DEVELOP AND EVALUATE DIFFERENT TYPES OF TRADITIONAL SOLAR COOKERS

By

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ABSTRACT

Fatma Morgan Abdel Aziz Mohamed: Develop and Evaluate Different Types of Traditional Solar Cookers, M.Sc. Thesis, Department of Agricultural Engineering, Ain Shams University, 2018.

The shortage and the cost of fuel are urgent issues that is continuously increasing. This study aims to develop and evaluate the performance of two different types of solar cookers viz. box type and truncated pyramid type. The both of the cookers were modified to improve the thermal performance. The experiments were carried out in Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, Shubra El-Khemia, Egypt (Latitude 30^o $11^\backslash$ N, Longitude 31^o $24^\backslash$ E).

The modified solar cookers were tested with different quantities of rice for cooking and biscuit dough for baking. The thermal performance was evaluated by using first figure of merit F1, second figure of merit F2, thermal efficiency, costs and maturity of cooking.

The added heat energy by the modification of the box cooker was 33.8, 50.2 and 108.7kJ for 0.5, 1.0 and 2.0L, respectively. The added heat energy by the modification of the truncated pyramid cooker was 35.5, 66.9 and 167.2kJ for 0.5, 1.0 and 2.0L, respectively. The modified box cooker achieved a higher thermal efficiency than the non- modified box cooker by about 23% at the maximum water mass of 2.0L. The modified cooker achieved a higher thermal efficiency than the non- modified truncated pyramid cooker by about 36% at the maximum water mass of 2.0L. The mean heat energy gained of the modified box cooker and modified truncated pyramid cooker for 2.0L of water is found to be 459.8kJ and 451.4kJ, respectively, so the modified box-type solar cooker is recommended for using.

Keywords: Solar energy applications, Solar cooker, Box solar cooker Truncated pyramid cooker.

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INTRODUCTION

Renewable energy is accepted as a good alternative for fossil fuels for the future. This is primarily due to fact that renewable energy resources have some advantages when compared to fossil fuels. However, environmental concerns and limited energy sources make renewable energy technology a good alternative for fossil fuels. It is important to harness that resources in view to find solution to energy shortage and environmental degradation.

Solar energy is now considered to be the most effective and economic alternative resource**.** Egypt has a high potential for production the energy from sunrays that can be considered as a reliable energy source, where Egypt characterized by average daily solar energy ranged from 5 to 8 kWh/m² and sunshine duration per year extends to about 3500 hours (**Sorensen, 2004).**

Cooking is one of the daily main activities for people. Cooking in a rural and remote areas mainly depends upon conventional energy sources such as straw, wood, coal, kerosene and other petroleum products for cooking, that it's led to air pollution. Electric cookers and liquid petroleum gas (LPG) are also used for cooking, on the other hand, the price of electricity is increasingly, and the supply of LPG is also burdened due to increasing population. Therefore, the solar energy is stongly required to stand next to the conventional energy sources in order to decrease the demand on the convential energy.

Solar cooking is one of the thermal solar applications that use solar radiation as an energy instead of using the traditional sources of energy. Saving fuel, saving cost, safe and healthy can be achieved by using solar cooker.

Solar cooking saves not only fossil fuels but also keeps the environment free from pollution without hampering the nutritional value of the food. The problem arises when fuel is either scarce or highly expensive. The problems are encountered more pronounced in remote and rural areas.

Therefore, the work conducted in this study presents two developed different prototypes of solar cookers. The performance of the two solar cookers has been investigated. The specific aims of this study are:

1- develope solar cooker systems.

2 - study the affecting factors to the performance of the system.

3 - use and test the developed cooker in the cooking and baking.

4 - determine the overall efficiency and the performance rate.

5. evaluate the system.

REVIEW OF LITERATURE

2.1. General overview on situation of energy in Egypt

NREA, (2008) to overcome the crisis of energy, the Egyptian government has taken numerous steps to address the crisis such as expanding the usage of renewab*l*e energy to reach 20% of production by 2020.

