DESIGN OF SOLAR COOKER

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Universiti Malaysia Sarawak
2001

Borang Penyerahan Laporan Projek
Universiti Malaysia Sarawak

BORANG PENYERAHAN LAPORAN PROJEK

Judul : DESIGN OF SOLAR COOKER

SESI PENGAJIAN: 1998/2001

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CATATAN
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This project report attached hereto, entitled " Design Of Solar Cooker ", prepared and submitted by **Muhd Rahiza Afieli Abd Rahman** as a partial fulfillment of the requirement for the degree of Bachelor of Engineering with honors (Mechanical And Manufacturing System) is hereby read and approved by:

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Prof. Madya Dr. Ir Wan Ali Wan Mat	**Date**
Supervisor	

DESIGN OF SOLAR COOKER

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Fakulti Kejuruteraan, Universiti Malaysia Sarawak
Sebagai Memenuhi Sebahagian Daripada Syarat
Penganugerahan Sarjana Muda Kejuruteraan
Dengan Kepujian (Kejuruteraan Mekanikal Dan Sistem Pembuatan)
Oktober 2001

Laporan Projek (Ijazah Pertama)

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Dengan Kepujian (Kejuruteraan Mekanikal Dan Sistem Pembuatan)
Oktober 2001

To my beloved parent, near relative brothers and sisters, friends and special for…atieku.

ACKNOWLEDGEMENTS

Design of a good Solar Cooker is not an easy task. Thus, I would like to take this opportunity to express sincere appreciation to all people in the Unimas Campus for their help and courage.

First of all I would like to thank the lecturer behind the development of this project, Dr. Wan Ali as a supervisor and also for his support comments and all his advice that driven me in completing this project.

Special thank to Mr. Rhyer, Mr. Masri, and other staff for their support in building up the model. Also thanks to my beloved family for their support and also to all my special friends for their help and their guide to complete the project.

After all thanks a lot for the involvement of other people either their contribution to this project indirectly or directly. Last but not least thanks to all the tutors and lecturers for their help and guidance.

ABSTRAK

Cahaya matahari merupakan salah satu sumber tenaga yang memberikan banyak faedah kepada manusia. Tenaga yang diberikan oleh matahari banyak menolong manusia didalam pelbagai aspek. Antara yang utamanya ialah menjadi salah satu sumber untuk mendapatkan kuasa elektrik menggunakan sistem photovoltaic, penggunaan sumber cahaya matahari dalam proses pengeringan dan juga untuk tujuan memasak.

Penyediaan masakan menggunakan pancaran cahaya matahari bukanlah perkara yang baru. Dengan menggunakan kepelbagaian konsep untuk menyediakan masakan dengan bantuan pancaran cahaya matahari, ianya dapat direalisasikan dan juga dapat dijadikan salah satu cara dalam penyediakan masakan. Walaupun ianya mengambil masa yang agak lama untuk menyediakan masakan jika dibandingkan dengan menggunakan sumber gas atau kayu api, tetapi ianya juga membantu mengurangkan kos dan yang utamanya dapat mengelakkan pencemaran alam sekitar.

Oleh itu, pengkaji telah menjalankan satu kajian terhadap perkara ini dan akhirnya merekacipta sebuah dapur solar untuk kegunaan masyarakat umumnya di Malaysia. Dalam proses merekacipta, pengkaji sebolehnya telah menggunakan bahan-bahan yang senang untuk didapati dan melibatkan kos yang rendah. Dengan terciptanya sebuah dapur solar ini, diharapkan ianya dapat membantu mereka yang terlibat. Walaupun begitu, dapur solar yang dicipta ini hendaklah dipermajukan lagi dari segi kesempurnaan dalam penggunaan supaya ianya dapat memberikan kepuasan yang sepenuh kepada penggunanya.

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Chapter 1

Introduction

1.0 Background

Sunlight, which is also called solar energy, is a useful in our life. The energy is free, abundant and expected to be infinitely renewable. The energy that produced will not polluted an environment. Fletcher (1995) has make a research to a solar thermo chemical and electrochemical found that how the solar energy could help to reduce the Carbon Dioxide Burden, which is a solution to environment.

The sunlight also provides, directly or indirectly, almost all the energy on earth. For example, in burning coal and oil, the energy that used are come from the sun in ages past when sunlight was trapped in plants and compressed into fossil fuel. It is the sun's heat that also powers the winds and cycles water from sea to rain.

