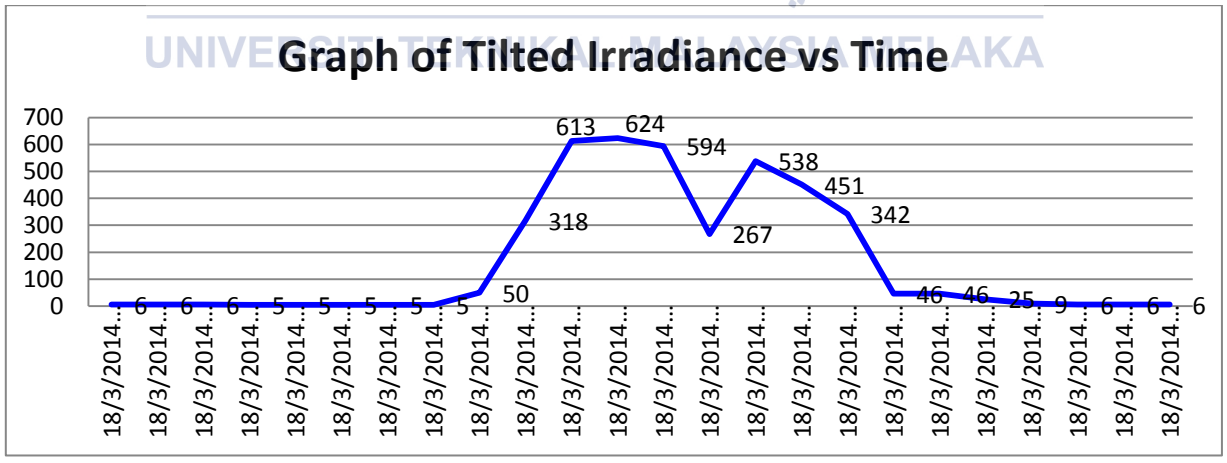


Figure 4.29: Plot of Lowest Average Tilted Irradiance on 18 March 2014

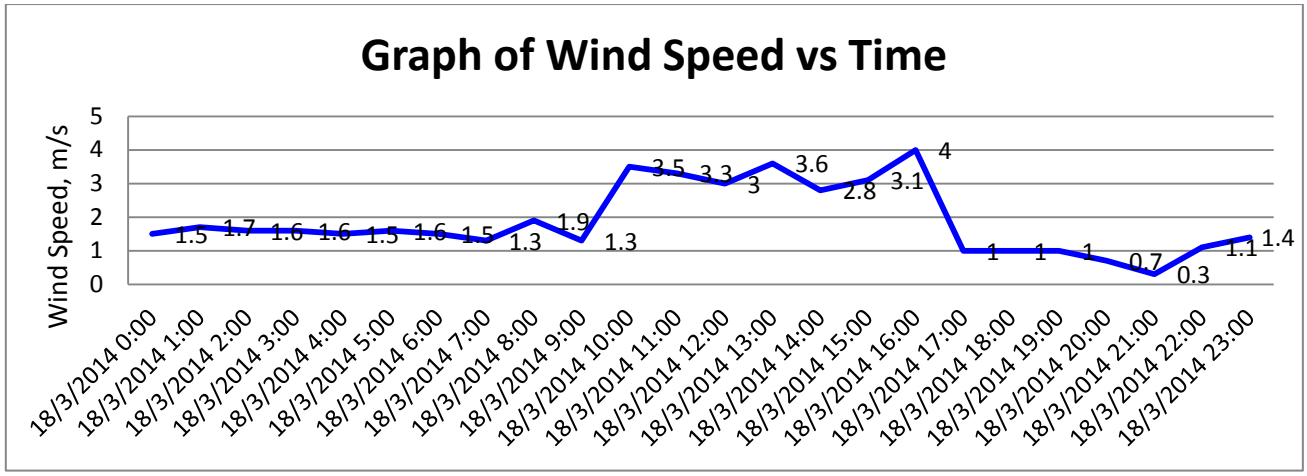


Figure 4.30: Plot of Wind Speed changes on 18 March 2014

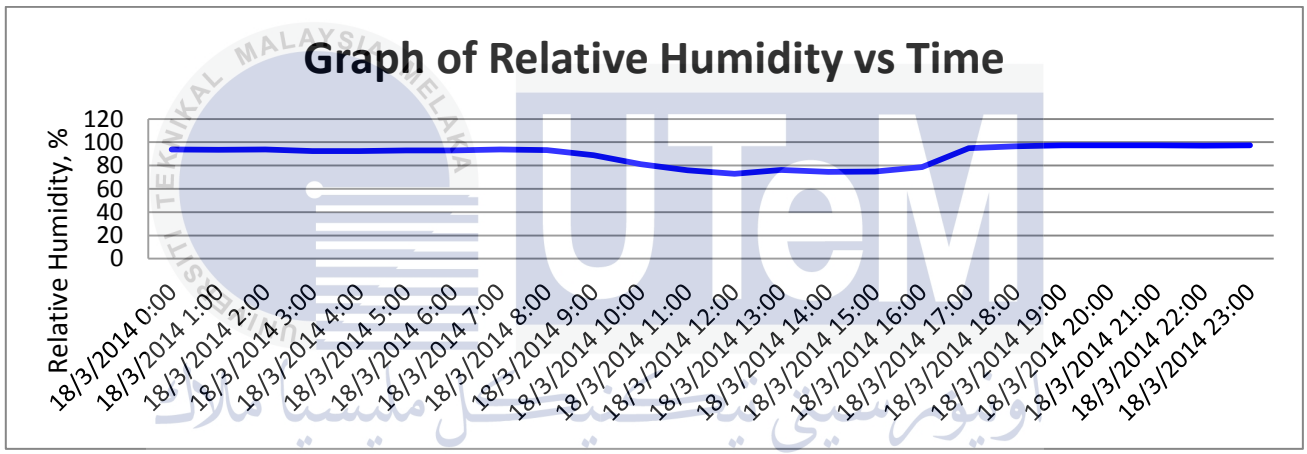


Figure 4.31: Plot of Relative Humidity changes on 18 March 2014

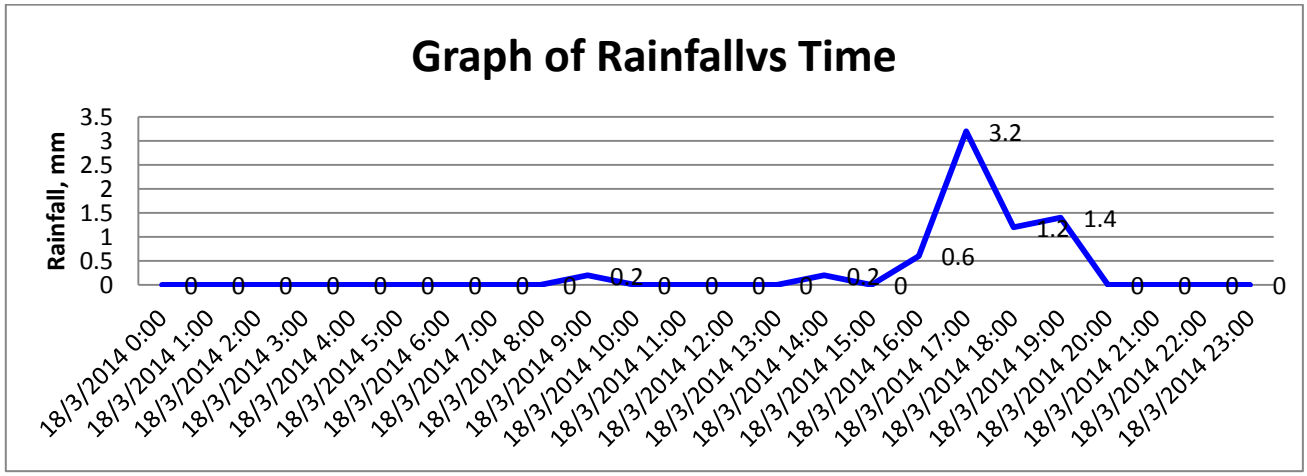


Figure 4.32: Plot of Rainfall changes on 18 March 2014

Table 4.17: Table recorded on 19 March 2014

Date	19/3/2014								
Environment condition	Haze and rain								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	70.6	36.2	100.3	44.6	26.9	576	79.8	2.3	0
11.00 am	76.3	37.2	110.3	45.7	28.5	803	70.5	3.3	0
12.00 pm	99.2	36.1	204.5	46.7	29.8	951	65	3.1	0
01.00 pm	110.3	50	184.2	44.8	30.8	925	61.8	2.3	0
02.00 pm	rain	rain	rain	rain	31.9	996	56.8	2	0
03.00 pm	rain	rain	rain	rain	32.3	849	55.5	2.2	0
04.00 pm	rain	rain	rain	rain	33.3	805	51.8	1.9	0

From the Table 4.17, it is recorded the relative humidity is high in the morning which is 79.8% and continuous to decrease over time, while ambient temperature continuous to raise up to 33.3^{o}C during 4.00pm, this environment changes cause reduction of tilted irradiance on parabolic dish surface. The relationship can been seen from Table 4.17 where at 10.00am, as relative humidity increase to 79.8% and ambient temperature recorded drop to 26.9^{o}C, this changes of environment then cause the limitation of solar irradiance 576W/m^2. The minimum of solar irradiance will disrupt the reliability of heat reflection to the receiver. Based on the data recorded at 25inch and 11inch parabolic dish, this whole day are not suitable for stirling engine to operate as the receiver temperature cannot reach higher than 250^{o}C. The data also shows that 25inch and 11inch parabolic dish the receiving temperature drop from 12.00pm due to environment effect, as shows in Figure 4.33.

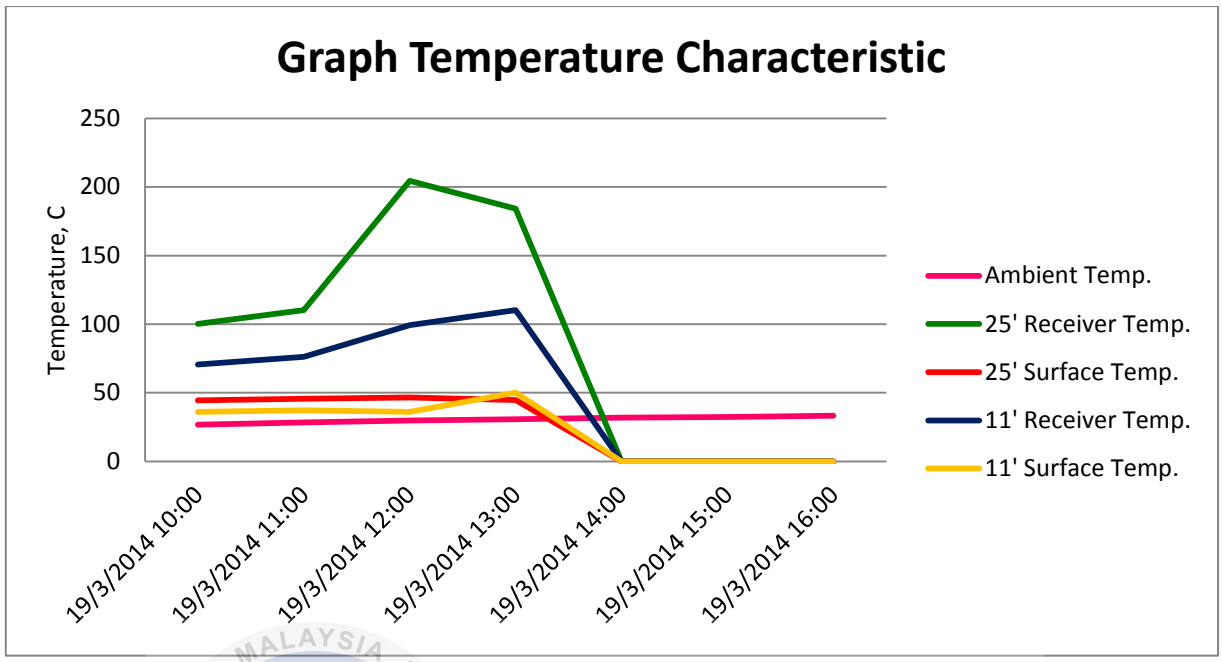


Figure 4.33: Graph of Temperature Characteristic on 19 March 2014

Table 4.18: Table recorded on 20 March 2014

Date	20/3/2014								
Environment condition	partially rain and haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	rain	rain	rain	rain	27.3	614	82.1	2.6	0
11.00 am	rain	rain	rain	rain	28.4	423	74.2	2.4	0
12.00 pm	88.7	42.3	100.2	43.5	29	364	70.9	1.6	0
01.00 pm	97.5	44.7	158.2	45.6	30.3	720	66.8	1.2	0
02.00 pm	180.7	55.7	200.5	56.2	31.6	842	63.3	1.4	0
03.00 pm	234.5	44.9	248.4	45.1	30.9	806	66.8	3.3	0
04.00 pm	164.6	44.8	189.5	45	29.6	315	73	2.3	0

From the Table 4.18, it is recorded the relative humidity is high in the morning which is 82.1% and continuous to decrease over time, while ambient temperature recorded high at 2.00pm which at 31.6^{o}C, this environment changes cause reduction of tilted irradiance on parabolic dish surface. It is recorded tilted irradiance this day was rather low, the higher tilted irradiance recorded only 842W/m^{2}. The minimum of solar irradiance will disrupt the reliability of heat reflection to the receiver. Based on the data recorded at 25inch and 11inch parabolic dish, this whole day are not suitable for Stirling engine to operate as the receiver temperature cannot reach higher than 250^{o}C. The data also shows that 25inch and 11inch parabolic dish the receiving temperature starting to increase from 12.00pm due reduction of relative humidity in the environment although don't reach 250^{o}C, as shows in Figure 4.34.

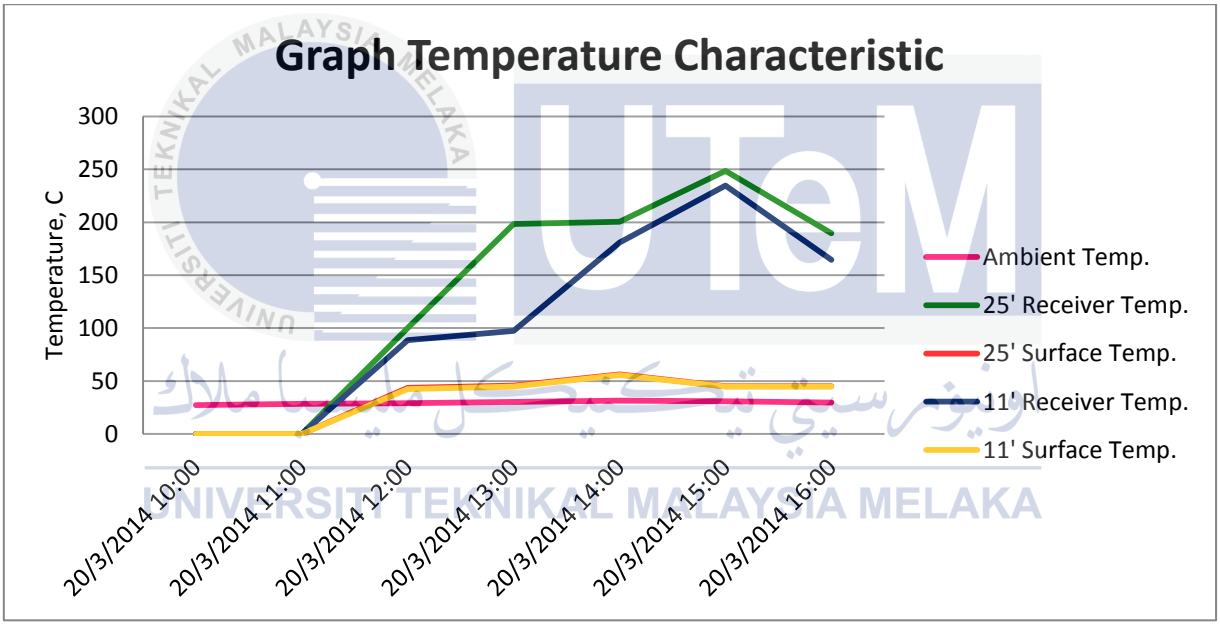


Figure 4.34: Graph of Temperature Characteristic on 20 March 2014

Table 4.19: Table recorded on 21 March 2014

Date	21/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	121.3	40.6	153.4	60.3	25.9	404	89.5	1.1	0
11.00 am	126.4	40.4	191.4	59.4	27.7	582	82.3	1.3	0
12.00 pm	236.9	48.6	270.4	60.5	28.8	668	75.5	1.8	0
01.00 pm	271.4	47.7	301.4	45.7	29.9	869	68.9	1.9	0
02.00 pm	195.3	45.1	292.3	44.9	30.8	784	66.1	1.7	0
03.00 pm	94	47.3	82.2	40.6	31.6	664	63.5	1.6	0
04.00 pm	rain	rain	rain	rain	31.7	466	64.5	1.4	0

From the Table 4.19, it is recorded the relative humidity is high in the morning which is 89.5% and continuous to decrease over time, while ambient temperature recorded increasing in temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. It is recorded tilted irradiance this whole day was rather low, the higher tilted irradiance recorded only 869W/m^2. The minimum of solar irradiance will disrupt the reliability of heat reflection to the receiver. Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], the data recorded at 25inch shows that temperature at receiver reach higher than 250^{o}C for three hour, while 11inch parabolic dish only be able to reach one hour temperature that higher than 250^{o}C. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.35.