IEA, (2011) showed that Egypt has been witnessing a growing consumption of electricity. Electricity demand has grown significantly in recent years due to the socio-economic development. Peak electricity demand increased by more than 200 %, from 6902 MW in 1990 to 22500MW in 2010.

IEA (2013) showed that Egypt depends on various energy sources such as natural gas, crude oil, hydropower, coal, in addition to renewable energies represented in the solar, wind and biomass energy. Egypt's energy mix is made up of: natural gas 53 %, oil 41 %, hydropower 3 %, coal 2 %, and renewables 1%, as indicated in **Fig. (1)**.

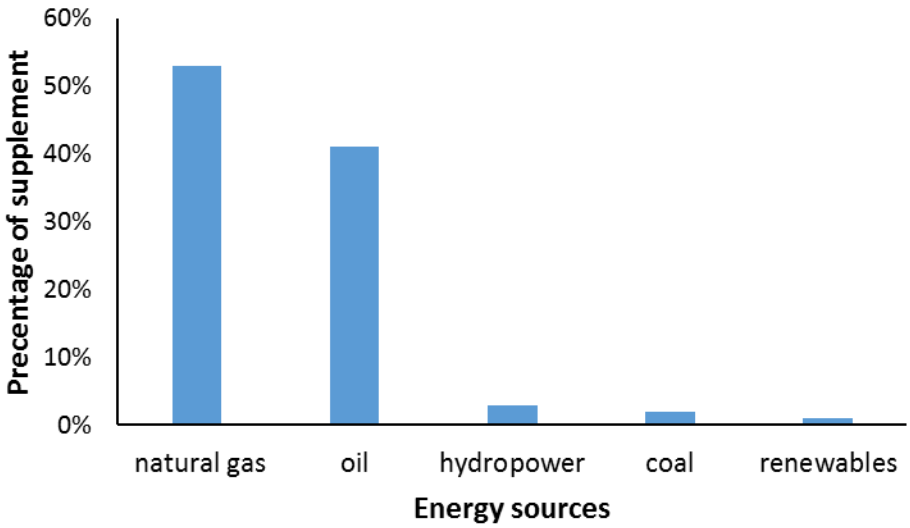

Fig. (1): Energy sources in Egypt, **(IEA, 2013)**.

AfDB, (2012) and Gawdat, (2013) reported that as for renewable energy, Egypt is considered by many observers to be a country which has the right environment to meet a large proportion of its energy needs by utilizing wind and solar power. Due to its location, topography and climate, Egypt is one of the best in the world which is suitable for setting up solar and wind energy systems. However, the country's potential in renewable energy is not properly utilized and it accounts for a minor share for Egypt's energy mix.

Nick, (2014) showed that Egypt's growing population and industrial development led to a significant rise in the demand for energy products in all sectors (residential, transportation and industrial). Subsequently the consumption of oil, gas and electricity has been boosted,.

USEIA, (2014) showed that Egypt is the second largest producer of natural gas in Africa yet. Egyptian consumption of natural gas has been increasing by approximately 7 % per year. So, the increasing level of consumption compared with the level of production led Egypt to become importer of natural gas over the last few years.

2.2. Solar energy in Egypt

TUB, (2013) reported that Egypt enjoys with annual solar radiation as shown in **Fig. (2)** ranging from about 1800 to more than 2500 kWh/m^2 per year. Because its geographic location, Egypt lies among the Sun Belt countries where solar energy is abundant.

Sorensen (2004), **ERCCU (2006)**, **Ibrahim (2012) and USEIA, (2014**) showed that sunshine duration ranging from 9 – 11 hours per day with has approximately 325 days of sunshine over the year and approximately with about 2300 - 4000 sunshine hours annually. The daily average solar energy has a magnitude of 5 to 8 kWh/m^2 with relatively steady daily profile and small variations making it very favorable for utilization. Both the solar radiation atlas and the German aerospace center