"I admit have read this report and it has followed the scope and quality in Partial Fulfillment of Requirement for the Degree of Bachelor Mechanical Engineering (Thermal Fluid)"

Signatures :……..

Supervisor :……..

Date :…….

# A FEASIBILITY STUDY ON PHOTOTHERAPY UNIT POWERED BY SOLAR ENERGY

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"I admit this report is my own work except summary and passage which all the source are state"

Signatures :……..

Author :……..

Date :…….

To my beloved father and mother

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# ABSTRAK

Mesin ‘phototherapy’ digunakan secara meluas dalam bidang perubatan untuk merawat penyakit kuning yang sering dihidapi oleh bayi yang baru dilahir. Mesin ini menggunakan cahaya untuk menukarkan ‘bilirubin’ kepada bahan lebih larut sebelum disingkirkan melalui pembuangan air kencing. Mesin ‘phototherapy’ ini menggunakan sumber kuasa elektrik untuk berfungsi. Namun dalam projek ini mesin tersebut akan ditukarkan kepada sumber kuasa solar yang boleh diperoleh secara percuma dari matahari. Sumber kuasa solar adalah bersih dari pencemaran alam dan mampu menggantikan sumber kuasa elektrik yang dihasil daripada pembakaran bahan api. Sumber tenaga solar yang terkumpul bagaimanapun perlu disimpan di dalam tempat simpanan iaitu bateri sebelum ditukarkan kepada arus ulang alik (AC) oleh ‘inverter’ untuk digunakan di dalam peralatan elektrik. Mesin solar ‘phototherapy’ ini dapat membantu meringankan masalah kos operasi yang tinggi di hospital atau klinik-klinik yang menyediakan rawatan penyakit kuning. Perkara utama dalam sistem solar ini ialah ia perlu menghasilkan tenaga elektrik yang mencukupi untuk digunakan dalam peralatan elektrik seperti mesin ‘phototherapy’ ini.

## ABSTRACT

Phototherapy unit device which is used in jaundice disease treatment is working by using light energy to change the bilirubin into a more soluble form to be excreted in the bile or urine. Conventional phototherapy unit use electrical power as their main source. However in this project, the solar energy free form sunlight is using to power up the machine. Solar energy is clean, reliable and affordable to replace the power from normal electricity. The most important device in solar system is its photovoltaic panel which is use to absorb sunlight before it will convert into useful electricity current. The collected solar energy however need to be store in a battery before it can be convert into AC since wave current by inverter in order to power up appliance. It is involve a proper calculation and best selecting devices in order to design a cost effective solar system. The solar phototherapy unit helps in reducing the high cost of operational for most hospital and clinic which provide a jaundice disease treatment. The important thing in this system is to produce enough amount of electric current which need to be use to powered up electrical appliance.

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| | | |
|---|---|---|
| *I* | = | Electric current, A |
| *J* | = | Current density |
| *L* | = | Distance |
| *M* | = | Mass, kg |
| *P* | = | Power |
| *V* | = | Volt |
| *Hz* | = | Hertz |
| *A* | = | Ampere |
| *h* | = | Hours |
| *AC* | = | Alternative Current |
| *DC* | = | Direct Current |
| *Ah* | = | Ampere hour |

# CHAPTER I

# INTRODUCTION

## 1.1 Study Background

Both renewable and non-renewable energy sources are utilized for power usage in Malaysia. Non-renewable energy resources include petroleum, natural gas and coal. Meanwhile, renewable sources include hydro power, solar power and biomass power. Energy consumption in Malaysia is sustainable with the current rate of economic development.

The growth in the world in terms of economy and population has caused an expansion of global energy market. As a result, the total global energy demand continues to increase. The share of energy resources are being dictated by geo-political events. Hence, the conventional fossil fuel supply and its sustainability is a critical issue of energy security. At the onset, one of the impacts is the ever increasing oil price. Another one is the environmental degradation caused by overzealous use of fossil fuels resulting in drastic climate change. Solar energy is the only primary source that can be directly exploited at any place on earth. The task is therefore to harness it in an efficient, reliable and affordable manner.

Solar energy comes from the light of the sun; it is a renewable source of energy. Solar uses its light to create pollution free electricity. When the sun shines on solar cells, they absorb the energy released by the sun causing a chemical reaction that generates electricity. The electricity generated by these solar cells is called photovoltaic system. It can be used at home and factories or stored in a battery. This stored energy then can be

used at night. The simplest photovoltaic system power is used in many of the small calculators and wristwatches.