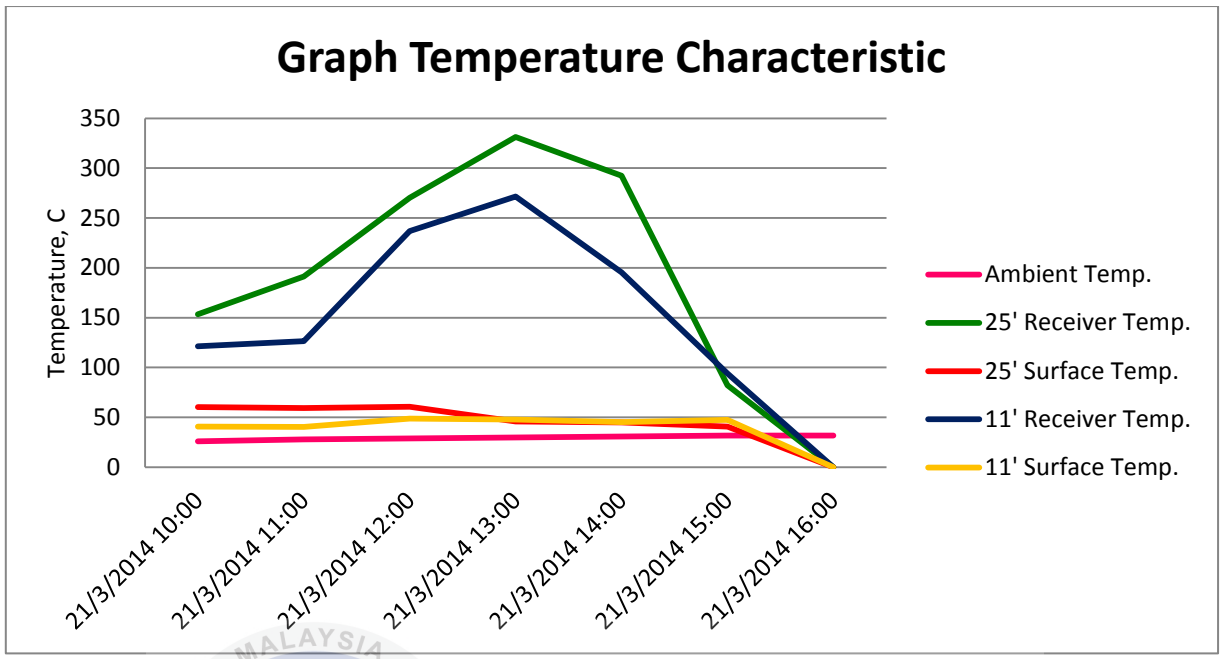


Figure 4.35: Graph of Temperature Characteristic on 21 March 2014

Table 4.20: Table recorded on 22 March 2014

Date	22/3/2014								
Environment condition	Clear sky and windy								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	78.1	40.5	110.4	44.5	25.8	375	84.3	3.9	0
11.00 am	179.3	41.2	175.6	45.6	27.1	556	77.7	4.1	0
12.00 pm	198.6	41.9	250.7	45.9	28.7	858	69.9	3.5	0
01.00 pm	180.9	44.5	275.6	50.6	29.5	997	65.1	4.4	0
02.00 pm	261.2	45.6	266.5	51.9	30.1	834	62.7	4.1	0
03.00 pm	253.4	43.2	257.5	50.8	30.8	827	59.1	3.9	0
04.00 pm	100.9	43.4	154.3	49.2	31.5	766	55.3	3.4	0

From the Table 4.20, it is recorded the relative humidity is high in the morning which is 84.3% and continuous to decrease over time, while ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. It is recorded tilted irradiance this whole day was rather low, the higher tilted irradiance recorded only 997W/m^2. The minimum of solar irradiance will disrupt the reliability of heat reflection to the receiver. Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], the data recorded at 25inch shows that temperature at receiver reach higher than 250^{o}C for four hour from 12.00pm until 3.00pm, while 11inch parabolic dish only be able to reach for two hour temperature that higher than 250^{o}C, this whole day are not suitable for Stirling engine to operate as the receiver temperature cannot reach higher than 250^{o}C. Figure 4.36 also shows that 11inch dish have significant drop in receiver temperature which cause by the movement of wind. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.36.

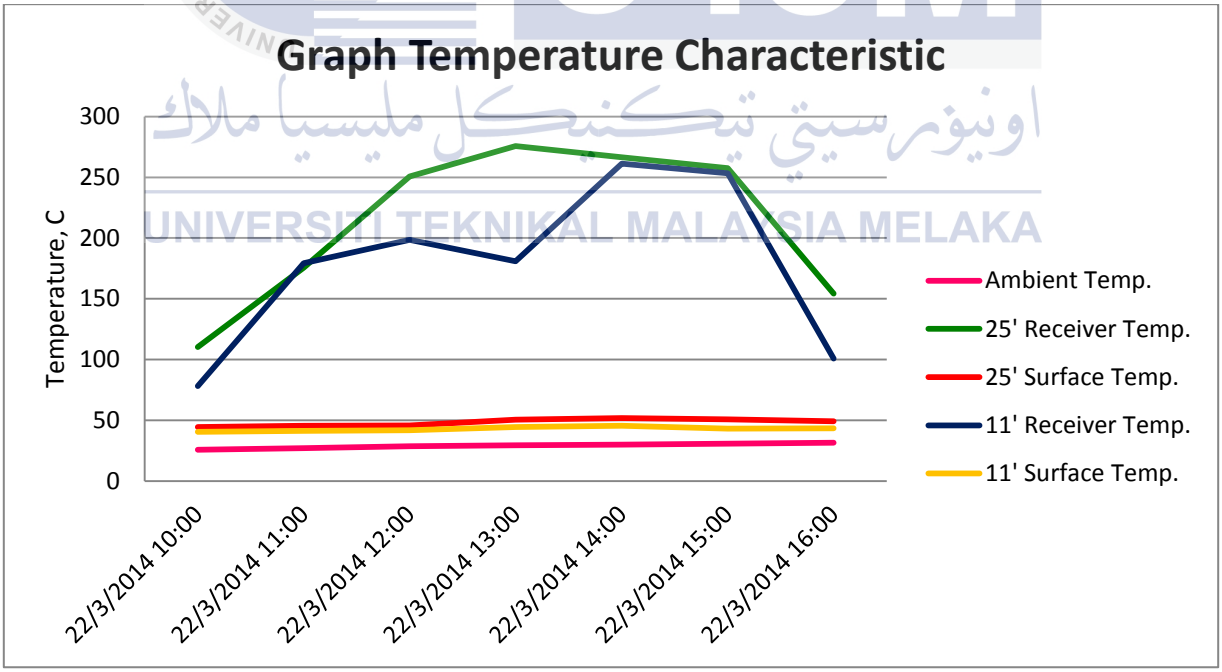


Figure 4.36: Graph of Temperature Characteristic on 22 March 2014

Table 4.21: Table recorded on 23 March 2014

Date	23/3/2014								
Environment condition	Haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	142.5	46.7	176.3	45.9	26.8	608	65.1	3	0
11.00 am	135.6	45.3	180.1	46.8	28.3	818	61.7	4.6	0
12.00 pm	258.3	46.5	273.4	46.7	30	966	57.1	4.5	0
01.00 pm	271.4	51.3	298	47.3	31.1	1040	53.6	5.6	0
02.00 pm	189.5	52.6	267.4	54.6	31.7	1034	52.3	4.9	0
03.00 pm	177.4	52.3	265.4	53.7	32.4	946	50.8	4.6	0
04.00 pm	154.3	50.3	184.3	48.9	32.9	718	47.5	4.2	0

From the Table 4.21, it is recorded the relative humidity were rather low, although ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. It is recorded tilted irradiance rather high more than $1000W/m^2$ for two hour although the wind speed recorded is high for this whole month. Based on previous research, the working temperature for Stirling engine to operate is 250^oC [19], the data recorded at 25inch shows that temperature at receiver reach higher than 250^oC for four hour from 12.00pm until 3.00pm, while 11inch parabolic dish only be able to reach for two hour temperature that higher than 250^oC which from 12.00pm until 1.00pm. Figure 4.37 also shows that the gradient of temperature characteristic between these two dishes is quite the same. It shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.37.

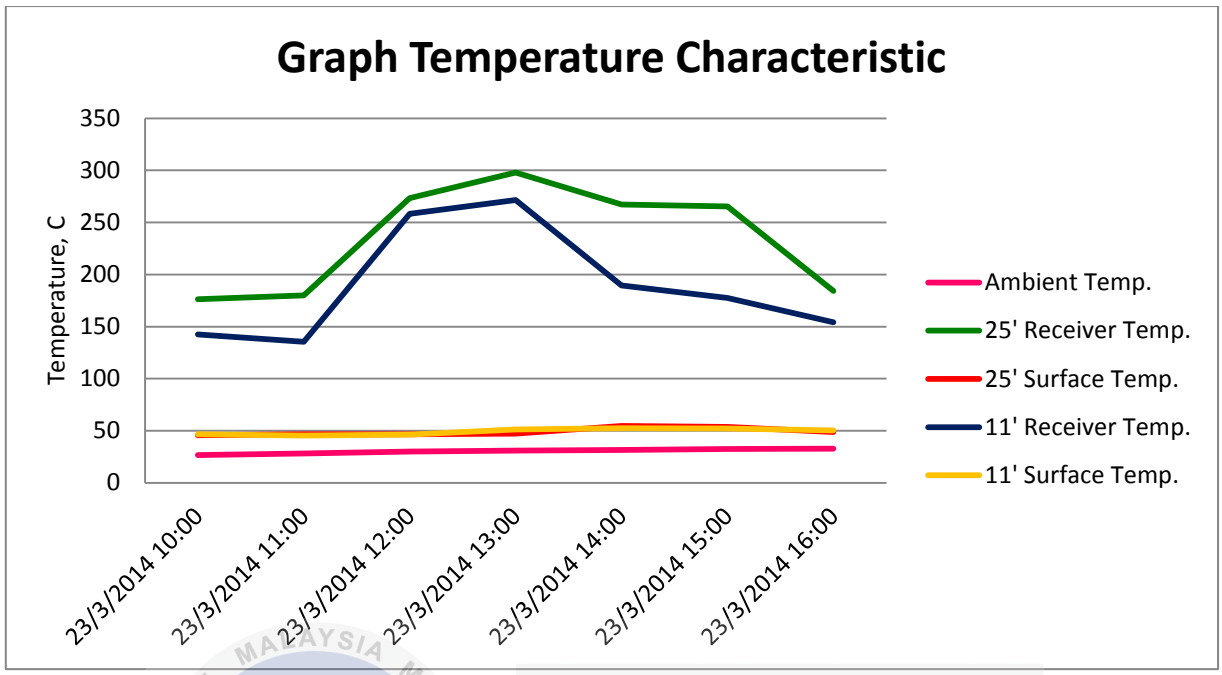


Figure 4.37: Graph of Temperature Characteristic on 23 March 2014

Table 4.22: Table recorded on 24 March 2014

Date	24/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	79.8	43.2	180.5	44.6	27	596	76	4.6	0
11.00 am	81.2	44.3	198.7	45.7	28.2	814	70.5	4.1	0
12.00 pm	181.3	44.4	240.6	47.8	29.4	869	63.4	4.1	0
01.00 pm	254.5	44.9	288.1	47.9	30.9	1018	56.6	3.4	0
02.00 pm	187.5	44.6	266.5	51.6	31.8	922	53.2	3	0
03.00 pm	190.5	44.8	231.7	49.9	32.4	831	51.1	3	0
04.00 pm	135.6	44.3	211.6	48.7	32.3	716	52	3.5	0

From the Table 4.22, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. The relationship can been seen from Table 4.22 where at 1.00apm, as relative humidity increase to 56.6% and ambient temperature recorded increase to 30.9^{o}C, thus contribute to increase the tilled irradiance to 1018W/m^{2}. The higher irradiance cause solar radiance can be reflected to receiver more effective, as in Table 4.22, during 1.00pm the receiver temperature recorded 288.1^{o}C for 25inch dish, while 11inch dish is recorded 254.5^{o}C Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], the data recorded at 25inch shows that temperature at receiver reach higher than 250^{o}C for two hour from 1.00pm until 2.00pm, while 11inch parabolic dish only be able to reach for one hour temperature that higher than 250^{o}C at 1.00pm. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.38.

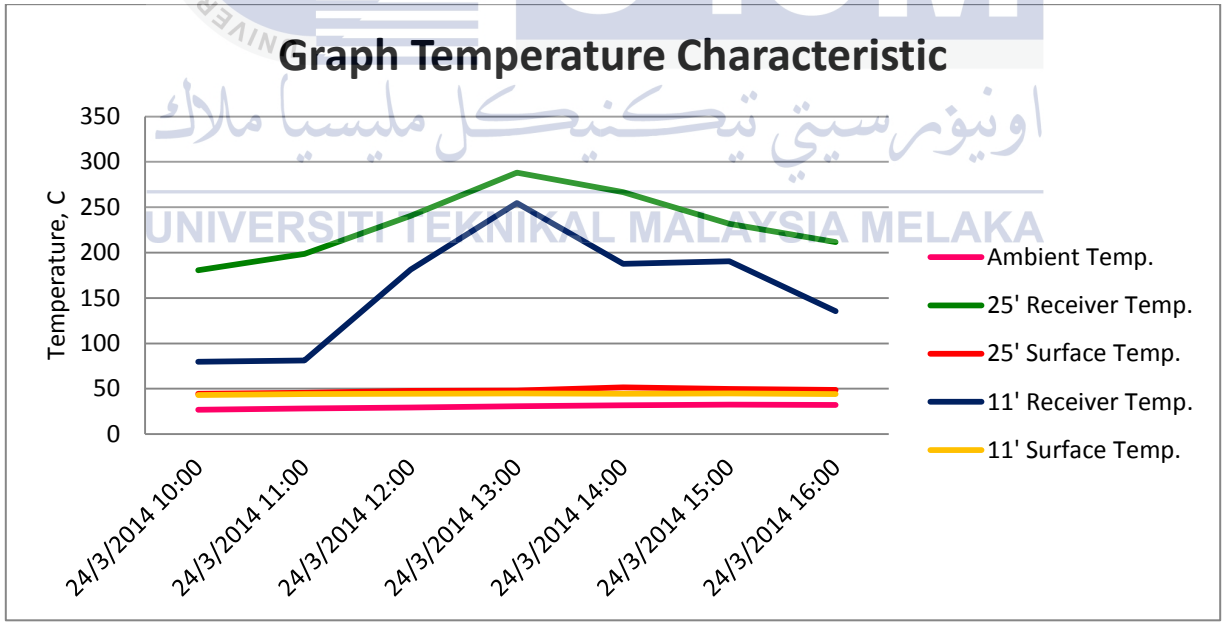


Figure 4.38: Graph of Temperature Characteristic on 24 March 2014

Table 4.23: Table recorded on 25 March 2014

Date	25/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	106.3	43.7	176.3	46.5	27.2	596	78	4.5	0
11.00 am	188.4	46.2	223.5	45.1	28.8	799	69.6	4.1	0
12.00 pm	242.7	46.7	284.6	45.8	30.1	947	63.9	4.3	0
01.00 pm	199.1	48.4	258.7	51.2	31.1	1017	58.4	4.3	0
02.00 pm	236.4	47.7	278.8	47.8	32	969	54.2	3.9	0
03.00 pm	180.2	45.8	250.7	45.9	33	830	49.4	3	0
04.00 pm	136.7	44.6	167.8	44.5	33.7	696	45.5	2.4	0

From the Table 4.23, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. During 1.00pm, temperature at receiver for both dish seen have drop although it were recorded 1017W/m^2 of tilted irradiance, it due to clouds block during the temperature be taken. Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], the data recorded at 25inch shows that temperature at receiver reach higher than 250^{o}C for four hour from 12.00pm until 3.00pm, while 11inch parabolic dish only be able to reach for one hour temperature that higher than 250^{o}C at 2.00pm. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.39.

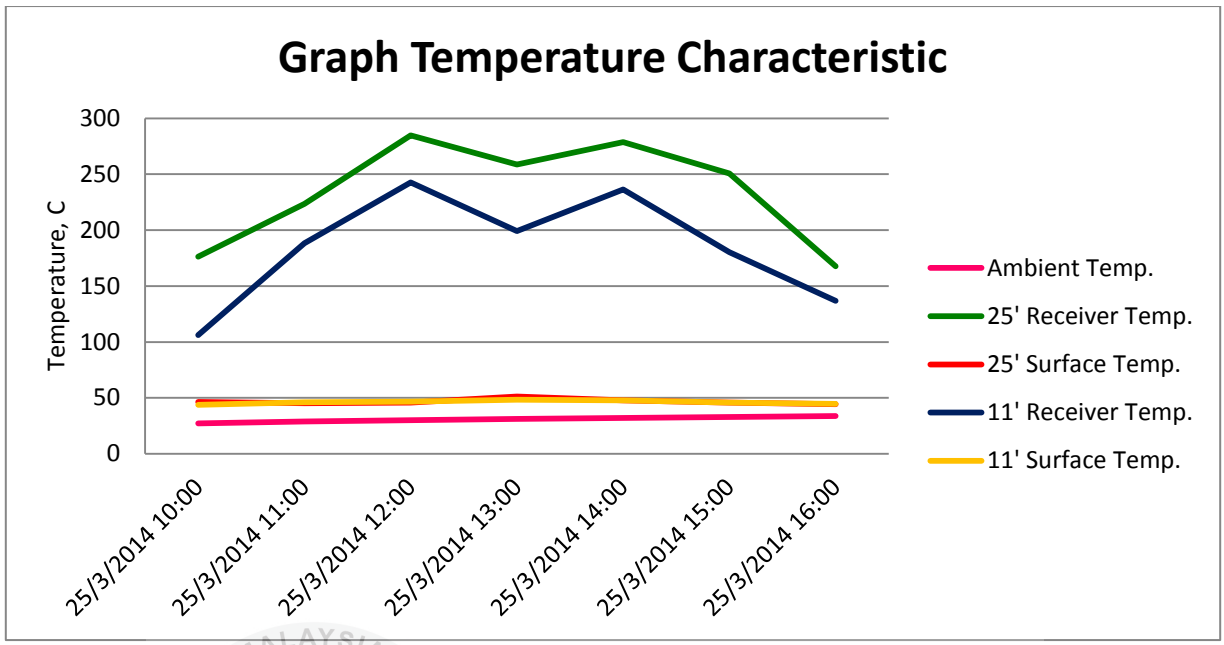


Figure 4.39: Graph of Temperature Characteristic on 25 March 2014

Table 4.24: Table recorded on 26 March 2014

Date	26/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	71.3	40.9	145.6	43.4	28.1	593	75.2	3.6	0
11.00 am	79.6	40.7	154.7	47.6	29.6	806	65.9	3.9	0
12.00 pm	104.5	43.2	168.7	48.9	30.7	958	61.7	3.7	0
01.00 pm	167.8	44.7	243.8	51.2	31.7	960	57.2	3.4	0
02.00 pm	263.4	49.8	296.8	53.4	32.5	915	54	3.1	0
03.00 pm	156.3	45	188.7	50.2	33.2	901	51.1	3.3	0
04.00 pm	147.1	43.2	144.5	42.1	33.4	771	49.8	3.4	0

From the Table 4.24, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day was rather intermediate, the tilted irradiance recorded have consistent solar irradiance for four hour in range of 900W/m^2. Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], it is recorded at 25inch shows that temperature at receiver reach higher than 250^{o}C up to three hour from 1.00pm until 3.00pm, while 11inch parabolic dish only be able to reach for one hour temperature that higher than 250^{o}C at 2.00pm. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.40.

