Effect of Multiple Glazing of Efficiency of the Flat Plate Solar Collector

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Abstract

The effect of multiple glazing on the efficiency of the flat-plate solar collector has been investigated. The solar radiation data was obtained from the Nigeria Meteorological Agency (NIMET) in Calabar, Southern Nigeria. The data collated from the results of our measurements have been graphically analysed. The central issue was the variation of the computed efficiency with increasing number of glass glazings. The results show that, efficiency of the flat-plate solar collector deteriorates with introduction of multiple glazings as against a single glazing. Inherent heat losses have not been evaluated.

Keywords: *Multiple, Glazing, Efficiency, Flat-plate, solar collector.*

I. INTRODUCTION

The continued rapid depletion of conventional energy resources, which are mainly hydrocarbons has made renewable energy sources the next option in the minds of most energy resource persons [1]. Furthermore, the adverse effects of hydrocarbons as energy sources has continued to degrade the environment with green- house gases [6]. This is reckoned as a considerable contribution to the devastating global warming and climate change the world is experiencing.

Solar energy is clearly about the most abundant and environment friendly energy resource available to mankind. One of the simplest devices that exploit solar energy is the flat plate solar collector [2].

In it most common form, the flat plate solar collector consists of an absorber plate at the bottom of an enclosure at the top of which is a single glazing, which may be plane glass or some other suitable material that can permit transmission of solar radiation[3]. This radiation peaks in the wavelength range of about 400nm to 500nm.

The absorber plate receives the radiation from the sun, less losses due to reflection and absorption by the glazing, and re-radiates long wavelength thermal energy which is trapped in the space within the collector, since the glass glazing is opaque to long wavelength radiation [4].

II. THEORETICAL BACKGROUND

The efficiency or thermal efficiency of a flat plate solar collector is the ratio of the useful thermal energy evolved in the absorber plate to the total incident solar radiation over the same time interval.[5]` Mathematically we write

$$\eta = \frac{Q\ evolved}{Q\ incident}\ x\ 100\%$$

The quantity $Q_{evolved}$ is easily obtained from

$$Q_{ev} = m.\ c_p.\ (T_c - T_a)$$

where m is the mass of the plate, C_p the specific capacity of material of the plate, T_c the collector temperature and T_a the ambient temperature. This is the energy generated at the absorber plate.

The total energy received by the collector is given by

$$Q_{in} = IA$$

where I is the solar irradiance in Wm^{-2} and A is the effective area or aperture area of the collector plate. We have not taken into account the reflection, absorption and transmission properties of the glass glazing’s, which reduce the actual irradiance that reaches the absorber[7]. All the other parameters are easily practically determined.

III. METHODOLOGY

The glass plates used as glazing allow 80% of the incidence solar radiation (400 – 500nm) due to reflection and absorption. Mercury in glass thermometers were used to measure the mean temperature between glazing and absorber plate and ambient temperature between 6:00 and 18:00 hours at intervals of 15 minutes for a period of 14 days and averages obtained in each case.

Measurement were made with one, two, three, to five glazing respectively, with constant separation of 5cm. The measured parameters of collector temperature, ambient temperature and mass of the absorber plate were used to calculate the efficiency of the flat- plate collector with the one , two, to five glass glazing respectively, as well as the thermal energy generated at the absorber plate.

IV. RESULTS

The solar radiation data was collected from the Nigeria Meteorological Agency (NIMET). The computed results are represented in Figure1 and 2. Figure 1 is a plot of the thermal energy evolved with the composite glazing as a function of collector temperature and Figure2 a plot of efficiencies against number of glazing

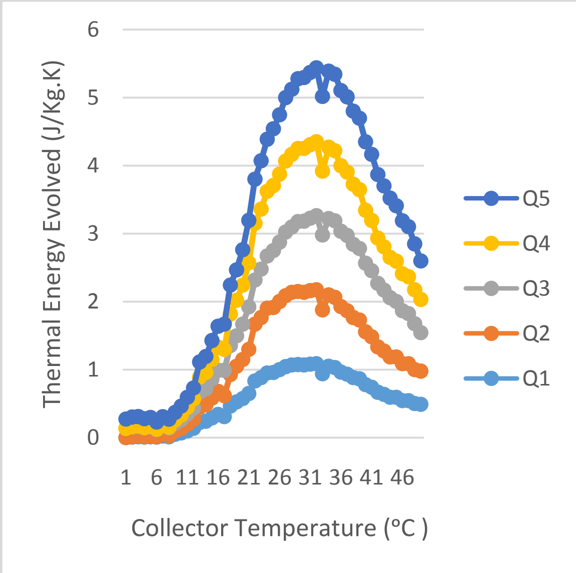

Fig 1: Thermal Energy Evolved (solar collector with different number of glazing's)

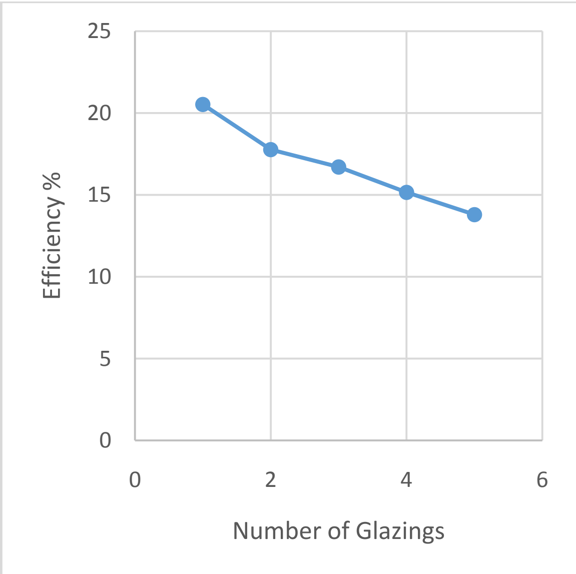

Fig2: Efficiency of multiple glazing.

It can easily be seen from Figure 1, by inspection that the thermal energy evolved in the single glazing collector is the highest at all temperatures while the five glazing system shows the least performance indices. Figure2 clearly shows that the collector efficiency decreases with in numbers of glazing.

V. DISCUSSIONS

As can be seen from Figure 1, the thermal energy trapped in the space between the absorber plate and the bottom glass glazing decreases with the addition of every other glass pane. This thermal energy which is evolved from the absorber plate is of course a measure of the efficiency or performance of the flat-plate solar collector. The result here is to be expected, because each of the glass glazing represents a finite resistance to the transmission of radiation, so that the glass panes which constitute our system of multiple glazing can be seen as series resistance.

VI. CONCLUSION

From our results we can easily conclude that the normal flat-plate solar collector performs best with a single glazing if glass is used. We can also deduce that a system of multiple glazing has a cooling effect on the enclosed space above the absorberplate, findings that could be explored for windows in the Tropics

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