## 1.2 Scope

- To study solar energy concept and theories
- To apply the solar energy concept and theories for applications
- To investigate the optimum requirement of solar panel (design and cost)
- To study the suitability of solar panel (size)
- Final justification and conclusion

## 1.3 Problem Statement

According to Judith Lauwers (2005) in *Counselling the Nursing Mother: A Lactation Consultant's Guide*, Bilirubin reaches a noticeable level by the third day of life. It remains slightly elevated for several days and falls by the end of the first week. It shows that during that period of time, phototherapy treatment is required to ensure the disease is still safe.

Dr. John f. Mills (2000) in *Fibreoptic phototherapy for neonatal jaundice* stated that percentage changes in SBR after 24 or 48 hours of treatment where the percentage changes in SBR for every hour or day of treatment. Working hour of phototherapy unit operation took long hours.

Phototherapy unit is the device use for jaundice disease treatment in hospital. This equipment is powered by electrical sources which required 125 Watt of power and 220 – 240V, 50Hz of power supply. The operation of this device usually takes long

hours and even until a few days. It depends on the jaundice level of seriousness on patient. In order to reduce the operation cost in hospital, solar energy is the best alternative source to be implemented in this device. This is because, solar energy provides clean, reliable, no hazardous waste and more importantly, we can get the energy for free from the sun since there will be no cost involved.

## 1.4 Objective of Study

The main objective of this study is to design a phototherapy unit powered by solar energy. It also aims to study the implementation of solar energy source into the device which will take the suitability of solar energy and cost of implementing into consideration before mode of the design is fabricated.

## 1.5 Significance of Study

This study is hoped to be able to make people realize how important it is for them to use free energy from the sun to be converted into useful electricity. Solar energy is the best alternative source power to replace the fossil fuels – gas, coal, and oil which are non-renewable energy. Furthermore, the result of this study will be able to show that solar energy system can be used in a wide range of products, from small consumer items to large commercial electrical system.

Last but not least, this study could also be a source of reference for future researchers that want to study or do more research on any aspects of solar energy applications. Besides, they could also use this study to make better research in future. The up most significant of this research is that it will make the readers realize and understand more about the renewable energy free from the sun.

## 1.6 Definitions of Terms

### 1.6.1 Photovoltaic

In 1998**,** National Solar Power Research Institute of United States defined Photovoltaic (PV) comprises the technology to convert sunlight directly to electricity. The term "photo" means light and "voltaic" means electricity. A photovoltaic (PV) cell, also known as "solar cell" is a semi-conductor device that generates electricity when light falls on it.

Mukund R. Patel (1999) in *Wind and Solar System* defined photovoltaic as the power technology uses semi-conductor cells (wafers), generally several square centimetres in size. From the solid-state physics point of view, the cell is basically a large area p-n diode with the junction positioned close to the top surface. The cell converts the sunlight into direct current electricity.

### 1.6.2 Phototherapy

Phototherapy - Serial transcutaneous bilirubin readings are rendered significantly unreliable following exposure to phototherapy (Hegyi, 1981; Fok, 1986; Yamanouchi, 1980). It has been suggested that correlation can be preserved if covered or less-exposed sites like the antero-lateral aspect of the thing are chosen (Lim, 1997; Hegyi, 1983; Dominguez, 1993).

U.S. National Cancer Institute defined phototherapy as a treatment of disease with certain types of light. Phototherapy can use lasers, LED, fluorescent lamps, and ultraviolet or infrared radiation. It is also known as light therapy.

Ministry of Health, Malaysia (Management of Neonatal Hyperbilirubinemia Report) defined phototherapy as a device of using the light energy to change bilirubin into a more soluble form to be excreted in the bile or urine.

# CHAPTER II

# LITERATURE REVIEWS

## 2.1 Overview

Research that looks at solar energy in Malaysia is very few compared to other country like Japan and United State. Yusof, O. (2004) said, in our country, research regarding solar energy and its effectiveness are less conducted. Even if there is research about renewable energy, the scopes are too narrow. But research in the west countries regarding solar energy and its application is quite a lot and some of it has begun decades ago, before we gain our independence.

## 2.2 Phototherapy Unit

Referring to Cigna Health Care Coverage Position through their report title *Home Phototherapy for Hyperbilirubinemia* said that Hyperbilirubinemia, or neonatal jaundice, is a condition in which there is a higher-than-normal level of bilirubin in the blood. Hyperbilirubinemia is a common condition of newborns characterized by yellow eyes and skin. The condition is the result of an imbalance between the production and excretion of bilirubin.

Cremer et al (1958) published their report on the successful use of phototherapy to bleach jaundiced infants. A decade later after the studies by Lucy et al in 1968 and Behrman and Hsia (1969), there was an explosion in the use of phototherapy. Since then

various forms of phototherapy, lights had been used. The aim of phototherapy is to prevent potentially dangerous bilirubin levels and to decrease the need for exchange transfusion.