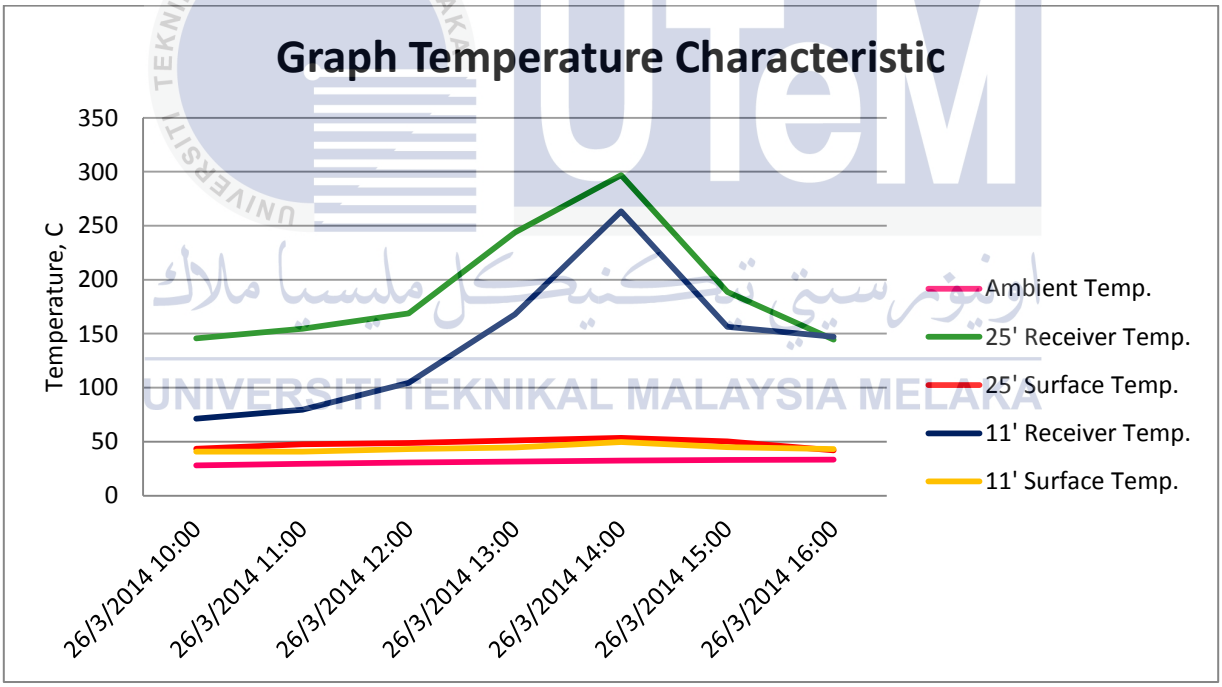


Figure 4.40: Graph of Temperature Characteristic on 26 March 2014

Table 4.25: Table recorded on 27 March 2014

Date	27/3/2014								
Environment condition	haze and partially rain								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	79.6	40.3	134.3	45.6	27.8	591	73.6	2.2	0
11.00 am	78.3	41.5	156.7	47.8	29.4	706	65.1	3.3	0
12.00 pm	159.7	42.8	198.3	51	30.7	939	61.5	3.3	0
01.00 pm	193.4	44.6	256.7	52.5	32.4	1014	54.3	2.8	0
02.00 pm	273.6	44.8	314.5	52.6	33.2	1016	49.2	2.8	0
03.00 pm	167.8	45.3	276.5	57.3	33.7	964	45.6	3.4	0
04.00 pm	rain	rain	rain	rain	34	768	43.8	3.6	0

From the Table 4.25, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day was rather high from 12.00pm until 3.00pm, the tilted irradiance recorded consist of two hour where temperature higher than $1000W/m^2$. Based on previous research, the working temperature for Stirling engine to operate is 250^oC [19], it is recorded at 25inch shows that temperature at receiver reach higher than 250^oC up to three hour from 1.00pm until 3.00pm, while 11inch parabolic dish only be able to reach for one hour temperature that higher than 250^oC at 2.00pm. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.41.

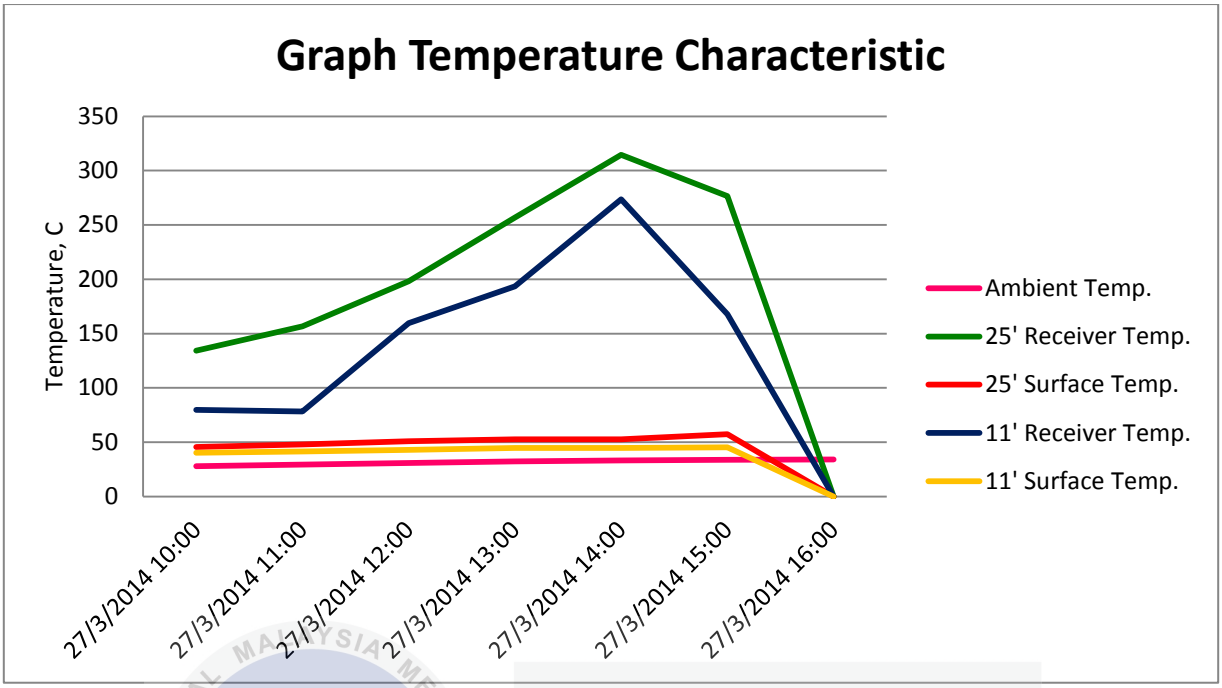


Figure 4.41: Graph of Temperature Characteristic on 27 March 2014

Table 4.26: Table recorded on 28 March 2014

Date	28/3/2014								
Environment condition	haze and partially rain								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^{o}C)	Surface Temp. (^{o}C)	Temp. at receiver (^{o}C)	Surface Temp. (^{o}C)	Ambient Temp. (^{o}C)	Tilted Irradiance (W/m^{2})	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	71.2	38.6	88.3	40.1	28.3	575	79.8	3.3	0
11.00 am	73.4	36.7	88.9	40.3	29.6	810	71.2	3.6	0
12.00 pm	75.6	38.9	93.4	43.4	31.1	936	64.4	3	0
01.00 pm	100.6	40.1	150.6	45.6	32.3	912	58.3	2.7	0
02.00 pm	83.4	36.5	143.4	44.3	33.4	867	53.5	2.3	0
03.00 pm	rain	rain	rain	rain	34.7	871	47.8	1.8	0
04.00 pm	rain	rain	rain	rain	33.6	511	57.3	2.3	0

From the Table 4.26, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day was rather low due to high relative humidity and rainfall. Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], from the data recorded, it shows that this day stirling engine will not operate. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.42, while the changes of rainfall shows in Figure 4.43.

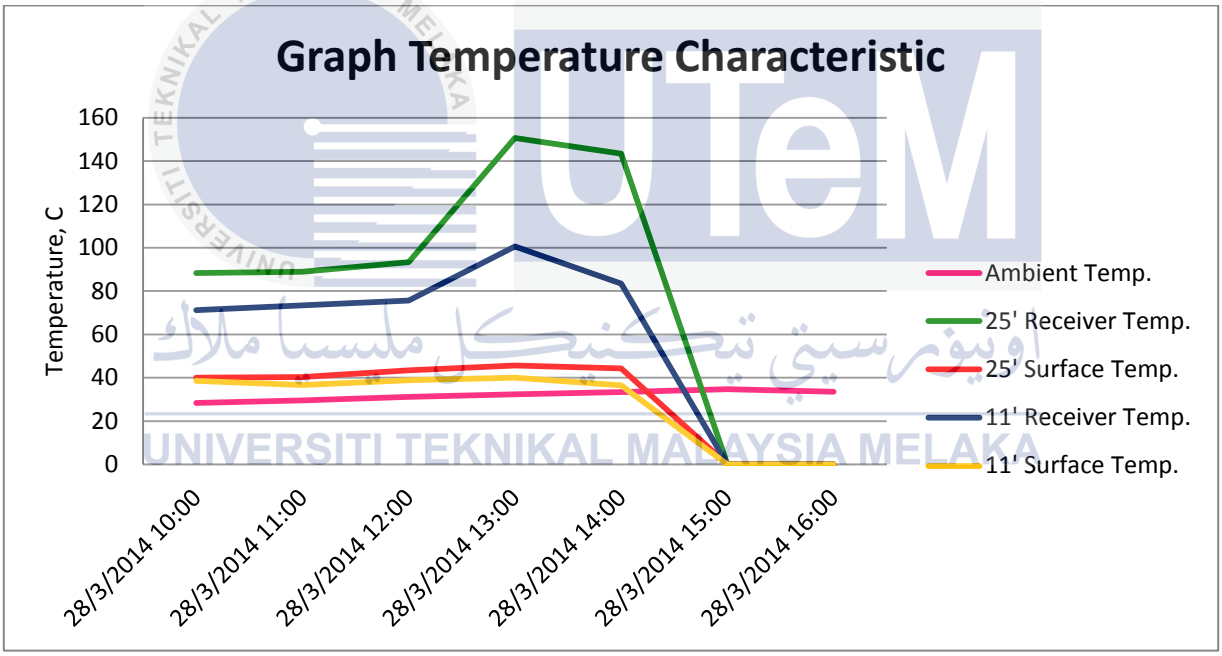


Figure 4.42: Graph of Temperature Characteristic on 28 March 2014

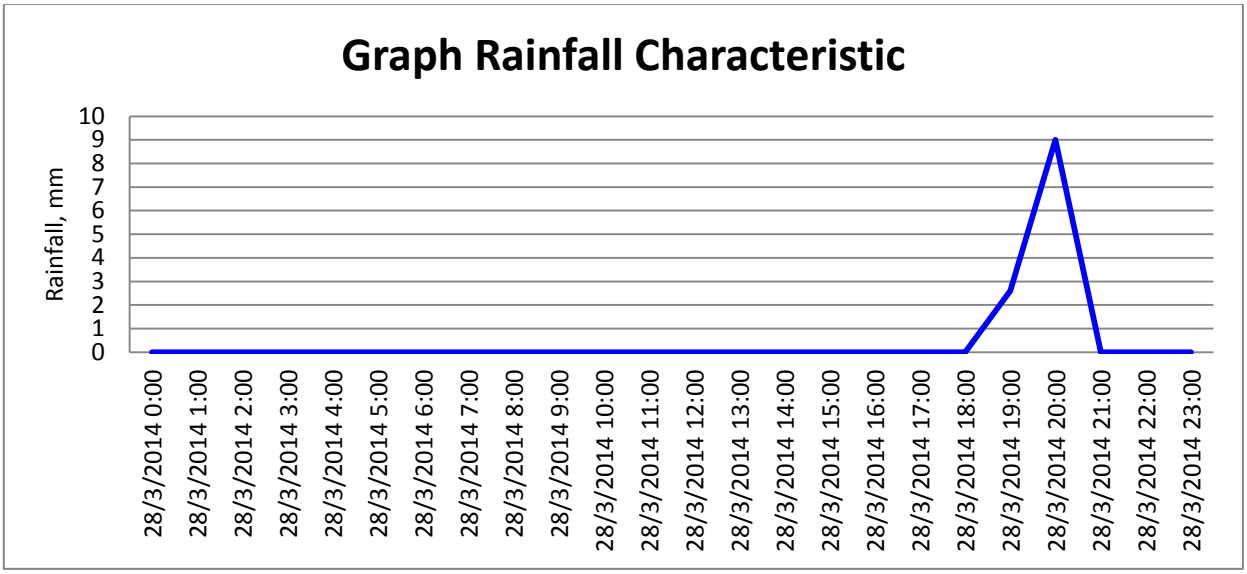


Figure 4.43: Graph of Rainfall Characteristic on 28 March 2014

Table 4.27: Table recorded on 29 March 2014

Date	29/3/2014								
Environment condition	cloudy and heavy rain								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (°C)	Tilted Irradiance (W/m²)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (°C)	Surface Temp. (°C)	Temp. at receiver (°C)	Surface Temp. (°C)					
10.00 am	63.2	33.6	62.7	34.5	26.6	293	90.4	1.3	0
11.00 am	88.3	33.5	100.1	37.6	28.6	643	81.3	1.3	0
12.00 pm	100.3	33.4	131.2	37	30.7	789	71.3	1.4	0
01.00 pm	rain	rain	rain	rain	31.8	717	64.4	1.5	0
02.00 pm	rain	rain	rain	rain	30.6	417	66.7	2.5	0
03.00 pm	rain	rain	rain	rain	24.6	54	92.4	3.3	17.4
04.00 pm	rain	rain	rain	rain	24	159	97.5	2.7	4.8

From the Table 4.27, it is recorded the relative humidity were rather high up to 90.4%, but ambient temperature recorded increasing of temperature until 1.00pmas the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day drop due to high relative humidity and heavy rainfall which recorded 17.4mm the higher for this month. Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], from the data recorded, it shows that this day stirling engine will not operate as the stirling engine cannot operate during rainy day as shows in Figure 4.44, while the changes of rainfall shows in Figure 4.45.

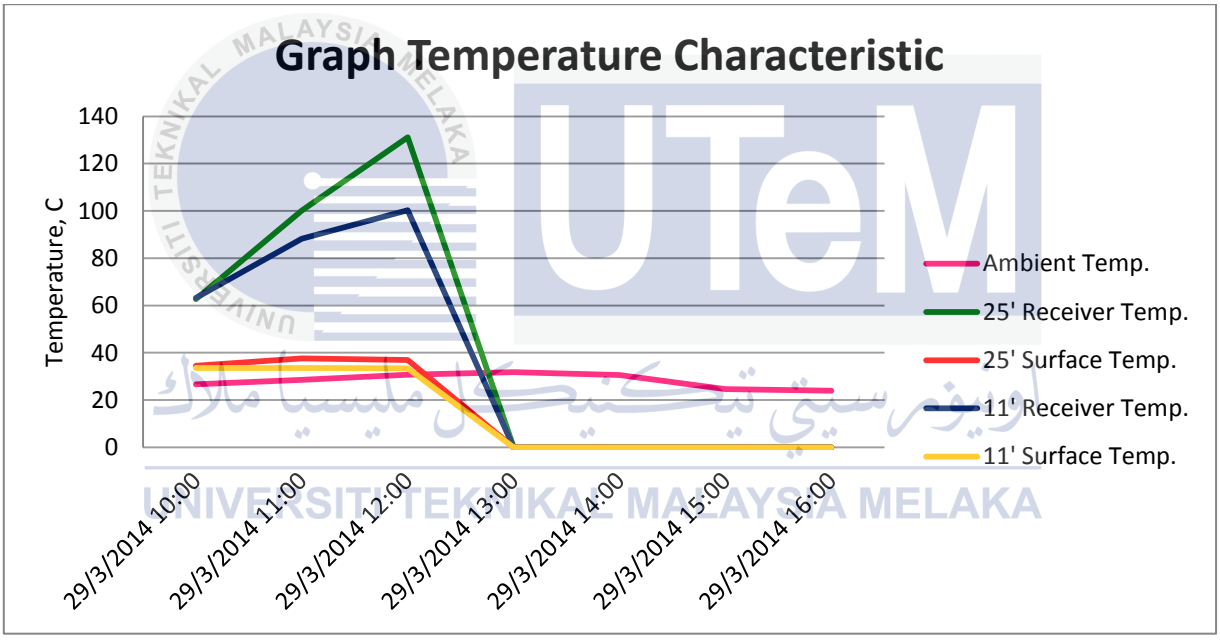


Figure 4.44: Graph of Temperature Characteristic on 29 March 2014

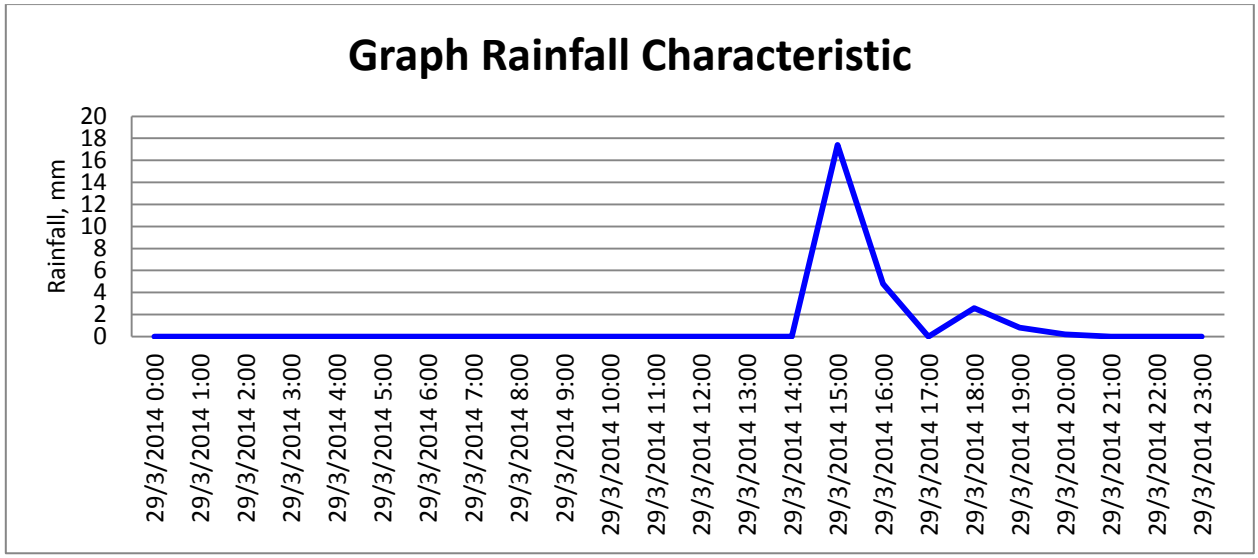


Figure 4.45: Graph of Rainfall Characteristic on 29 March 2014

Table 4.28: Table recorded on 30 March 2014

Date	30/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	121.3	40.3	180.3	45.6	26.4	528	87	1.5	0
11.00 am	100.4	40	133.2	43.2	28.5	754	77.9	1.8	0
12.00 pm	192.3	39.4	260.3	43.9	29.9	821	71.9	2	0
01.00 pm	279.3	34.4	289	45.9	31.4	923	63.8	1.6	0
02.00 pm	198.7	45.6	246.7	51.4	32.2	608	60.4	1.3	0
03.00 pm	132.4	48.2	298.1	53.2	33	855	56.8	1.4	0
04.00 pm	122.5	47.7	178.3	44.3	33.4	489	54.7	1.2	0

From the Table 4.28, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day was rather low due to high relative humidity and haze. Based on previous research, the working temperature for Stirling engine to operate is 250^{o}C [19], from the data recorded, it shows 25inch dish will be able to working stirling engine for four hours from 12.00pm until 3.00pm, while 11inch dish only be able to operating stirling engine for one hours. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.46.