The power density of solar energy reaches a maximum of about 1000W/m² at sea level. This is made up of two components that are the radiation in the direct beams from the sun and diffuse radiation from the sky. On the clear day, diffuse energy may amount to 15 to 20 percent of global irradiance whereas on the cloudy day it will be 100 percent.

1.1 Solar Characteristics.

The characteristics of the sun's energy available outside the earth' atmosphere are first considered.

The sun is a large sphere of very hot gas, the heat being generated by various kinds of fusion reactions. Its diameter is 1.39×10^6 km, while that on earth is 1.27×10^6 km. The mean distance between the two is 1.50×10^8 km. Although the sun is large, it subtends an angle of only 32 minutes at the earth's surface. This is because it is very large distance. Thus, the beam radiation received from the sun on the earth is almost parallel. The brightness of the sun varies from its center to its edge. However, from the engineering calculations, it is customary to assume that the brightness all over the solar disc is uniform. As viewed from the earth, the radiation coming from the sun appears to be essentially equivalent to that coming from a black surface at 5762 K [Sukhatme, 1984].

The sun interior consists of two nested shells surrounding an energy-generating core. The central gaseous material is compressed to such high densities and temperatures that thermonuclear reactions can take place there. Energy is transported by radiation within the overlying radiative zone. In the outer convective zone, energy is carried by the turbulent motion of hot gas. The radiative transport of energy briefly takes over again in the thin visible surface of sun or photosphere. The sun maintains an enormous temperature different between the 15 million degree core and its 5780-degree visible disk. A million degree corona envelops the photosphere; magnetism molds this outer atmosphere, confining the hot material in coronal loops and cooler material in prominences. Coronal holes offer escape routes for high-speed solar wind.

The sun is mainly composed of light elements, hydrogen and helium, which are terrestrially rare, whereas the earth is primarily made out of heavy elements that are relatively uncommon in the sun. For example, Hydrogen is about one million times more abundant than iron in the sun, but iron is one of the main constituents of the earth, which cannot even retain hydrogen gas in its atmosphere [Kenneth, 1995].

The sun continuously radiates energy that spreads throughout space. This radiation is called "electromagnetic" because it propagates by the interplay of oscillating electrical and magnetic fields in space. Electromagnetic waves all travel through empty space at the same constant speed (about 299 793 km per second) that are no energy can transport more swiftly than a speed of light [Kenneth, 1995].

The sun is relentlessly losing its energy, radiating it away at an enormous rate. In just one second, the sun emits more energy than human have used since the beginning of civilization. Its fire too brilliant to be perpetually sustained, after all nothing can stay hot forever and all thing wear out with time. William Thomson state that the sun could have illuminated the earth at the present rate for a much longer time, about 100 million years, by slowly contracting. If the sun was gradually shrinking, the in falling matter would collide and heat the solar gases to incandescence, just as the tire pump warms when it is compressed.

1.2 Solar Radiation At The Earth's Surface

Solar radiation is received at the earth's surface after being subjected to the mechanism of attenuation, reflection and scattering in the earth's atmosphere. The radiation received without change of direction is called beam radiation, while that received after it direction is called by scattering and reflection is called diffuse radiation. The sum of the beam and diffuse radiation flux is referred to as total radiation of global radiation. [Sukhatme: 1984]

1.3 Law of Radiation

There are several laws regarding to the radiation of sunlight. There are as follows:

1.3.1. Kirchoff's Laws

An object, which perfectly black absorbs all radiation that fall on it, so no real object can absorb more radiation than a 'black body' of the same size. The absorption α is the ratio of the radiation absorbed by a surface to the radiation falling on the surface, and for a black body $\alpha = 1$ and for another body α is between 0 and 1.

Khirchoff also showed that no real object could emit more radiation that a similar black body at the same temperature. The emittance ε of a surface is the ratio of the radiation emitted from the surface and that emitted by a similar black body at the same temperature. For a black body $\varepsilon = 1$, while for any other object ε is between 0 and 1.

For radiation of any given wavelength λ, the absorptance of a surface for the monochromatic radiation is equal to its emittance. This result is true for all surfaces when the emittance and absorptance are measured at the same surface temperature.

1.3.2. Planck's Radiation Laws

The power per unit wavelength radiated by unit area of a black body at temperature T (K) is given by

$$P = C_1 / \lambda^3 [\exp(C_2 / T) - 1]$$

where

$$C_1 = 3.74 x 10^{-16} Wm^2$$

$$C_2 = 0.0144 mK$$

In deriving his radiation law, Max Planck had to make the assumption that radiant energy occurred in tiny discrete chunks called 'quanta'. He thus founded quantum theory, which underlies all the modern electronic technology.