Phototherapy, the use of light to treat hyperbilirubinemia, is effective because bilirubin absorbs blue light and converts to a water-soluble compound, permitting more rapid excretion in the urine. The goals of phototherapy are to prevent the already elevated TSB levels from rising higher, to prevent the occurrence of encephalopathy or kernicterus, and to prevent the TSB from rising to a level that requires exchange transfusion. The effectiveness of phototherapy depends upon the type of light source used (i.e., dose, spectral emission curve, depth of penetration), the distance between the light and the infant, the surface area treated, the characteristics of the infant's skin and tissue, the etiology of the jaundice, and the TSB level at the onset of the phototherapy.

According to the report of Ministry of Health Malaysia titled *Management of Neonatal Hyperbilirubinemia*, the native bilirubin is insoluble in water thus phototherapy works by using the light energy to change bilirubin into a more soluble form to be excreted in the bile or urine. When native bilirubin absorbs light, there is a photochemical reaction called isomerisation. This is excreted in the urine.
In the treatment of hyperbilirubinemia, phototherapy should be considered at serum bilirubin levels of 222-260μmol/l taking into account other clinical factors. White light phototherapy is recommended, using intensive or blue light phototherapy only if serum bilirubin levels are high and it does not respond to conventional phototherapy.

Conventional phototherapy provides light in the 425-475 nm wavelength bands corresponding to the peak absorption of light by bilirubin. The usual light intensity is 6-12 μWatt/cm$^2$ per nm. There have been many modifications of the traditional phototherapy over the last 3 decades - the number and configurations of phototherapy bulbs, the source of light (fluorescent vs. halogen bulb) and the color of bulbs (white, blue, or green). All, however, have involved the delivery of light from a source at a

distance from the baby, usually 35-50 cm above the baby. The number of the bulbs used range from six to eight, comprised of blue (F20T12/B), special blue light (F20T12/BB) or Daylight fluorescent tubes. To mitigate this effect, four special blue light tubes may be used in the central portion of a standard phototherapy unit and two daylight fluorescent tubes may be used on either side of the unit. Other units use tungsten-halogen lamps in different configurations.

## 2.3 Photovoltaic Cells

According to U.S Department of Energy through their report of research *Solar Energy Utilization* (April, 2005), solar power can be converted directly into electrical power in photovoltaic (PV) cells, commonly called solar cells. The sun has a surface temperature of about 6000˚C, and its hot gases at this temperature emit light that has a spectrum ranging from the ultraviolet, through the visible, into infrared.

According to quantum theory, light can behave either as waves or as particles, depending upon the specific interaction of light with matter; this phenomenon is called the wave-particle duality of light. In the particle description, light consists of discrete particle-like packets of energy called photons. Sunlight contains photons with energies that reflect the sun's surface temperature; in energy units of electron volts (eV), the solar photons range in energy (hν) from about 3.5 eV (ultraviolet region) to 0.5 eV (infrared region). The energy of the visible region ranges from 3.0 eV (violet) to 1.8 eV (red); the peak power of the sun occurs in the yellow region of the visible region, at about 2.5 eV. At high noon on a cloudless day, the surface of the Earth receives 1,000 watts of solar power per square meter (1 $kW/m^2$).

Photovoltaic cells generally consist of a light absorber that will only absorb solar photons above certain minimum photon energy. This minimum threshold energy is

called the “energy gap” or “band gap” (Eg); photons with energies below the band gap pass through the absorber, while photons with energies above the band gap are absorbed. The light absorber in PV cells can be either inorganic semiconductors, organic molecular structures, or a combination of both.

In inorganic semiconductor materials, such as Si, electrons (e-) have energies that fall within certain energy ranges, called bands. The energy ranges, or bands, have energy gaps between them. The band containing electrons with the highest energies is called the valence band. The next band of possible electron energies is called the conduction band; the lowest electron energy in the conduction band is separated from the highest energy in the valence band by the band gap. When all the electrons in the absorber are in their lowest energy state, they fill up the valence band, and the conduction band is empty of electrons. This is the usual situation in the dark.

When photons are absorbed, they transfer their energy to electrons in the filled valence band and promote these electrons to higher energy states in the empty conduction band. There are no energy states between the valence and conduction bands, which is why this separation is called a band gap and why only photons with energies above the band gap can cause the transfer of electrons from the lower-energy-state valence band into the higher-energy-state conduction band. When photons transfer electrons across the band gap, they create negative charges in the conduction band and leave behind positive charges in the valence band; these positive charges are called holes (h+). Thus, absorbed photons in semiconductors create pairs of negative electrons and positive holes. In a PV cell, the electrons and holes formed upon absorption of light separate and move to opposite sides of the cell structure, where they are collected and pass through wires connected to the cell to produce a current and a voltage — thus generating electrical power.

In organic molecular structures, the energy of the photons also must first exceed a certain threshold to be absorbed. This absorption creates an energetic state of the