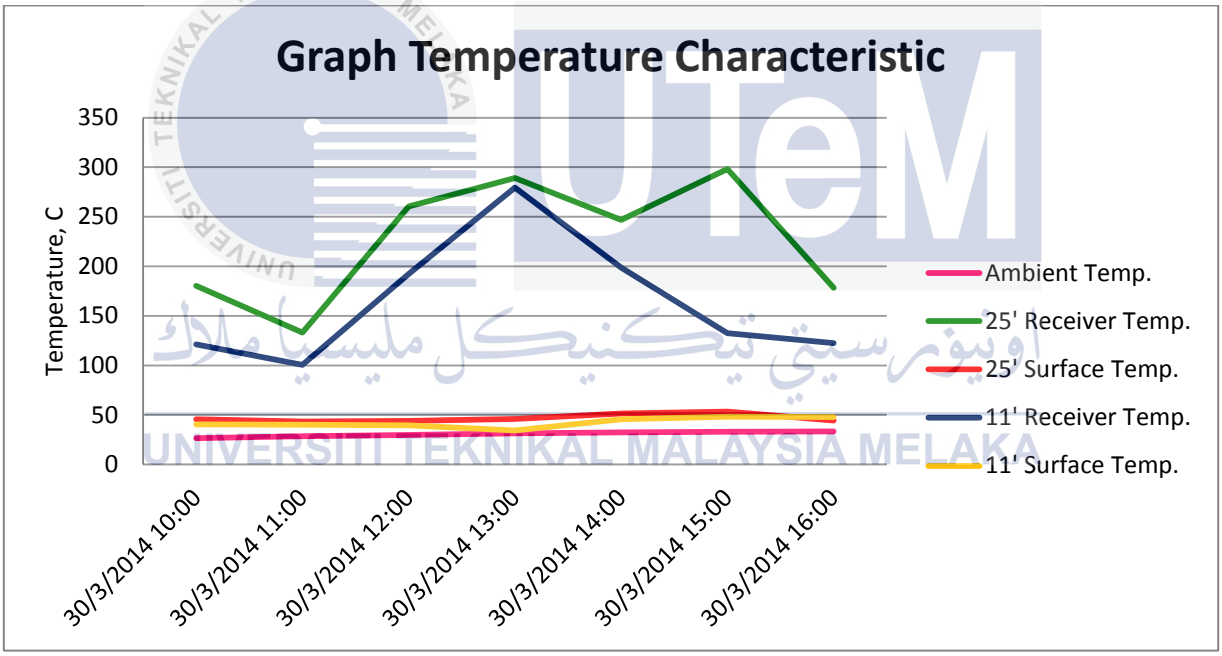


Figure 4.46: Graph of Temperature Characteristic on 30 March 2014

Table 4.29: Table recorded on 31 March 2014

Date	31/3/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	126.5	36.7	171.2	39.1	28.5	483	81.6	1.7	0
11.00 am	227.4	37.3	281.3	39.6	29.6	601	75.9	1.9	0
12.00 pm	70.4	33.6	96.4	35.6	30.8	726	69.3	1.7	0
01.00 pm	rain	rain	rain	rain	32.5	962	61.8	1.2	0
02.00 pm	rain	rain	rain	rain	33.2	903	57.6	1.3	0
03.00 pm	71.3	32.4	75.6	33.5	33.6	567	56	1.3	0
04.00 pm	73.4	32.6	76.8	34.5	32.3	409	62.7	2.3	0

From the Table 4.29, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day was rather low, $962W/m^2$ is highest tilted irradiance this due to high relative humidity and haze. Based on previous research, the working temperature for Stirling engine to operate is 250^oC [19], from the data recorded, it shows 25inch and 11inch dish only be able to working stirling engine for one hour at 11.00am. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.47.

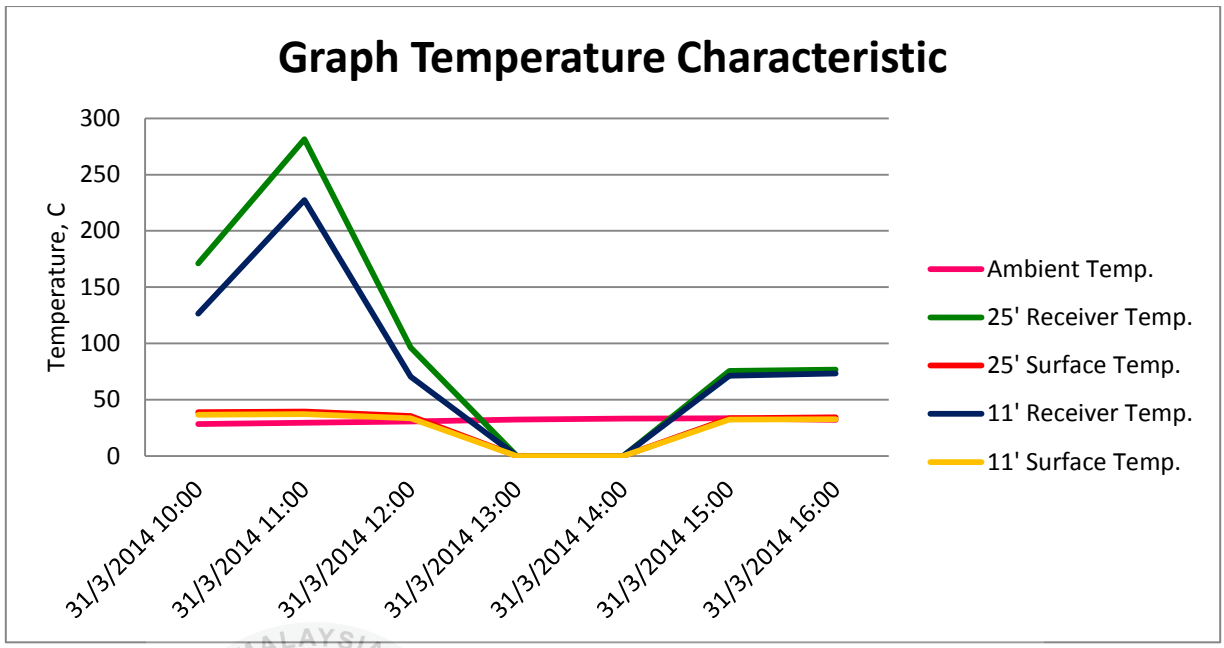


Figure 4.47: Graph of Temperature Characteristic on 31 March 2014

Table 4.30: Table recorded on 1 April 2014

Date	1/4/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am	100.4	41.3	134.5	43.5	25.9	304	94.8	1	0
11.00 am	109.5	42.4	156.7	45.6	28.6	673	81.7	0.9	0
12.00 pm	134.7	44.5	167.9	47.8	31	835	69.3	0.9	0
01.00 pm	261.7	48.7	268.4	50.1	31.3	568	65.6	1.1	0
02.00 pm	225.6	48.9	289.6	52.6	32.5	547	61.9	0.9	0
03.00 pm	197.3	47.6	203.3	49.7	31.6	702	65.8	2.7	0
04.00 pm	164.2	45.1	184.7	44.1	31.8	485	64.2	2.1	0

From the Table 4.30, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day was rather low, 835W/m^2 is highest tilted irradiance this due to high relative humidity and haze. Based on previous research, the working temperature for stirling engine to operate is 250^{o}C [19], from the data recorded, it shows 25inch dish only be able to working stirling engine for two hour, while 11inch only be able to working the dish for one hour. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.48.

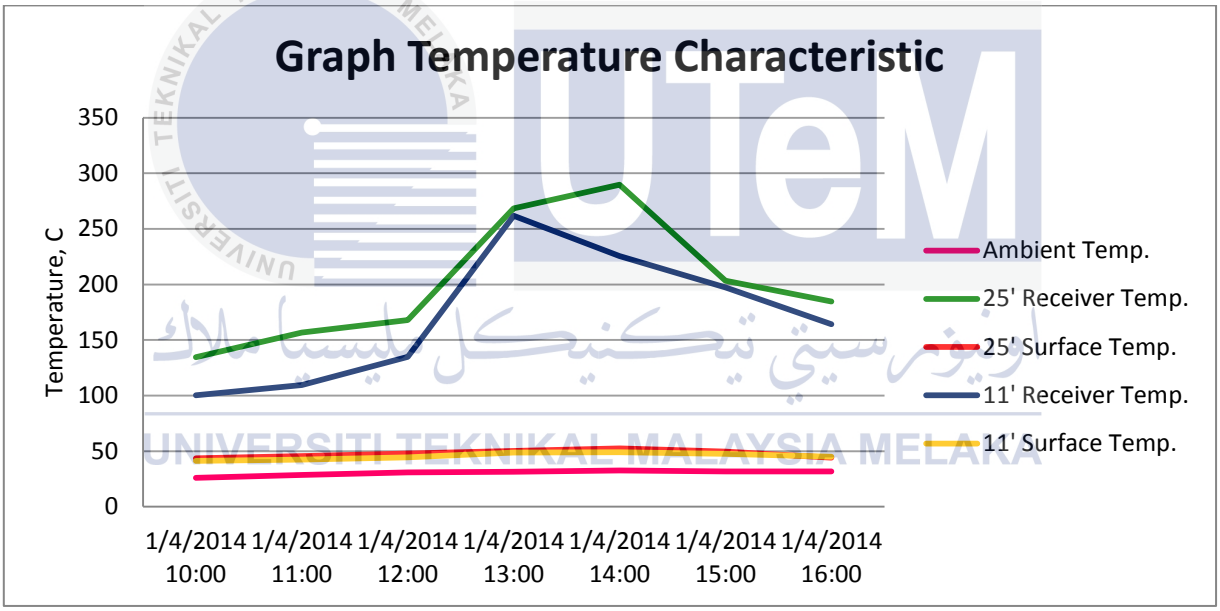


Figure 4.48: Graph of Temperature Characteristic on 1 April 2014

Table 4.31: Table recorded on 2 April 2014

Date	2/4/2014								
Environment condition	haze								
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size		Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)					
10.00 am	131.2	41.9	141.2	40.6	27.2	262	86	1.6	0
11.00 am	109.7	38.7	167.9	43.7	28.2	341	80.2	1	0
12.00 pm	224.8	38.9	249.9	43.8	29.9	687	71.5	1.2	0
01.00 pm	251.6	43.4	260.6	46.5	31.2	720	65.2	1.4	0
02.00 pm	177.3	44	198.7	50.1	31.9	716	64.5	1.5	0
03.00 pm	168.1	49.7	188.4	53.4	32.1	656	64.8	1.9	0
04.00 pm	127.1	40.3	176.3	47.3	30.9	448	69	3	0

From the Table 4.31, it is recorded the relative humidity were rather high in the morning, but ambient temperature recorded increasing of temperature as the relative humidity decrease, this increasing of ambient temperature also cause increasing tilted irradiance on parabolic dish surface. The increasing of tilted irradiance will increase the temperature at receiver. It is recorded tilted irradiance this whole day was rather low, $720W/m^2$ is highest tilted irradiance this due to high relative humidity and haze. Based on previous research, the working temperature for Stirling engine to operate is 250^oC [19], from the data recorded, it shows 25inch and 11inch dish only be able to working stirling engine for one hour at 1.00pm. The data shows that 25inch parabolic dish has higher efficiencies in term of temperature focused to the receiver compared to 11inch parabolic dish as shows in Figure 4.49.

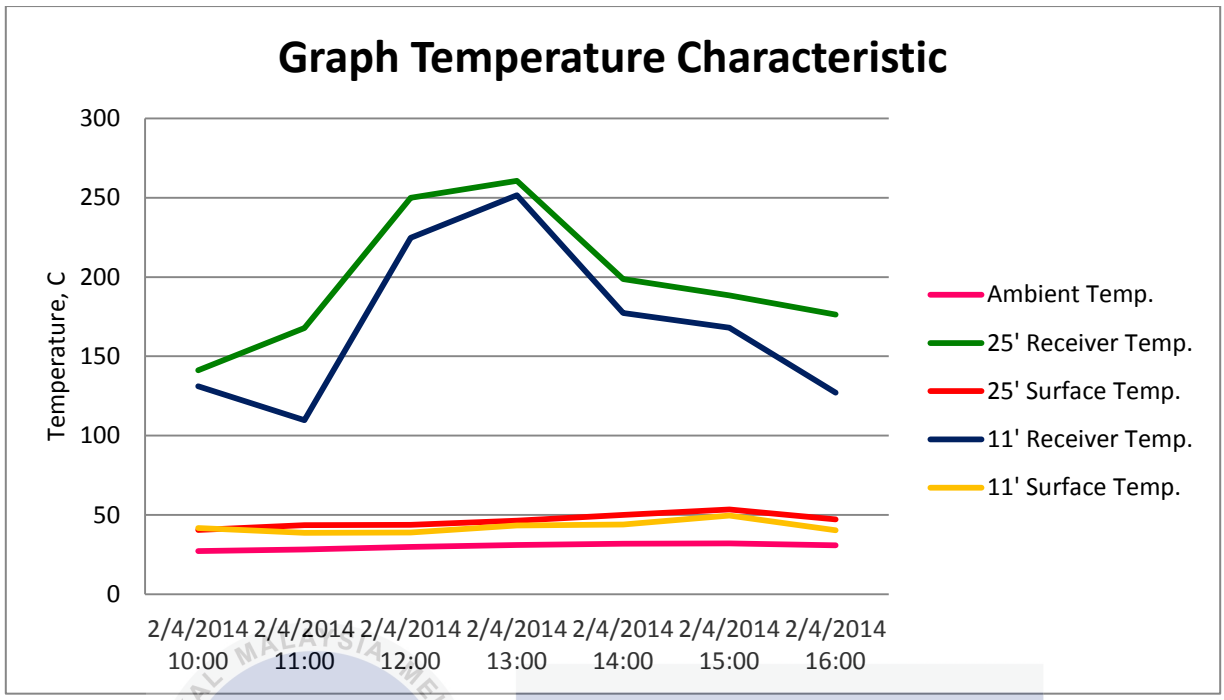


Figure 4.49: Graph of Temperature Characteristic on 2 April 2014

From this one month field measurement and data logger, as from previous research, the temperature for Stirling engine Beta-type to working is at 250^{o}C at the receiver point. The data measured that form 25inch parabolic dish shows that it be able to produce 250^{o}C temperature at receiver more effective compared to 11inch parabolic dish [19]. Table 4.32 shows the range of environment changes that are able to contribute to 250^{o}C temperature at receiver.

	25inch Dish	11inch Dish
Tilted Irradiance, W/m^2	817 - 1081	943 -1081
Ambient Temperature, ^{o}C	29.0 – 33.8	30.5 – 33.8
Relative Humidity, %	42.2% - 60%	38% - 47.5%
Wind Speed, m/s	2.7 – 3.1	2.5 – 2.8

Table 4.32: Environments effect changes

Other than that rainfall also one of main contributor that affect the performance of parabolic dish, where the relation is, as there are a rainfall, this will cause to the increasing of relative humidity and the drop of ambient temperature. Thus would interfere with the reliability of solar irradiance that can be concentrated to receiver by parabolic dish

On the other hand, if this analysis been compared in term of temperature concentrated daily to receiver, it shows that 25inch dish able to concentrate temperature up to four hours daily under Malaysia environment condition. Meanwhile, for 11inch parabolic dish be able to concentrate temperature to 250^{o}C only one to two hour daily, which also under consistent tilted irradiance. From the analysis that been made from the data recorded it shows that 25inch parabolic dish be able to concentrate temperature up to 250^{o}C for 23days in a month, while compared to 11inch parabolic dish shows that it be able to concentrate the temperature up to 250^{o}C for only 20days for the whole month.

The proper design of parabolic dish such as dish size and material is also important in order to realistic to implement the Concentrating Solar Power(CSP) technology in Malaysia environment. Through this study and analysis, the high level of solar irradiance resource in Melaka is suitable for CSP technology to be implement, because of the general high level cloudiness and tropical humidity associated with this source for concentrating solar power (CSP) is generally less than adequate, unless a specific time in a year such as during less number of rain fall.

The effect of environment on solar dish concentrators has been clearly demonstrated in the results and graphical display. The greater thermal efficiency can be achieved by a variety of geometric shapes in solar dish concentrators, and reflective materials efficiently. Furthermore, from the data obtained, 25inch parabolic dish shows more efficient than the 11inch parabolic dish concentrators.

CHAPTER 5

CONCLUSION

5.0 Overview

In this chapter, all the analysis that had been done will be concluded. Then, some recommendations or suggestions will be made for future work.