1.3.3 Stefan's Law

The power per unit area of radiation emitted from a black surface at temperature T(K) is given by Stefan's law as

$$P = \sigma T^4$$

Where σ = Stefan's Constant = $5.67 \times 10^{-8}\ Wm^{-2}\ K^{-4}$

For a surface with an emittance ε

$$P = \varepsilon\, \sigma T^4$$

The earth's surface has many different colors and therefore many different values of emittance for different areas such as sea, forest, sand and others.

1.4 Law of Reflection

In order to formulate a ray tracing procedure suitable for all cases, it is convenient to put the laws of reflection and refraction into vector form.

Figure 1.4 shows the geometries with unit's vectors $\tilde{i}$ and $\tilde{r}$ along incident and reflected rays and a unit vector $\tilde{n}$ along the normal pointing away from the reflected surface.

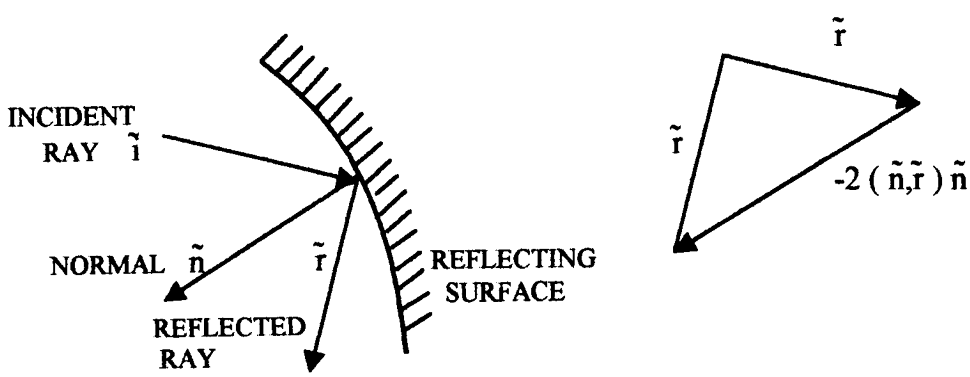

Figure 1.4: Vector formulation of reflection

Formula:

Since the angle of incidence = the angle of reflection

$$\tilde{i}.\tilde{n} = \tilde{r}.\tilde{n}$$

And $\tilde{i}$, $\tilde{n}$, and $\tilde{r}$ lie in the same plane

$$(\tilde{i} \times \tilde{r}).\tilde{n} = 0$$

If $\tilde{i}$ and $\tilde{r}$ are specified, $\tilde{n}$ is given by

$$n = (\tilde{i} + \tilde{r})(2 + \tilde{i}.\tilde{r})\text{-}1/2$$

On the other hand, when $\tilde{i}$ and $\tilde{n}$ are given, $\tilde{r}$ is given by

$$r\hat{} = -\tilde{i} + 2(\tilde{i}.\tilde{n})\tilde{n}$$

1.5 Solar Energy

Solar energy has been recognized as a major energy source for many years, but it is only since 1973 that substantial research, development and demonstration projects have been undertaken throughout the world. Two of the main applications are in the provision of heat and electricity. Many applications can be made from this type of energy. One of that is Photovoltaic Cell that are converts sunlight directly into electricity by using various instruments for pumping waters used for village, power supplies for building in remote areas such as farms, mosques, schools and others, refrigerated the vaccines, street lighting, calculators, batteries charging etc. In using the solar energy for daily usage, will reduce the costs and pollution.

So, according to the advantages that give by solar energy, a research of designing a solar cooker for usage, mostly for villagers that live far away from town was made. Hopefully with this research can give benefits to them that are much time and money is spent on collecting firewood and buying gas to cook with.

In designing a good solar cooker, many criteria must be concern to study. These criterions are such, as the condition of weather needed, effects, how to create a design, cost of design and so on.

1.6 Solar Cooker

The history of solar cooking goes back to dim recess of antiquity. The use of solar power to ignite altar fires has been mentioned (Meinel 1997). References indicate the use of sunrays to melt chemicals and metals. First solar furnace was fabricated in France by the famed naturalist George Louis Leclere Buffon (1707 – 1788).

However, the first reference relating to solar cooking was that of Nicholas-de-Saussure (1740 – 1799). There are over 50 major designs of solar cookers, some of which are patented, and more than 100 variations. Of these, this review covers