5.3 Conclusion

In this project, it is proposed to investigate the potential of CSP parabolic dish, based on this study title "Technical Viability of Parabolic Dish Concentrating Solar Power in Malaysia Environment". Malaysia as one of the countries with abundant solar energy and since Malaysia is one of countries in tropical region with its own environment changes, such as relative humidity, rain, wind speed and rapid change of clouds. Concentrating Solar Power (CSP) is one of technology that using solar energy after Photovoltaic (PV). The parabolic dish where chosen as it have the highest efficiency in Concentrating Solar Power (CSP) technology. The aim of this project is to identify the technical viability where the use of CSP technology in Melaka be taken into consideration, this project also to study the potential of using different type of parabolic dish in Melaka environment and to analyze of environment changes that can disturb the effectiveness of concentrator parabolic dish in term of thermal efficient. This project could give a useful information, for further development of CSP which suitable with Malaysia environment and could further maximizing the effectiveness of the parabolic dish itself.

Based on the analysis and discussion that been made in Chapter 4, it can be said that all the objectives of this project are accomplished. From the data enquire it can be concluded that temperature able to receiver reach 250^{o}C when the tilted irradiance recorded in range between 817W/m^2 to 1081W/m^2, the effect environment effect also contribute to effectiveness performance of the stirling engine, where during the humidity level recorded about 60% to 42.2% is where the parabolic dish be able to reach the best performance. From the analysis it also can be concluded that stirling engine be able to operate during the wind speed 2.7m/s to 3.1m/s. Other than that rainfall also can be said as one of main contributor that affect the performance of parabolic dish, where the relation is, as there are a rainfall, this will cause to the increasing of relative humidity and the drop of ambient temperature, which will cause of limitless of solar irradiance be concentrated to receiver by parabolic dish. Therefore, it can concluded that to there is possible to implement the technology of CSP parabolic dish stirling engine system in Melaka due to high level of solar resource through the countries, but the further development in increasing the effectiveness of parabolic dish in Malaysia such as using reflective film with better reflectivity and improve scaling technology or using technology anodised aluminum layer so that the reflectivity can be improved.

5.2 Recommendations

As stated in the objective of this project, to identify the potential of using two sizes of parabolic dish Stirling engine beta-type in Melaka environment. Where the project can be relate to the performance of parabolic dish. It is suggested that there will be further study that will use a Stirling engine beta-type in the study in future. Where by in that future research it can relate the electrical power output that can be produces by Stirling engine by considering Malaysia environment

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APPENDICES

Appendices A

TITLE

Technical Viability of Parabolic Dish Concentrating Solar Power in Malaysia Environment

OBJECTIVE

i. To measure the ambient temperature and focal point temperature daily
ii. To measure the environment condition that affects the temperature at the parabolic dish.
iii. To make an analysis of the daily changes of temperature at the parabolic dish.
iv. To make comparison of efficiencies of parabolic dish surface between 11 inch and 25 inch parabolic dish.

EQUIPMENT REQUIRED

i. 11 inch and 25 inch Parabolic dish size.
ii. Digital material thermometer

EXPERIMENT PROCEDURE

1. Before starting the experiment the focal length of each parabolic dish be calculated and identify.
2. By referring the Figure 1 below, the temperature will be taken at point A and point B on parabolic dish 11 inch and 25 inch.

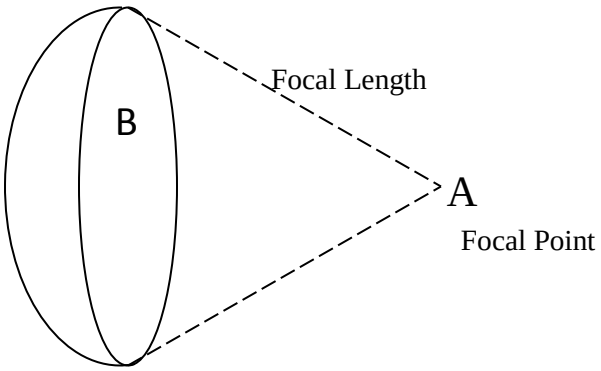

Figure 1

3. The temperature at point A and point B will be measure 10am until 4pm in one hours interval.
4. Environments condition daily such as cloudy, haze and clear sky condition also be recorded.
5. Environment condition such as relative humidity, wind speed and rainfall been recorded from Data Logger
6. All the data recoded will be representing in graphical form and will be done analysis based on Malaysia environment.

Table 1: Data Recorded Table

Date									
Environment condition									
Data Collection	Field Data Measurement				Data Logger				
Parabolic Mirror	11 inch size		25 inch size						
Time	Temp. at receiver (^oC)	Surface Temp. (^oC)	Temp. at receiver (^oC)	Surface Temp. (^oC)	Ambient Temp. (^oC)	Tilted Irradiance (W/m^2)	Relative Humidity (%)	Wind Speed (m/s)	Rain (mm)
10.00 am									
11.00 am									
12.00 pm									
01.00 pm									
02.00 pm									
03.00 pm									
04.00 pm									

Appendices B

Station ID	Data Timestamp	Global Irradiance	Tilted Irradiance	Ambient Temp.	Relative Humidity Avg.	Rain Fall	Panel Temp. Avg.	Wind Speed Avg.
1	3/3/2014 1:00	5	5	26.5	65.8	0	23.7	2.3
1	3/3/2014 2:00	5	5	25.7	70.8	0	22.7	2.1
1	3/3/2014 3:00	5	5	25	79.5	0	22.5	2.9
1	3/3/2014 4:00	6	6	24.7	82.4	0	22.3	2.7
1	3/3/2014 5:00	5	5	24.4	83.6	0	21.5	2.2
1	3/3/2014 6:00	5	5	24	85.9	0	21.1	2.1
1	3/3/2014 7:00	6	5	24.1	86.5	0	21.4	1.6
1	3/3/2014 8:00	21	23	23.9	87.3	0	20.9	1.6
1	3/3/2014 9:00	152	183	24.5	83.5	0	25.2	1.9
1	3/3/2014 10:00	358	425	26.2	74.5	0	32.7	2.8
1	3/3/2014 11:00	580	659	28	60.3	0	40.1	3.1
1	3/3/2014 12:00	738	796	30.4	44.6	0	46.8	2.5
1	3/3/2014 13:00	869	902	32.4	39	0	52.1	2.2
1	3/3/2014 14:00	899	896	33.1	41	0	53.7	2.3
1	3/3/2014 15:00	851	819	33.7	41	0	51	2.4
1	3/3/2014 16:00	698	656	34.5	39.7	0	51	2.1
1	3/3/2014 17:00	523	482	34.1	41.1	0	46.8	2
1	3/3/2014 18:00	261	268	32.3	50.1	0	37.7	2.5
1	3/3/2014 19:00	94	91	30.8	57.5	0	31.1	1.9
1	3/3/2014 20:00	12	12	29.8	61.8	0	27.2	0.7
1	3/3/2014 21:00	5	5	28.7	69.6	0	25.4	0.6
1	3/3/2014 22:00	5	5	28.1	69.9	0	24.7	0.9
1	3/3/2014 23:00	5	5	27.3	69.2	0	24	1.5
1	4/3/2014 0:00	5	5	26.3	73.8	0	23.2	2.3
1	4/3/2014 1:00	5	5	25.6	77.9	0	22.8	3
1	4/3/2014 2:00	5	5	25.1	81	0	22.3	2.8
1	4/3/2014 3:00	5	5	24.7	84.5	0	21.9	3
1	4/3/2014 4:00	5	5	24.4	86.6	0	21.7	3.4
1	4/3/2014 5:00	5	5	24.4	88.1	0	21.7	3.5
1	4/3/2014 6:00	5	5	24.3	88.3	0	21.7	3.6
1	4/3/2014 7:00	5	5	24.2	88	0	21.5	3.6
1	4/3/2014 8:00	28	32	24.1	88.1	0	21.8	3.4
1	4/3/2014 9:00	141	165	24.7	84.7	0	25.4	3.3
1	4/3/2014 10:00	327	372	25.9	78.2	0	30.8	3.8
1	4/3/2014 11:00	293	302	26.8	73.5	0	31.8	3.3
1	4/3/2014 12:00	651	681	28.2	68.1	0	41.6	2.7
1	4/3/2014 13:00	853	884	29.8	62.7	0	49.9	2.1
1	4/3/2014 14:00	926	923	31.6	56.6	0	54.9	1.7
1	4/3/2014 15:00	791	761	33.2	51.1	0	54.5	1.1
1	4/3/2014 16:00	670	627	32	59.5	0	48	3.5
1	4/3/2014 17:00	529	478	31.2	63.7	0	42	3.1
1	4/3/2014 18:00	260	269	30.6	63.7	0	35.6	3.3
1	4/3/2014 19:00	96	92	29.6	65.4	0	29.4	3.6
1	4/3/2014 20:00	11	10	29	66.8	0	26.4	1.9
1	4/3/2014 21:00	6	5	28.5	68.1	0	25.2	1.5
1	4/3/2014 22:00	5	5	27.9	69.3	0	24.6	1.5
1	4/3/2014 23:00	5	5	26.8	74.7	0	23.6	1.6
1	5/3/2014 0:00	5	5	26.2	79	0	23.1	2.1
1	5/3/2014 1:00	5	5	25.6	81.8	0	22.6	2.5
1	5/3/2014 2:00	5	5	25.2	82	0	22.3	2.7
1	5/3/2014 3:00	5	5	24.9	80.5	0	22	2.8
1	5/3/2014 4:00	5	5	24.5	82.2	0	21.5	2.7
1	5/3/2014 5:00	5	5	24.2	84.3	0	21	2.6
1	5/3/2014 6:00	5	4	23.7	86.6	0	20.5	2.2
1	5/3/2014 7:00	5	5	23.4	88.3	0	20.2	2.4
1	5/3/2014 8:00	26	33	23.3	88.7	0	20.3	2.3
1	5/3/2014 9:00	186	261	24.2	84	0	26	2.4
1	5/3/2014 10:00	433	554	25.6	77.6	0	33.5	4.1
1	5/3/2014 11:00	663	779	27.2	67.9	0	39.7	4.1
1	5/3/2014 12:00	868	953	29.2	60.5	0	47.1	3.1
1	5/3/2014 13:00	1003	1046	30.9	52.8	0	52.8	2.9
1	5/3/2014 14:00	1054	1045	32.5	42.2	0	54.5	2.7
1	5/3/2014 15:00	990	943	33.8	36.2	0	54.2	2.5
1	5/3/2014 16:00	871	789	34.4	32.7	0	50.7	2.8
1	5/3/2014 17:00	679	579	34.6	30.9	0	45.3	3.2
1	5/3/2014 18:00	245	317	34.3	32.7	0	38.8	3.2
1	5/3/2014 19:00	102	108	31.3	60.3	0	31.7	1.8
1	5/3/2014 20:00	14	12	29.2	69.1	0	26.4	2.2
1	5/3/2014 21:00	5	5	28.2	74.5	0	24.4	0.8
1	5/3/2014 22:00	5	5	27.3	80.6	0	23.4	0.7
1	5/3/2014 23:00	5	5	26.9	75.3	0	22.8	0.9
1	6/3/2014 0:00	5	5	26.4	64.4	0	22.9	2.5
1	6/3/2014 1:00	5	4	25.5	67.7	0	21.7	1.6
1	6/3/2014 2:00	5	4	24.4	77.5	0	20.8	2.4
1	6/3/2014 3:00	5	5	23.9	81.5	0	20.7	3.1
1	6/3/2014 4:00	5	4	23.5	83.9	0	19.9	1.9
1	6/3/2014 5:00	5	4	23.1	85.2	0	19.7	2.4
1	6/3/2014 6:00	5	4	23	85.2	0	19.9	3.2
1	6/3/2014 7:00	5	4	23	84.9	0	19.9	3.3
1	6/3/2014 8:00	31	45	22.9	85.8	0	19.9	2.8
1	6/3/2014 9:00	218	323	24	79.2	0	26.6	3.1
1	6/3/2014 10:00	465	603	26	71.3	0	34.6	4
1	6/3/2014 11:00	691	815	27.5	63	0	41.1	3.9
1	6/3/2014 12:00	868	950	29.3	52.5	0	47.7	3.1
1	6/3/2014 13:00	1022	1062	31	43.8	0	53.1	2.9
1	6/3/2014 14:00	1071	1064	32	41	0	55.4	2.7
1	6/3/2014 15:00	1004	961	32.8	39.1	0	54.2	2.8
1	6/3/2014 16:00	886	814	33.5	36.2	0	53.1	2.1
1	6/3/2014 17:00	502	441	33.6	36.7	0	43.7	2.3
1	6/3/2014 18:00	317	334	33.7	37	0	39.4	2.1
1	6/3/2014 19:00	118	129	31.9	49.3	0	32.3	2.1
1	6/3/2014 20:00	16	15	29.5	62.4	0	26.7	1.7
1	6/3/2014 21:00	5	5	28.8	62.1	0	25.2	1.2
1	6/3/2014 22:00	5	5	27.9	64.8	0	24.5	1.9
1	6/3/2014 23:00	5	5	26.8	67.2	0	23.3	1.8

1	7/3/2014 0:00	5	5	25.7	72.8	0	22.2	1.9
1	7/3/2014 1:00	5	5	24.8	78.5	0	21.6	2.7
1	7/3/2014 2:00	5	5	24.4	81.5	0	21.2	2.3
1	7/3/2014 3:00	5	5	23.8	84.6	0	20.5	1.9
1	7/3/2014 4:00	5	5	23.7	86.2	0	20.5	2.4
1	7/3/2014 5:00	5	4	23.8	85.8	0	20.5	2.1
1	7/3/2014 6:00	5	4	23.6	85.8	0	20	2.2
1	7/3/2014 7:00	5	4	23.5	85.5	0	20.1	2.7
1	7/3/2014 8:00	24	30	23.1	88.1	0	20.1	2.6
1	7/3/2014 9:00	180	251	24.2	84.2	0	25.4	3
1	7/3/2014 10:00	436	555	26.3	74	0	33.8	3.5
1	7/3/2014 11:00	693	817	28	65.2	0	40.9	4.2
1	7/3/2014 12:00	907	993	29.9	54.3	0	47.1	3.8
1	7/3/2014 13:00	1042	1081	31.1	47.5	0	53.3	2.8
1	7/3/2014 14:00	999	995	32.2	43.2	0	54.9	2.4
1	7/3/2014 15:00	807	772	32.6	40.4	0	49.6	2.7
1	7/3/2014 16:00	770	701	33.5	36.5	0	50.2	2.2
1	7/3/2014 17:00	644	561	34.2	36.6	0	48.3	1.8
1	7/3/2014 18:00	306	287	33.6	39.4	0	39.4	2.1
1	7/3/2014 19:00	122	117	30.9	58.4	0	31.7	2.5
1	7/3/2014 20:00	14	13	29.3	65.4	0	26.7	1.5
1	7/3/2014 21:00	5	5	28.6	66.7	0	25.1	1.3
1	7/3/2014 22:00	5	5	28.2	66.8	0	24.7	1.4
1	7/3/2014 23:00	5	4	27.3	70.7	0	23.6	1
1	8/3/2014 0:00	5	5	26.4	75.5	0	22.8	1.7
1	8/3/2014 1:00	5	5	25.5	80.6	0	22.3	2.4
1	8/3/2014 2:00	5	4	25	85.1	0	21.7	2
1	8/3/2014 3:00	5	4	24.4	88.2	0	21.1	2.4
1	8/3/2014 4:00	5	4	24.1	90	0	21	2.7
1	8/3/2014 5:00	5	4	23.9	91	0	20.6	2.3
1	8/3/2014 6:00	5	4	23.7	92.3	0	20.7	2.7
1	8/3/2014 7:00	5	4	23.8	92.5	0	20.9	3
1	8/3/2014 8:00	25	31	23.6	92.3	0	20.7	3.2
1	8/3/2014 9:00	163	215	24.1	89.2	0	23.7	3.6
1	8/3/2014 10:00	413	508	25.5	82.1	0	31.8	4.6
1	8/3/2014 11:00	649	756	27.1	72.9	0	39	4.6
1	8/3/2014 12:00	847	919	29.1	63.5	0	46.2	3.4
1	8/3/2014 13:00	980	1014	30.5	56.6	0	52.3	2.5
1	8/3/2014 14:00	981	972	32.1	50.4	0	56.5	1.9
1	8/3/2014 15:00	982	938	33.3	45	0	57.2	1.8
1	8/3/2014 16:00	724	663	34.3	41.3	0	51.9	1.4
1	8/3/2014 17:00	471	414	33.8	45.3	0	45	2.1
1	8/3/2014 18:00	281	308	31.9	55.3	0	37.3	3.2
1	8/3/2014 19:00	112	105	30.8	57.3	0	31	2.4
1	8/3/2014 20:00	14	12	29.6	60.3	0	26.6	1.8
1	8/3/2014 21:00	5	5	28.8	63	0	24.9	0.7
1	8/3/2014 22:00	5	5	27.7	70	0	23.8	0.5
1	8/3/2014 23:00	5	5	26.8	71.9	0	23.5	1.7
1	9/3/2014 0:00	5	5	26	73.2	0	23.1	2.7
1	9/3/2014 1:00	5	5	25.3	75.2	0	22.4	3.4
1	9/3/2014 2:00	5	5	24.8	77.5	0	22	3.7
1	9/3/2014 3:00	5	5	24.3	79.6	0	21.5	3.6
1	9/3/2014 4:00	5	4	23.9	81.3	0	21	3.7
1	9/3/2014 5:00	5	4	23.4	83.7	0	20.5	3.6
1	9/3/2014 6:00	5	4	23.3	84.2	0	20.4	3.6
1	9/3/2014 7:00	5	4	23.2	83.7	0	20.2	3.5
1	9/3/2014 8:00	26	34	23.2	81	0	20.6	3.6
1	9/3/2014 9:00	170	228	23.9	75	0	24.6	5.1
1	9/3/2014 10:00	412	507	25.1	69.4	0	30.7	5.3
1	9/3/2014 11:00	644	755	27	62.6	0	38.7	3.7
1	9/3/2014 12:00	865	943	28.7	57.3	0	45.9	3.3
1	9/3/2014 13:00	997	1030	30.6	50.5	0	52.4	2.6
1	9/3/2014 14:00	1010	998	32.4	44.9	0	56.3	1.9
1	9/3/2014 15:00	909	866	33.5	39.5	0	55.3	1.8
1	9/3/2014 16:00	810	739	34.5	35.1	0	52.9	1.6
1	9/3/2014 17:00	502	442	33.6	44.7	0	45.7	1.8
1	9/3/2014 18:00	280	277	32	53.3	0	37.6	2.7
1	9/3/2014 19:00	113	102	30.6	57.3	0	31.1	2.4
1	9/3/2014 20:00	12	11	29.7	60.8	0	27.1	1.2
1	9/3/2014 21:00	5	5	28.5	67.3	0	25.3	1.4
1	9/3/2014 22:00	5	5	27.6	66.1	0	24.6	2.1
1	9/3/2014 23:00	5	5	26.6	67.3	0	23.6	2.4
1	10/3/2014 0:00	5	5	25.6	72.5	0	22.5	2.5
1	10/3/2014 1:00	5	5	24.9	76.2	0	21.9	3.2
1	10/3/2014 2:00	5	5	24.5	80.4	0	21.6	3.3
1	10/3/2014 3:00	5	5	24.2	82.1	0	21.1	3.3
1	10/3/2014 4:00	5	4	23.9	84.1	0	20.9	3.3
1	10/3/2014 5:00	5	5	23.7	85.3	0	20.7	3.6
1	10/3/2014 6:00	5	5	23.5	85.6	0	20.6	3.8
1	10/3/2014 7:00	5	4	23.3	86.8	0	20.4	3.7
1	10/3/2014 8:00	23	26	23.2	87.3	0	20.6	3.4
1	10/3/2014 9:00	158	199	24	83.6	0	24.6	3.8
1	10/3/2014 10:00	410	502	25.6	74.9	0	31.4	4.8
1	10/3/2014 11:00	659	773	27.4	65.6	0	38.5	4.9
1	10/3/2014 12:00	862	939	28.7	59.1	0	43.4	4.8
1	10/3/2014 13:00	976	1009	30.2	53.7	0	48.2	4
1	10/3/2014 14:00	1002	993	31.6	47.5	0	51.5	3
1	10/3/2014 15:00	975	931	32.5	42.4	0	52.4	3
1	10/3/2014 16:00	797	730	33.2	39.3	0	49.5	2.6
1	10/3/2014 17:00	457	401	33.4	39.1	0	41.9	2.5
1	10/3/2014 18:00	299	303	33.3	39.1	0	38	2.9
1	10/3/2014 19:00	119	105	32.5	43.8	0	32	2.4
1	10/3/2014 20:00	12	12	30.2	56.5	0	27.5	2.3
1	10/3/2014 21:00	5	5	28.3	60.5	0	25.5	2.2
1	10/3/2014 22:00	5	5	27.4	61.5	0	24.4	2.3
1	10/3/2014 23:00	5	5	26.6	63.4	0	23.4	2

1	11/3/2014 0:00	5	5	25.6	71.4	0	22.5	2.3
1	11/3/2014 1:00	5	5	25.1	79.1	0	22.2	3.2
1	11/3/2014 2:00	5	5	24.8	82	0	21.9	3.1
1	11/3/2014 3:00	5	5	24.3	83.8	0	21.3	3.5
1	11/3/2014 4:00	5	4	24.1	84.5	0	21.1	3.5
1	11/3/2014 5:00	5	4	23.7	86.1	0	20.6	3
1	11/3/2014 6:00	5	4	23.7	85.7	0	20.6	3.1
1	11/3/2014 7:00	5	4	23.9	83.3	0	20.8	3.9
1	11/3/2014 8:00	30	44	23.9	80.3	0	21.2	3.7
1	11/3/2014 9:00	221	332	24.7	75.8	0	27.1	3.4
1	11/3/2014 10:00	496	635	26.8	61.7	0	34.7	4.6
1	11/3/2014 11:00	718	855	28.3	54.9	0	40.8	5.2
1	11/3/2014 12:00	914	993	30.3	46.2	0	46.4	4.2
1	11/3/2014 13:00	1039	1069	31.6	39.8	0	49.5	4.4
1	11/3/2014 14:00	1076	1060	32.9	35.7	0	52.2	3.8
1	11/3/2014 15:00	1039	985	34	32.3	0	53.4	3.3
1	11/3/2014 16:00	870	785	34.8	31.1	0	51.2	2.9
1	11/3/2014 17:00	571	491	34.5	34.4	0	43.8	2.7
1	11/3/2014 18:00	302	299	34.1	36.3	0	38.4	2.6
1	11/3/2014 19:00	107	92	32.8	41.7	0	31.9	2.6
1	11/3/2014 20:00	10	9	31.1	48.1	0	28	2.3
1	11/3/2014 21:00	5	5	29.7	53	0	26.1	1.2
1	11/3/2014 22:00	5	5	28.4	62.1	0	25	2.1
1	11/3/2014 23:00	5	5	27.1	70.8	0	23.8	2.1
1	12/3/2014 0:00	5	5	26.4	76.9	0	23.3	1.9
1	12/3/2014 1:00	5	5	25.9	80.3	0	22.7	2
1	12/3/2014 2:00	5	5	25.3	84.2	0	22.3	3
1	12/3/2014 3:00	5	5	25.1	85.6	0	22.3	3.9
1	12/3/2014 4:00	5	5	25	86	0	22.2	4
1	12/3/2014 5:00	5	5	24.7	87	0	21.9	4.1
1	12/3/2014 6:00	5	4	24.2	88.9	0	21.2	3.5
1	12/3/2014 7:00	5	4	24.1	89.2	0	21	3.8
1	12/3/2014 8:00	29	40	24	89	0	21.4	3.3
1	12/3/2014 9:00	196	288	25.2	82.8	0	26.9	3.8
1	12/3/2014 10:00	462	589	26.6	75.2	0	33.4	5.7
1	12/3/2014 11:00	697	816	28.3	65	0	40	4.8
1	12/3/2014 12:00	888	963	29.7	57.7	0	45.1	4.4
1	12/3/2014 13:00	1005	1035	31.1	50.5	0	49.9	4.2
1	12/3/2014 14:00	965	952	32.4	44.3	0	52.6	2.9
1	12/3/2014 15:00	833	794	33.3	38.9	0	51.5	2.4
1	12/3/2014 16:00	781	708	34.2	35.2	0	52.1	1.7
1	12/3/2014 17:00	737	631	34.2	38.8	0	50	2.4
1	12/3/2014 18:00	328	309	31.9	51.8	0	37.8	3.5
1	12/3/2014 19:00	124	100	31.2	52.6	0	31.2	2.6
1	12/3/2014 20:00	13	12	30	56.1	0	27.1	1.6
1	12/3/2014 21:00	5	5	29	60.8	0	25.9	1.1
1	12/3/2014 22:00	5	5	28.2	65.4	0	24.9	1.4
1	12/3/2014 23:00	5	5	27.1	70.1	0	24.1	2.5
1	13/3/2014 0:00	5	5	26.2	72.7	0	23.2	2.6
1	13/3/2014 1:00	5	5	25.5	77.1	0	22.5	2.8
1	13/3/2014 2:00	5	5	25.1	81.1	0	22.2	3.4
1	13/3/2014 3:00	5	4	24.7	83.9	0	21.8	3.1
1	13/3/2014 4:00	5	4	24.3	86	0	21.3	2.7
1	13/3/2014 5:00	5	5	24.2	86.4	0	21.2	3.1
1	13/3/2014 6:00	5	5	24	87.7	0	21	3.1
1	13/3/2014 7:00	5	5	23.9	87.8	0	20.9	3.3
1	13/3/2014 8:00	26	30	23.9	87.7	0	21.3	3.3
1	13/3/2014 9:00	162	207	24.5	85.5	0	25.6	3.3
1	13/3/2014 10:00	378	452	26.1	77.1	0	32.2	3.4
1	13/3/2014 11:00	608	692	27.7	69.1	0	39.6	3.4
1	13/3/2014 12:00	814	874	29.2	62.5	0	46.1	3.2
1	13/3/2014 13:00	900	925	31	55.8	0	52.2	2
1	13/3/2014 14:00	855	844	32.2	51.6	0	53.1	1.9
1	13/3/2014 15:00	807	768	33.4	46.4	0	53.8	1.4
1	13/3/2014 16:00	708	641	34.6	41.9	0	52.6	1.5
1	13/3/2014 17:00	545	477	34.3	44.4	0	47.7	1.8
1	13/3/2014 18:00	289	262	32.6	52.3	0	37.7	3.1
1	13/3/2014 19:00	98	87	31.2	55	0	31	2.9
1	13/3/2014 20:00	11	11	29.8	59.4	0	27.2	2.9
1	13/3/2014 21:00	6	6	28.9	65.2	0	25.8	2.3
1	13/3/2014 22:00	5	5	28	70.6	0	24.6	1
1	13/3/2014 23:00	5	5	27.2	73.3	0	24.1	2.1
1	14/3/2014 0:00	5	5	26.8	69.6	0	24	2.7
1	14/3/2014 1:00	5	5	26.2	72.9	0	22.9	1.8
1	14/3/2014 2:00	5	5	25.5	80.6	0	22.2	1.8
1	14/3/2014 3:00	5	5	25.1	86	0	21.9	2.1
1	14/3/2014 4:00	5	5	24.9	88.6	0	21.7	2.2
1	14/3/2014 5:00	5	5	24.6	90.4	0	21.5	2.2
1	14/3/2014 6:00	5	5	24.4	91.6	0	21.2	2.1
1	14/3/2014 7:00	5	5	24.4	92.2	0	21.1	2.1
1	14/3/2014 8:00	22	24	24.3	92	0	21.5	2.7
1	14/3/2014 9:00	165	206	25	88.5	0	25.5	3.2
1	14/3/2014 10:00	403	493	26.9	79.9	0	34	3.6
1	14/3/2014 11:00	666	770	28.7	68.8	0	41.3	4
1	14/3/2014 12:00	886	955	30.4	61.4	0	49.1	3.1
1	14/3/2014 13:00	950	977	31.7	54.7	0	51.7	3.1
1	14/3/2014 14:00	736	725	32.9	49.5	0	48.8	2.3
1	14/3/2014 15:00	677	645	33.5	47.1	0	48.5	2.5
1	14/3/2014 16:00	389	363	33.9	45.6	0	42.4	2
1	14/3/2014 17:00	272	253	33.8	46.1	0	38.5	2.2
1	14/3/2014 18:00	269	247	31.7	61	0	36.5	2.5
1	14/3/2014 19:00	118	100	31.1	64.4	0	31.8	2.3
1	14/3/2014 20:00	10	10	29.9	66.3	0	27.3	1.5
1	14/3/2014 21:00	5	5	29.6	67	0	26.2	1.6
1	14/3/2014 22:00	5	5	28.8	62.8	0	25.3	1.9
1	14/3/2014 23:00	5	5	27.6	67.6	0	24.6	3.1

1	15/3/2014 0:00	5	5	26.8	74	0	23.7	2.3
1	15/3/2014 1:00	5	5	26.1	80.2	0	23	2.4
1	15/3/2014 2:00	5	5	25.6	85	0	22.6	2.6
1	15/3/2014 3:00	5	5	25.4	86.9	0	22.6	2.9
1	15/3/2014 4:00	5	5	25.1	88.2	0	22.2	3.1
1	15/3/2014 5:00	5	5	25.2	88.4	0	22.2	2.1
1	15/3/2014 6:00	5	5	25	88.4	0	21.8	2
1	15/3/2014 7:00	5	5	24.8	88.5	0	21.4	1.9
1	15/3/2014 8:00	32	46	24.4	90.5	0	21.7	2
1	15/3/2014 9:00	219	323	25.9	83.8	0	29.5	1.4
1	15/3/2014 10:00	426	530	28.4	71.5	0	36.4	3
1	15/3/2014 11:00	627	717	29.5	66.2	0	39.4	4.6
1	15/3/2014 12:00	853	909	31.2	59.9	0	44.9	4.1
1	15/3/2014 13:00	890	914	32.5	54.2	0	48	3.8
1	15/3/2014 14:00	743	724	32.9	52.8	0	46.1	3.5
1	15/3/2014 15:00	743	702	33.4	50.6	0	45.4	3.7
1	15/3/2014 16:00	668	610	33.4	51.8	0	43.9	3.7
1	15/3/2014 17:00	613	527	33.7	49.5	0	43.3	3.7
1	15/3/2014 18:00	102	98	29.5	70.2	0	31.2	3.1
1	15/3/2014 19:00	31	30	27	87.8	0.6	25.1	2.1
1	15/3/2014 20:00	10	10	26.9	89.4	0	24.5	0.8
1	15/3/2014 21:00	6	6	26.9	89.7	0	23.7	0.7
1	15/3/2014 22:00	6	6	27	86.3	0	23.8	1.8
1	15/3/2014 23:00	6	5	27.3	78.8	0	24.1	2.7
1	16/3/2014 0:00	5	5	27.2	79.4	0	23.9	2
1	16/3/2014 1:00	5	5	26.7	82.7	0	23.5	2.3
1	16/3/2014 2:00	5	5	26.3	84.8	0	23.2	2.3
1	16/3/2014 3:00	5	5	25.9	86.9	0	22.8	1.9
1	16/3/2014 4:00	6	5	25.6	89.3	0	22.6	1.9
1	16/3/2014 5:00	6	5	25.7	89.1	0	22.7	2.7
1	16/3/2014 6:00	6	6	25.8	88.4	0	23.2	2.9
1	16/3/2014 7:00	6	6	25.5	90.3	1	23	2.6
1	16/3/2014 8:00	14	14	25.1	92.7	0	22.5	1.6
1	16/3/2014 9:00	139	151	25.2	93.2	0	25.4	2.5
1	16/3/2014 10:00	292	307	26.1	86.7	0	31.2	3
1	16/3/2014 11:00	372	390	26.7	81.4	0	32.5	3.8
1	16/3/2014 12:00	292	291	24.9	89.8	2	27.5	2.4
1	16/3/2014 13:00	746	754	27.6	78.4	0	43.3	2.6
1	16/3/2014 14:00	957	941	29.7	69.5	0	47.5	3.1
1	16/3/2014 15:00	443	425	30.1	66.5	0	37.5	3.2
1	16/3/2014 16:00	405	390	28.8	76.2	0	32	2.5
1	16/3/2014 17:00	189	186	26.9	85.1	0.2	26.7	1.7
1	16/3/2014 18:00	81	81	26.3	87	0	25.8	1.1
1	16/3/2014 19:00	29	29	25.7	90.8	4.8	24.3	1.5
1	16/3/2014 20:00	8	7	25.1	94.5	0.6	22.8	0.9
1	16/3/2014 21:00	7	6	24.8	96.7	0.2	22.5	1
1	16/3/2014 22:00	6	6	24.6	96.9	0.2	22.3	1.2
1	16/3/2014 23:00	6	6	24.4	96.8	0	22.2	1.6
1	17/3/2014 0:00	6	6	24.6	96.1	0	22.2	1
1	17/3/2014 1:00	6	6	24.7	96.5	0	22.2	1.2
1	17/3/2014 2:00	6	6	24.7	96.3	0	22.2	1
1	17/3/2014 3:00	6	6	24.6	96.8	0	22.2	1.5
1	17/3/2014 4:00	6	6	24.5	96.9	0	22	1
1	17/3/2014 5:00	6	6	24.4	96.8	0	22	1.5
1	17/3/2014 6:00	6	5	24.4	96.1	0	21.8	1.6
1	17/3/2014 7:00	6	5	24.2	96.1	0	21.5	1.8
1	17/3/2014 8:00	35	50	24.3	95.6	0	21.9	1.8
1	17/3/2014 9:00	205	289	25.3	91.8	0	27.9	0.9
1	17/3/2014 10:00	370	425	26.4	86.4	0	34.4	1.9
1	17/3/2014 11:00	646	704	28.2	77.8	0	43.2	2.2
1	17/3/2014 12:00	520	536	28.5	76.1	0	39.2	2.7
1	17/3/2014 13:00	581	589	29.5	71.6	0	42.3	2.5
1	17/3/2014 14:00	546	537	29.7	72.3	0	42	2.6
1	17/3/2014 15:00	214	206	26.2	87.9	0.2	26.7	2.7
1	17/3/2014 16:00	92	88	26.6	87.8	0	25.3	2
1	17/3/2014 17:00	60	56	25.4	92.9	0.6	23.7	2.1
1	17/3/2014 18:00	56	55	25.2	94.9	0.8	23.6	1.2
1	17/3/2014 19:00	34	34	25.2	94.3	0.4	23.3	1
1	17/3/2014 20:00	10	10	25.2	94.5	0	22.5	0.8
1	17/3/2014 21:00	6	6	25.3	92.8	0	22.2	1.7
1	17/3/2014 22:00	6	6	25.2	92.6	0	22	0.8
1	17/3/2014 23:00	6	6	25.1	93.6	0	22.2	2.1
1	18/3/2014 0:00	6	6	25.1	93.7	0	22.2	1.5
1	18/3/2014 1:00	6	6	25.1	93.4	0	22.2	1.7
1	18/3/2014 2:00	6	6	24.9	93.9	0	22.1	1.6
1	18/3/2014 3:00	6	5	25	92.3	0	21.8	1.6
1	18/3/2014 4:00	6	5	24.8	92.5	0	21.5	1.5
1	18/3/2014 5:00	6	5	24.5	92.9	0	21.4	1.6
1	18/3/2014 6:00	5	5	24.5	92.9	0	21.1	1.5
1	18/3/2014 7:00	5	5	24.2	93.7	0	21	1.3
1	18/3/2014 8:00	32	50	24.3	93.2	0	21.5	1.9
1	18/3/2014 9:00	213	318	25.4	88.9	0.2	27.9	1.3
1	18/3/2014 10:00	486	613	26.9	81.1	0	36.8	3.5
1	18/3/2014 11:00	555	624	28	76	0	39.5	3.3
1	18/3/2014 12:00	585	594	28.6	72.8	0	40.7	3
1	18/3/2014 13:00	275	267	27.9	76.1	0	31.9	3.6
1	18/3/2014 14:00	549	538	28.1	74.5	0.2	36.7	2.8
1	18/3/2014 15:00	462	451	28.1	74.7	0	35.4	3.1
1	18/3/2014 16:00	365	342	27.5	78.8	0.6	33.4	4
1	18/3/2014 17:00	50	46	25.2	94.8	3.2	23.8	1
1	18/3/2014 18:00	50	46	24.9	96.6	1.2	23.6	1
1	18/3/2014 19:00	26	25	24.8	97.3	1.4	23	1
1	18/3/2014 20:00	10	9	24.9	97.3	0	22.6	0.7
1	18/3/2014 21:00	7	6	25.1	97.4	0	22.7	0.3
1	18/3/2014 22:00	7	6	25	97.2	0	22.7	1.1
1	18/3/2014 23:00	7	6	24.9	97.3	0	22.6	1.4

1	19/3/2014 0:00	7	6	24.9	96	0	22.4	1.6
1	19/3/2014 1:00	7	6	25.2	94	0.2	22.4	1.5
1	19/3/2014 2:00	7	6	25.1	93.6	0	22.3	1.4
1	19/3/2014 3:00	6	6	24.8	95	0	21.8	1.3
1	19/3/2014 4:00	6	6	24.5	96	0	21.7	1.8
1	19/3/2014 5:00	6	5	24.3	95.7	0	21.6	2.2
1	19/3/2014 6:00	6	5	24.1	95.8	0	21.4	1.9
1	19/3/2014 7:00	5	5	24.1	94.9	0	21.2	1.8
1	19/3/2014 8:00	46	63	24.1	95	0	21.7	0.6
1	19/3/2014 9:00	216	313	25.5	89.5	0	27.7	1
1	19/3/2014 10:00	475	576	26.9	79.8	0	37.3	2.3
1	19/3/2014 11:00	698	803	28.5	70.5	0	43.8	3.3
1	19/3/2014 12:00	893	951	29.8	65	0	49.6	3.1
1	19/3/2014 13:00	911	925	30.8	61.8	0	51.9	2.3
1	19/3/2014 14:00	1021	996	31.9	56.8	0	56.9	2
1	19/3/2014 15:00	907	849	32.3	55.5	0	54.5	2.2
1	19/3/2014 16:00	899	805	33.3	51.8	0	54.6	1.9
1	19/3/2014 17:00	381	336	32.1	61.5	0.2	37.3	2
1	19/3/2014 18:00	429	358	31.2	63.1	0	39.3	3.2
1	19/3/2014 19:00	34	33	24.5	94.8	8.2	23.4	2.2
1	19/3/2014 20:00	10	9	23.3	94.6	0.8	21.4	1.6
1	19/3/2014 21:00	6	6	23.8	91	0	21	0.9
1	19/3/2014 22:00	6	6	24	94.2	0	20.8	0.7
1	19/3/2014 23:00	6	6	23.6	95.7	0	20.8	1
1	20/3/2014 0:00	6	6	23.9	95.1	0	21.1	0.8
1	20/3/2014 1:00	6	6	24.2	94.6	0	21.4	0.9
1	20/3/2014 2:00	6	6	24.1	94.9	0	21.3	1.2
1	20/3/2014 3:00	6	6	24.3	94.5	0	21.5	1.5
1	20/3/2014 4:00	6	6	24.3	94.7	0	21.7	2.4
1	20/3/2014 5:00	6	6	24.5	94.4	0	22	2.2
1	20/3/2014 6:00	6	6	24.8	92.5	0	22	2.2
1	20/3/2014 7:00	6	6	24.8	92.6	0	22.1	2.2
1	20/3/2014 8:00	25	26	24.8	92.8	0	22.4	1.9
1	20/3/2014 9:00	187	231	25.4	90.7	0	27.3	1.9
1	20/3/2014 10:00	503	614	27.3	82.1	0	38.6	2.6
1	20/3/2014 11:00	396	423	28.4	74.2	0	37.4	2.4
1	20/3/2014 12:00	364	364	29	70.9	0	36.9	1.6
1	20/3/2014 13:00	721	720	30.3	66.8	0	48.8	1.2
1	20/3/2014 14:00	868	842	31.6	63.3	0	56.6	1.4
1	20/3/2014 15:00	863	806	30.9	66.8	0	49.3	3.3
1	20/3/2014 16:00	336	315	29.6	73	0	38.7	2.3
1	20/3/2014 17:00	22	22	24.2	94.8	17.2	22.6	4
1	20/3/2014 18:00	35	35	23.1	95.8	2.4	21.6	2.1
1	20/3/2014 19:00	53	52	23.7	93.7	0	22.5	1.9
1	20/3/2014 20:00	10	10	23.7	94.1	0	21.4	0.9
1	20/3/2014 21:00	7	6	23.8	92.3	0	21.1	0.9
1	20/3/2014 22:00	7	6	23.9	92.3	0	21.1	0.9
1	20/3/2014 23:00	6	6	23.8	95.3	0	21.2	1
1	21/3/2014 0:00	6	5	23.5	95.8	0	20.7	1.1
1	21/3/2014 1:00	6	5	23.4	95.2	0	20.5	0.6
1	21/3/2014 2:00	6	5	23.5	95.5	0	20.6	0.9
1	21/3/2014 3:00	6	6	23.4	95.7	0	20.7	0.7
1	21/3/2014 4:00	6	6	23.5	96.3	0	20.6	0.5
1	21/3/2014 5:00	6	6	23.4	96.2	0	20.8	0.6
1	21/3/2014 6:00	6	6	23.7	95.1	0	21	0.5
1	21/3/2014 7:00	6	6	23.8	95.6	0	21.1	0.4
1	21/3/2014 8:00	26	26	23.7	96.3	0	21	0.6
1	21/3/2014 9:00	163	186	24.4	93.9	0	24.1	0.7
1	21/3/2014 10:00	353	404	25.9	89.5	0	34.1	1.1
1	21/3/2014 11:00	531	582	27.7	82.3	0	42.2	1.3
1	21/3/2014 12:00	632	668	28.8	75.5	0	45	1.8
1	21/3/2014 13:00	860	869	29.9	68.9	0	51.2	1.9
1	21/3/2014 14:00	800	784	30.8	66.1	0	51.9	1.7
1	21/3/2014 15:00	699	664	31.6	63.5	0	49.2	1.6
1	21/3/2014 16:00	499	466	31.7	64.5	0	46.1	1.4
1	21/3/2014 17:00	319	293	30.2	68.9	0	36	3.2
1	21/3/2014 18:00	225	205	30	68.8	0	33.2	2.3
1	21/3/2014 19:00	81	76	29.3	73.3	0	28.8	1.8
1	21/3/2014 20:00	14	13	28	72.8	0	25.6	1.6
1	21/3/2014 21:00	5	5	27.3	78	0	24.3	1.5
1	21/3/2014 22:00	6	6	26.6	83.2	0	24.1	1
1	21/3/2014 23:00	6	6	26.3	85.4	0	23.9	1
1	22/3/2014 0:00	5	5	26.8	78.7	0	23.8	3
1	22/3/2014 1:00	5	5	25.9	82.6	0	23.1	3.2
1	22/3/2014 2:00	5	5	25.2	88.4	0	21.9	1.3
1	22/3/2014 3:00	5	5	24.7	91	0	21.4	1.7
1	22/3/2014 4:00	5	5	24.4	92	0	21.3	2
1	22/3/2014 5:00	5	5	24.2	91.6	0	21.2	2.5
1	22/3/2014 6:00	5	5	24	92.5	0	21.1	2.6
1	22/3/2014 7:00	5	5	24.2	91.1	0	21.3	3.2
1	22/3/2014 8:00	29	31	24.1	91	0	21.4	2.4
1	22/3/2014 9:00	107	128	24.5	88.8	0	24	3.3
1	22/3/2014 10:00	313	375	25.8	84.3	0	30.1	3.9
1	22/3/2014 11:00	499	556	27.1	77.7	0	35.8	4.1
1	22/3/2014 12:00	808	858	28.7	69.9	0	44	3.5
1	22/3/2014 13:00	982	997	29.5	65.1	0	46.2	4.4
1	22/3/2014 14:00	852	834	30.1	62.7	0	45.4	4.1
1	22/3/2014 15:00	892	827	30.8	59.1	0	46	3.9
1	22/3/2014 16:00	870	766	31.5	55.3	0	46.8	3.4
1	22/3/2014 17:00	685	567	31.8	54.4	0	43.4	3.4
1	22/3/2014 18:00	318	248	31.5	54.7	0	35.2	3.4
1	22/3/2014 19:00	97	71	30.9	56.6	0	29.6	2.4
1	22/3/2014 20:00	13	11	29.6	63.3	0	26.5	1.3
1	22/3/2014 21:00	5	5	28.4	70.7	0	25	1.8
1	22/3/2014 22:00	5	5	27.8	76.5	0	24.6	1.8
1	22/3/2014 23:00	5	5	26.9	78.8	0	23.6	2.3

1	23/3/2014 0:00	4	4	25.9	79.1	0	22.5	2
1	23/3/2014 1:00	4	4	25.1	83.7	0	21.7	2.3
1	23/3/2014 2:00	4	4	24.4	86.4	0	20.9	2
1	23/3/2014 3:00	4	4	24.1	86	0	20.5	2.1
1	23/3/2014 4:00	4	4	24.2	80.5	0	20.6	2.3
1	23/3/2014 5:00	4	4	23.5	82	0	19.7	1.7
1	23/3/2014 6:00	4	4	23	82.9	0	19	1.2
1	23/3/2014 7:00	4	4	23.3	78.6	0	19.5	2.3
1	23/3/2014 8:00	38	70	22.9	79.7	0	20	1.7
1	23/3/2014 9:00	226	336	24.7	71.8	0	27.8	2
1	23/3/2014 10:00	486	608	26.8	65.1	0	35.9	3
1	23/3/2014 11:00	721	818	28.3	61.7	0	40.9	4.6
1	23/3/2014 12:00	907	966	30	57.1	0	45.5	4.5
1	23/3/2014 13:00	1029	1040	31.1	53.6	0	47.7	5.6
1	23/3/2014 14:00	1071	1034	31.7	52.3	0	49.8	4.9
1	23/3/2014 15:00	1025	946	32.4	50.8	0	50	4.6
1	23/3/2014 16:00	824	718	32.9	47.5	0	46.2	4.2
1	23/3/2014 17:00	700	565	33.3	46	0	44	3.5
1	23/3/2014 18:00	458	326	33	45.1	0	37.8	3.5
1	23/3/2014 19:00	169	97	31.9	47.9	0	30.9	2.9
1	23/3/2014 20:00	10	10	30.2	52.5	0	27	2.3
1	23/3/2014 21:00	5	5	28.7	57.3	0	25.1	1.8
1	23/3/2014 22:00	5	4	27.4	61.4	0	23.8	1.8
1	23/3/2014 23:00	5	4	26.6	67.1	0	23.1	2.1
1	24/3/2014 0:00	5	5	25.8	74	0	22.4	2.1
1	24/3/2014 1:00	5	5	25.1	78.3	0	22	3.1
1	24/3/2014 2:00	5	5	24.5	81.3	0	21.4	2.7
1	24/3/2014 3:00	5	5	24.7	81.5	0	22.3	4.6
1	24/3/2014 4:00	5	5	24.7	83	0	22.3	4.8
1	24/3/2014 5:00	5	5	24.6	85.1	0	21.9	4.4
1	24/3/2014 6:00	5	5	24.7	85.2	0	21.9	4
1	24/3/2014 7:00	5	5	24.6	85.8	0	21.7	3.6
1	24/3/2014 8:00	37	64	24.3	86.8	0	22	3.8
1	24/3/2014 9:00	204	295	25.5	81.4	0	27.3	4.4
1	24/3/2014 10:00	480	596	27	76	0	34.3	4.6
1	24/3/2014 11:00	719	814	28.2	70.5	0	41.1	4.1
1	24/3/2014 12:00	818	869	29.4	63.4	0	45	4.1
1	24/3/2014 13:00	1008	1018	30.9	56.6	0	49.5	3.4
1	24/3/2014 14:00	951	922	31.8	53.2	0	51.3	3
1	24/3/2014 15:00	895	831	32.4	51.1	0	49.5	3
1	24/3/2014 16:00	817	716	32.3	52	0	46.3	3.5
1	24/3/2014 17:00	573	472	32.4	51.4	0	41.4	3.4
1	24/3/2014 18:00	424	308	31.6	54.7	0	36.4	4.1
1	24/3/2014 19:00	155	94	30.4	58.9	0	29.9	4
1	24/3/2014 20:00	15	12	29.1	63.6	0	26.7	2.8
1	24/3/2014 21:00	6	6	28.2	69.2	0	25.9	1.8
1	24/3/2014 22:00	6	6	27.7	73.7	0	25.4	1.6
1	24/3/2014 23:00	5	5	26.9	78.2	0	23.9	1.8
1	25/3/2014 0:00	5	5	26.3	80.9	0	23.3	2.4
1	25/3/2014 1:00	5	5	25.7	85	0	22.8	3.1
1	25/3/2014 2:00	5	5	25.2	88.5	0	22.3	3.3
1	25/3/2014 3:00	5	5	24.9	90.6	0	22.2	3.4
1	25/3/2014 4:00	5	5	24.9	90.9	0	22.1	3.3
1	25/3/2014 5:00	5	5	24.7	91.8	0	21.8	3.1
1	25/3/2014 6:00	5	5	24.5	92.5	0	21.7	2.9
1	25/3/2014 7:00	5	5	24.6	91.6	0	21.7	3
1	25/3/2014 8:00	37	57	24.7	90.2	0	22.1	3.3
1	25/3/2014 9:00	223	323	25.8	84.3	0	28.4	3.9
1	25/3/2014 10:00	480	596	27.2	78	0	35.3	4.5
1	25/3/2014 11:00	705	799	28.8	69.6	0	42.2	4.1
1	25/3/2014 12:00	893	947	30.1	63.9	0	46.9	4.3
1	25/3/2014 13:00	1009	1017	31.1	58.4	0	49.5	4.3
1	25/3/2014 14:00	1003	969	32	54.2	0	51.1	3.9
1	25/3/2014 15:00	901	830	33	49.4	0	50.6	3
1	25/3/2014 16:00	794	696	33.7	45.5	0	50.1	2.4
1	25/3/2014 17:00	524	452	33.9	45.3	0	45.6	2.1
1	25/3/2014 18:00	94	89	32	59.7	0	32.9	2
1	25/3/2014 19:00	55	52	30.6	69.7	0	29.5	1.5
1	25/3/2014 20:00	11	10	29.8	73	0	27.3	1.6
1	25/3/2014 21:00	6	5	29.1	73.4	0	26.2	1.4
1	25/3/2014 22:00	6	6	28.7	70.7	0	26.1	1.9
1	25/3/2014 23:00	6	6	28.1	74	0	25.6	2
1	26/3/2014 0:00	6	5	27.2	78.4	0	24.6	2.4
1	26/3/2014 1:00	5	5	26.5	83.3	0	23.7	2.7
1	26/3/2014 2:00	5	5	25.8	88	0	23	3.1
1	26/3/2014 3:00	5	5	25.4	90.6	0	22.3	2
1	26/3/2014 4:00	5	5	25.4	90.8	0	22.4	3.2
1	26/3/2014 5:00	5	5	25.4	90.9	0	22.8	3.5
1	26/3/2014 6:00	5	5	25.6	89.6	0	23	3.2
1	26/3/2014 7:00	5	5	25.3	91	0	22.5	3
1	26/3/2014 8:00	40	62	25.5	89.5	0	23.3	3.5
1	26/3/2014 9:00	225	321	26.6	84	0	29.5	3.3
1	26/3/2014 10:00	478	593	28.1	75.2	0	36.9	3.6
1	26/3/2014 11:00	714	806	29.6	65.9	0	43.3	3.9
1	26/3/2014 12:00	904	958	30.7	61.7	0	48.8	3.7
1	26/3/2014 13:00	954	960	31.7	57.2	0	51.4	3.4
1	26/3/2014 14:00	946	915	32.5	54	0	52.4	3.1
1	26/3/2014 15:00	977	901	33.2	51.1	0	53.6	3.3
1	26/3/2014 16:00	893	771	33.4	49.8	0	49.6	3.4
1	26/3/2014 17:00	684	553	34.2	45.5	0	46.5	2.9
1	26/3/2014 18:00	459	365	33.9	47.7	0	41.1	3.2
1	26/3/2014 19:00	93	86	31.1	64	0	31.2	3.1
1	26/3/2014 20:00	10	10	30.1	69.2	0	27.7	2
1	26/3/2014 21:00	5	5	29.6	68	0	26.4	1.5
1	26/3/2014 22:00	5	5	28.7	70.6	0	25.7	2
1	26/3/2014 23:00	5	5	27.7	75.4	0	25	2.6

1	27/3/2014 0:00	5	5	27	80.3	0	23.9	2
1	27/3/2014 1:00	5	5	26.2	84.3	0	23.1	2.3
1	27/3/2014 2:00	5	5	25.7	87.9	0	22.6	2.3
1	27/3/2014 3:00	5	5	25.2	90.7	0	22.2	3
1	27/3/2014 4:00	5	5	24.9	92.2	0	22.1	2.3
1	27/3/2014 5:00	5	5	25.2	90	0	21.9	2.1
1	27/3/2014 6:00	5	5	24.9	89.8	0	21.7	2.6
1	27/3/2014 7:00	5	5	24.7	89.7	0	21.3	2.1
1	27/3/2014 8:00	41	66	24.6	90.1	0	21.8	1
1	27/3/2014 9:00	225	321	25.7	86.4	0	29.9	1.4
1	27/3/2014 10:00	500	591	27.8	73.6	0	39.7	2.2
1	27/3/2014 11:00	632	706	29.4	65.1	0	43.2	3.3
1	27/3/2014 12:00	889	939	30.7	61.5	0	49.1	3.3
1	27/3/2014 13:00	1011	1014	32.4	54.3	0	54.3	2.8
1	27/3/2014 14:00	1058	1016	33.2	49.2	0	55.2	2.8
1	27/3/2014 15:00	1052	964	33.7	45.6	0	54.4	3.4
1	27/3/2014 16:00	888	768	34	43.8	0	50.5	3.6
1	27/3/2014 17:00	679	541	34.3	42.2	0	46.6	2.8
1	27/3/2014 18:00	433	299	34.2	43.2	0	39.7	2.6
1	27/3/2014 19:00	167	90	33.7	45.5	0	32.8	2
1	27/3/2014 20:00	11	9	32.3	50.7	0	28.7	1.1
1	27/3/2014 21:00	5	5	31	57.3	0	27.1	1.3
1	27/3/2014 22:00	5	5	29.7	62.9	0	26.2	1.5
1	27/3/2014 23:00	5	5	28.7	68.7	0	24.7	0.7
1	28/3/2014 0:00	5	5	27.9	70.9	0	24.3	1.6
1	28/3/2014 1:00	5	5	27	75.8	0	23.7	1.7
1	28/3/2014 2:00	5	5	26.4	79	0	23	1.5
1	28/3/2014 3:00	5	5	25.7	84.7	0	22.5	1.8
1	28/3/2014 4:00	5	5	25.3	88	0	22	1.4
1	28/3/2014 5:00	5	5	25.2	90.3	0	22.2	2.4
1	28/3/2014 6:00	5	5	25.4	91.9	0	22.4	2.9
1	28/3/2014 7:00	5	5	25.5	92.8	0	22.5	2.6
1	28/3/2014 8:00	37	56	25.5	92.7	0	23	2.7
1	28/3/2014 9:00	220	312	26.6	87.6	0	29.5	2.8
1	28/3/2014 10:00	468	575	28.3	79.8	0	38	3.3
1	28/3/2014 11:00	721	810	29.6	71.2	0	43.8	3.6
1	28/3/2014 12:00	885	936	31.1	64.4	0	50.4	3
1	28/3/2014 13:00	903	912	32.3	58.3	0	53.2	2.7
1	28/3/2014 14:00	902	867	33.4	53.5	0	53.4	2.3
1	28/3/2014 15:00	947	871	34.7	47.8	0	56.9	1.8
1	28/3/2014 16:00	579	511	33.6	57.3	0	46.8	2.3
1	28/3/2014 17:00	654	522	33.2	57.9	0	44.5	3.3
1	28/3/2014 18:00	316	239	32.6	58.7	0	37.8	2.7
1	28/3/2014 19:00	69	68	31.4	62.9	2.6	31	2.3
1	28/3/2014 20:00	8	7	26.4	95	9	24.3	1.8
1	28/3/2014 21:00	7	7	26.3	95	0	24	0.9
1	28/3/2014 22:00	6	6	25.7	95.2	0	23.2	1.3
1	28/3/2014 23:00	6	6	25.5	94.3	0	22.6	1.1
1	29/3/2014 0:00	7	6	25.3	93.9	0	22.6	1
1	29/3/2014 1:00	7	7	25.4	91.4	0	23	1.3
1	29/3/2014 2:00	6	5	25.4	92.2	0	22.8	1.5
1	29/3/2014 3:00	6	6	25.5	92.7	0	22.5	1.2
1	29/3/2014 4:00	6	5	25.2	94.6	0	22.2	1.6
1	29/3/2014 5:00	6	5	25.3	94.7	0	22.2	1.4
1	29/3/2014 6:00	6	5	25.4	95.2	0	22.6	2.3
1	29/3/2014 7:00	6	6	25.4	95.6	0	22.7	1.4
1	29/3/2014 8:00	14	14	25.6	94.9	0	23.1	1.8
1	29/3/2014 9:00	72	71	25.9	93.9	0	24.5	1.2
1	29/3/2014 10:00	265	293	26.6	90.4	0	30.7	1.3
1	29/3/2014 11:00	588	643	28.6	81.3	0	45.1	1.3
1	29/3/2014 12:00	759	789	30.7	71.3	0	50.4	1.4
1	29/3/2014 13:00	715	717	31.8	64.4	0	50.8	1.5
1	29/3/2014 14:00	428	417	30.6	66.7	0	44.1	2.5
1	29/3/2014 15:00	54	54	24.6	92.4	17.4	23.8	3.3
1	29/3/2014 16:00	170	159	24	97.5	4.8	24.8	2.7
1	29/3/2014 17:00	77	72	25.7	93.7	0	26.5	0.8
1	29/3/2014 18:00	17	17	25.3	95.2	2.6	23.3	0.9
1	29/3/2014 19:00	14	14	25	97.3	0.8	22.9	0.9
1	29/3/2014 20:00	7	7	25	97.5	0.2	22.6	1
1	29/3/2014 21:00	6	6	24.8	98.3	0	22.4	1
1	29/3/2014 22:00	6	6	24.6	98	0	21.9	0.8
1	29/3/2014 23:00	6	6	24.5	96.5	0	21.9	1
1	30/3/2014 0:00	6	6	24.3	95.9	0	21.7	1.1
1	30/3/2014 1:00	6	6	24.3	96.1	0	21.5	0.7
1	30/3/2014 2:00	6	6	24.2	96.4	0	21.1	0.5
1	30/3/2014 3:00	6	6	23.9	97.8	0	20.9	0.6
1	30/3/2014 4:00	6	6	23.7	98.2	0	20.9	0.6
1	30/3/2014 5:00	6	6	23.6	98	0	20.8	1.2
1	30/3/2014 6:00	6	6	23.5	97.7	0	21	1.6
1	30/3/2014 7:00	6	6	23.4	98.4	0	20.8	1.1
1	30/3/2014 8:00	33	38	23.5	98	0	21	0.8
1	30/3/2014 9:00	195	251	24.5	94	0	24.8	1.1
1	30/3/2014 10:00	439	528	26.4	87	0	35.9	1.5
1	30/3/2014 11:00	675	754	28.5	77.9	0	46.2	1.8
1	30/3/2014 12:00	787	821	29.9	71.9	0	49.3	2
1	30/3/2014 13:00	924	923	31.4	63.8	0	54.9	1.6
1	30/3/2014 14:00	623	608	32.2	60.4	0	50.1	1.3
1	30/3/2014 15:00	929	855	33	56.8	0	56.8	1.4
1	30/3/2014 16:00	541	489	33.4	54.7	0	50.2	1.2
1	30/3/2014 17:00	302	262	31.4	67.8	0	36.3	2.8
1	30/3/2014 18:00	355	273	31.3	65.5	0	36.7	2.7
1	30/3/2014 19:00	144	110	30.6	65.4	0	31.1	2.4
1	30/3/2014 20:00	15	14	29.7	68.7	0	27.5	1.1
1	30/3/2014 21:00	6	6	29.1	73.4	0	26.3	1.3
1	30/3/2014 22:00	6	6	28.6	77.7	0	25.6	1.3
1	30/3/2014 23:00	6	6	27.7	82.2	0	24.8	1.5

1	31/3/2014 0:00	5	5	26.9	85.7	0	23.8	1
1	31/3/2014 1:00	5	5	26.5	88.4	0	23.2	0.7
1	31/3/2014 2:00	6	5	26.2	90.3	0	22.7	1
1	31/3/2014 3:00	5	5	25.6	92.3	0	22.4	1
1	31/3/2014 4:00	6	5	25.3	93.7	0	22.2	1.3
1	31/3/2014 5:00	5	5	25.3	93.7	0	22.2	1.4
1	31/3/2014 6:00	5	5	25.2	94	0	22.2	1.3
1	31/3/2014 7:00	5	5	25	94.8	0	22.1	1.3
1	31/3/2014 8:00	39	46	25.3	94.7	0	22.8	1.9
1	31/3/2014 9:00	195	244	26.6	90.3	0	28	1.2
1	31/3/2014 10:00	413	483	28.5	81.6	0	38.5	1.7
1	31/3/2014 11:00	554	601	29.6	75.9	0	43.6	1.9
1	31/3/2014 12:00	706	726	30.8	69.3	0	48.9	1.7
1	31/3/2014 13:00	967	962	32.5	61.8	0	59.6	1.2
1	31/3/2014 14:00	942	903	33.2	57.6	0	59.8	1.3
1	31/3/2014 15:00	602	567	33.6	56	0	52.5	1.3
1	31/3/2014 16:00	451	409	32.3	62.7	0	41.2	2.3
1	31/3/2014 17:00	394	354	31.1	68.4	0.2	34.7	2.6
1	31/3/2014 18:00	236	208	30.6	68	0	34	3
1	31/3/2014 19:00	75	72	29.1	79.6	0	28.8	2.3
1	31/3/2014 20:00	8	8	28.4	84.8	0	26.1	1.3
1	31/3/2014 21:00	6	5	27.7	89.5	0.2	24.7	0.9
1	31/3/2014 22:00	6	6	26.3	94.3	0.4	23.8	1.1
1	31/3/2014 23:00	6	6	25.9	95.9	0	23.1	0.9
1	1/4/2014 0:00	6	6	25.6	96.2	0	22.9	0.7
1	1/4/2014 1:00	6	6	25.5	95.7	0	22.6	0.7
1	1/4/2014 2:00	6	6	25.5	96.8	0	22.5	0.7
1	1/4/2014 3:00	6	6	25.2	97.5	0	22.3	0.7
1	1/4/2014 4:00	6	6	24.9	98.6	0	21.9	0.3
1	1/4/2014 5:00	6	6	24.7	99	0	21.9	0.4
1	1/4/2014 6:00	6	6	24.6	99.2	0	21.7	0.5
1	1/4/2014 7:00	6	6	24.4	99.2	0	21.6	0.4
1	1/4/2014 8:00	30	30	24.4	99.1	0	22.1	0.8
1	1/4/2014 9:00	130	135	24.6	99.2	0	24.2	1.1
1	1/4/2014 10:00	284	304	25.9	94.8	0	30.6	1
1	1/4/2014 11:00	625	673	28.6	81.7	0	46.6	0.9
1	1/4/2014 12:00	811	835	31	69.3	0	56.1	0.9
1	1/4/2014 13:00	572	568	31.3	65.6	0	48.7	1.1
1	1/4/2014 14:00	574	547	32.5	61.9	0	50.4	0.9
1	1/4/2014 15:00	761	702	31.6	65.8	0	48.5	2.7
1	1/4/2014 16:00	543	485	31.8	64.2	0	44	2.1
1	1/4/2014 17:00	486	430	32.1	62.1	0	43.9	1.8
1	1/4/2014 18:00	123	125	30.3	69.1	0	32.3	1.8
1	1/4/2014 19:00	58	59	27.4	77.7	0	27	2.4
1	1/4/2014 20:00	8	8	27.1	79.2	0	25.1	0.9
1	1/4/2014 21:00	6	6	26.7	81.4	0	24.7	0.8
1	1/4/2014 22:00	6	6	26.4	85.5	0	24.1	0.8
1	1/4/2014 23:00	6	5	26.3	86	0	23.6	0.6
1	2/4/2014 0:00	6	5	26	89	0	23.4	0.7
1	2/4/2014 1:00	6	6	25.6	91.9	0	23.1	0.8
1	2/4/2014 2:00	6	6	25.6	92.9	0	23.3	0.9
1	2/4/2014 3:00	6	6	25.5	92.6	0	23.3	0.8
1	2/4/2014 4:00	6	6	25.4	93.5	0	22.8	0.6
1	2/4/2014 5:00	6	5	25.3	94.6	0	22.4	0.5
1	2/4/2014 6:00	6	5	25.2	94.8	0	22	0.2
1	2/4/2014 7:00	6	6	25.3	93	0	22.4	1.6
1	2/4/2014 8:00	31	30	25.7	91.1	0	23.6	1.8
1	2/4/2014 9:00	185	192	26.1	90.2	0	28.6	1.1
1	2/4/2014 10:00	250	262	27.2	86	0	32.9	1.6
1	2/4/2014 11:00	333	341	28.2	80.2	0	36.4	1
1	2/4/2014 12:00	667	687	29.9	71.5	0	48.6	1.2
1	2/4/2014 13:00	721	720	31.2	65.2	0	52.9	1.4
1	2/4/2014 14:00	743	716	31.9	64.5	0	51.2	1.5
1	2/4/2014 15:00	705	656	32.1	64.8	0	49.4	1.9
1	2/4/2014 16:00	502	448	30.9	69	0	41.6	3
1	2/4/2014 17:00	362	316	30.8	65	0	38.5	2.6
1	2/4/2014 18:00	197	175	30.4	66.7	0	33.7	2.2
1	2/4/2014 19:00	106	96	30.4	66.3	0	31.2	1.4
1	2/4/2014 20:00	13	12	29.7	69.6	0	27.3	1.5
1	2/4/2014 21:00	6	5	28.9	73.4	0	25.8	1.2
1	2/4/2014 22:00	5	5	28.3	77.4	0	24.9	0.8
1	2/4/2014 23:00	5	5	27.6	83.7	0	24	0.6
1	3/4/2014 0:00	5	5	26.8	88.1	0	23.5	0.6
1	3/4/2014 1:00	5	5	26.6	88.4	0	23.1	0.4
1	3/4/2014 2:00	5	5	26.4	90.5	0	22.7	0.5
1	3/4/2014 3:00	6	6	26.4	90.5	0	22.7	0.3
1	3/4/2014 4:00	5	5	25.8	93.1	0	22.4	0.4
1	3/4/2014 5:00	5	5	25.6	93.3	0	22.2	0.8
1	3/4/2014 6:00	6	5	25.2	95.4	0	22.2	0.5
1	3/4/2014 7:00	5	5	25.4	93.6	0	22.1	0.4
1	3/4/2014 8:00	40	45	25.3	95.3	0	22.8	0.8
1	3/4/2014 9:00	192	234	26.2	90.4	0	27.9	0.9
1	3/4/2014 10:00	440	511	28.6	80.4	0	40.5	1
1	3/4/2014 11:00	632	678	30.3	71.3	0	49.5	1.2
1	3/4/2014 12:00	727	744	31.5	65.4	0	51.8	1.2
1	3/4/2014 13:00	587	590	30.5	71.4	0	44.3	2.9
1	3/4/2014 14:00	412	407	28.7	79.2	0.6	36.9	2.7
1	3/4/2014 15:00	406	386	28	84.4	0.8	31.1	1.8
1	3/4/2014 16:00	667	601	30.5	71	0	47.4	1.7
1	3/4/2014 17:00	364	340	31.2	63.8	0	39.9	1.5
1	3/4/2014 18:00	108	110	27.5	87.3	0.4	27.7	2.2
1	3/4/2014 19:00	53	51	25.6	93	0.8	24.1	1.4
1	3/4/2014 20:00	8	7	25.3	95.8	0.8	22.9	0.8
1	3/4/2014 21:00	6	6	25.5	97	0	23.1	1.1
1	3/4/2014 22:00	6	6	25.4	95.7	0	22.7	0.8
1	3/4/2014 23:00	6	6	25.5	97.1	0	22.7	0.8

Resume

Career Objective:

To work in a firm with a work environment that is driven by a professional where i can use and apply knowledge, skills that would allow me as a fresh graduate to grow while meeting the goals of the organization.

MOHAMAD SAFUWAN BIN ROMLI

Contact No : 012-5284676
E-mail : safuwan91@gmail.com

Age : 23
Gender : Male
Address : 2303 Kebun 4 Relong, Sg Tiang, 06750 Pendang, Kedah Darul Aman.
Status : Single
Health : Excellent

IC No : 910211-02-6343
Date of Birth : 11 February 1991
Nationality : Malaysia

Language

Bahasa Melayu : ●●●●●
English : ●●●○○

Educational Background

Bachelor Level

Finish Date : July 2014
University : Universiti Teknikal Malaysia Melaka (UTeM), Melaka
Field of Study: Bachelor of Electrical Engineering (Industrial Power) With Honour.
CGPA : 3.26/4.00 (Semester 7)

Matriculation Program

Finish Date : April 2010
College : Johor Technical Matriculation Collage (JTMC), Johor.
Field of Study : Electric and Electronic Engineering.
CGPA : 3.48/4.00

Sijil Pelajaran Malaysia (SPM)

Finish Date : December 2008
School : Sekolah Menengah Teknik Pendang (SMTP), Kedah.
Field of Study : Study Electrical and Electronic Engineering.
Gred : 4A, 4B, 2C

Extra-Curricular Activity

At Sekolah Menengah Teknik Pendang (SMTP):

- Hokey Tournament - First place (District).
- Kadet Remaja Sekolah Tournament - Second place (District).
- Committee Members of Publication Club, (SMTP).
- Committee Members of Ping-Pong Club, (SMTP).
- Committee of ASPURA, (SMTP)

At Johor Technical Matriculation Collage (JTMC):

- Facilitator orientation new students session 2010/2011, JMTC.
- College Hostel Exco, JTMC.
- Committee Members of Kembara Club, JMTC.
- Committee preparation of Elegant Night, JMTC.
- Join Seminar Biro Tata Negara, Terengganu (National).
- Participate in Cycling, JTMC.
- Participate in Futsal Tournament - Second place (Collage).
- Participate in Bowling Tournament - Fourth place (Collage).
- Participate in Gadgets Tournament - Third place (Collage).
- Participate in English drama - First place (Collage).
- Participate in Explorace Inter- Fourth place (Collage)

At Universiti Teknikal Malaysia Melaka (UTeM):

- Committee Members of Dikir Barat Sri Kejora Club.
- Members of Hokey Club.
- Members of Kembara Club.
- Join Basic Leadership Seminar, UTeM.
- Join Seminar Underwater Robot, UTeM.
- Participate in Climbing Gunung Datuk, N.Sembilan.
- Participate in Line Follower Robot, UTeM (Faculty).
- Participate in Dikir Barat Competition, UTeM(Faculty).

Experience History

1) **Shop & Save Sdn Bhd**

Duration	: June 2010- August 2010
Position Title	: Operator
Position Level	: Fresh/Entry Level
Specialization	: Operation-Electronic Department
Work scope	: Assembly electronic part including soldering, testing (checking) and packaging

2) **Jabatan Kerja Raya (JKR Electrical Engineering Branch)**

Duration	: Jun 2013- August 2013
Position Title	: Maintenance
Position Level	: Fresh/Trainee
Specialization	: Electrical Engineering Department
Work Scope	: Maintenance electrical problem, temporary wiring, manage contract price and AutoCAD drawing.

Top Skill

1) **Hands-on :**
   - Manual Technical Drawing ●●●●●●●●○○
   - Soldering ●●●●●●○○○○
   - Wiring ●●●●●○○○○○
2) **Software :**
   - Microsoft Office ●●●●●●●●○○
   - AutoCAD ●●●●●●●○○○
   - Multisim ●●●●●●●○○○
   - PSpice ●●●●●●●○○○
   - MATLAB ●●●●○○○○○○
   - PLC Programming ●●●●○○○○○○

Strengths

Personal Qualities : Ability to work under pressure.
: Able to work independently or in team.
: Mistake is the best teacher.
: Willing to travel.

Preferred Work Style : I prefer to work in any organized environment, where my performance can be measured with some accuracy.

References

1) **Dr. Zikri Abadi Bin Baharudin**

Position	: Lecturer /Academic Advisor
Company	: Universiti Teknikal Malaysia Melaka
Phone	: 013-7995374
Email	: zikri@utem.edu.my

2) **En. Rozaidi Bin Mat Isa**

Position	: Assistant Electrical Engineer
Company	: Jabatan Kerja Raya (JKR Electrical Engineering Branch).
Phone	: 019-4401444
Email	: rozaidi@jkr.gov.my