COMPARISON OF THE EFFICIENCIES OF A SOLAR AIR HEATER

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Abstract

Solar energy is the natural resource of energy. Solar energy is rapidly advancing as an important means of renewable energy resource. The Sun is the source of all energy. The energy obtained from the sun is the most promising renewable energy sources since it is clean, safe and free. Solar power is the technology of obtaining usable energy from the light of the sun. Solar energy has been used in many traditional technologies for centuries and has come into widespread use. Applications of solar energy are commercially available and are used by millions of people in various parts of the world. One of the promising areas of the applications of solar energy is solar air heater. Solar air heaters are used for drying and space heating. Cultivation is one of the important occupations for the livelihood of the people in villages. Grapes, Tea, Cardamom, Pepper, and Coffee are mainly cultivated in Theni District in Tamilnadu, India. Drying the products in a hygienic manner is one of the important processes in agriculture. Hence a **novel solar air heater** was designed and a study on **thermal efficiency of the air heater by varying the material of the collectors** was performed.

Key words: Solar heaters, space heating, drying, collectors.

I. INTRODUCTION

Solar energy has immense applications in all fields of science, engineering and technology. Agriculture is the major occupation and India and food security is indeed a challenge in competence with the growing population intensity. Agricultureal products need to processed before they are made available for consumption. Hence a research was envisaged to dry grapes, tea, cardamom, pepper and coffee cultivated in Theni District.

Drying the products in a hygienic manner is one of the important processes in agriculture. A **novel solar air heater** was designed to study the **thermal efficiency of the air heater by varying the material of the collectors**. Glass, Polythene sheet and aluminium foils are the various materials used to compare the efficiencies of the air heater. The main advantage of it is that no insulation material is needed.

This type of air heaters can be used to dry the agricultural products which require hot air at low temperature ranges from 40°C – 100°C. This type of air heater can be utilized for various applications such as dehydration and drying. This would be beneficial not only in conserving the fossil fuels, but also in protecting the environment by the emissions of harmful pollutants and green house gases.

II DESIGN AND FABRICATION OF SOLAR AIR HEATER

Solar air heater fabricated consists of

1. Glass cover
2. Absorber plate
3. Baffles
4. Drying unit.

No insulation material is needed in this type, which reduces the cost. Sunlight passes through the glass and strikes the absorber plate, which is black coated. Baffles are fixed on the absorber plate through which air is circulated by mechanical fans. The heat absorbed by the plate heats the air that flows through the baffles, which increases the thermal efficiency. The hot air passes through the products in the drying chamber directly after it leaves the baffles.

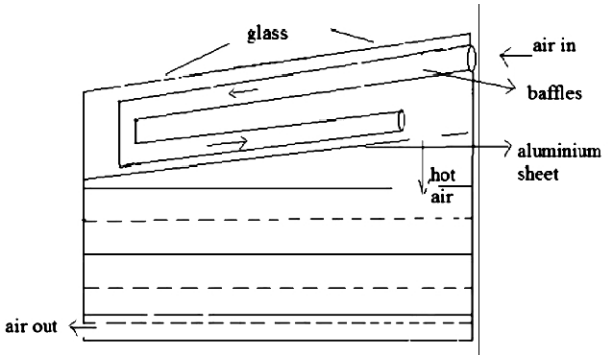

Fig. 1 Two pass Air heater with drying chamber

III EFFICIENCY OF AIR HEATER

Efficiency is calculated using the formula

$$\eta = [m\,Cp\,(T0 - Ti)]\,/Ac\,G \qquad ...(1)$$

Where

m - mass flow rate (Kg/s)

C*p* - specific heat capacity (J/Kg/k)

Ti - inlet temperature (°C)

To - outlet temperature (°C)

Ac - Area of the drier (m^2)

G - Incident solar radiation (w/m^2)

The readings taken are tabulated as follows and efficiencies were calculated.

Table 1. Thermal efficiency of solar heater for drying pototo slices.

Time	Glass η %	Polythene sheet η %	Aluminium foil η %
10.00	56.78	50.74	57.37
11.00	73.74	58.74	72.79
12.00	152.8	62.73	79.24
1.00	104.8	48.80	69.59
2.00	87.49	31.95	57.67
3.00	59.63	21.13	21.86

Table 2. Thermal efficiency of solar heater for drying Cardamom

Time	Glass η %	Polythene sheet η %	Aluminium foil %
10.00	54.64	25.57	51.66
11.00	72.08	25.45	58.74
12.00	153.72	57.76	62.73
1.00	106.7	50.90	48.80
2.00	83.92	31.36	31.95
3.00	63.12	28.55	21.13

Table 3. Thermal efficiency of solar heater for drying Grapes

Time	Glass η %	Polythene sheet η %	Aluminium foil η %
10.00	59.96	14.80	26.19
11.00	70.85	29.15	47.27
12.00	72.24	54.83	56.68
1.00	56.24	55.28	68.51
2.00	36.85	49.61	52.64
3.00	24.41	41.22	25.36

Table 4. Thermal efficiency of solar heater for drying Peanuts

Time	Glass η %	Polythene sheet η %	Aluminium foil η %
10.00	57.37	23.37	25.31
11.00	72.79	32.23	45.46
12.00	79.24	47.73	54.75
1.00	69.59	58.20	62.73
2.00	57.67	29.16	63.55
3.00	21.86	19.91	48.48

IV RESULTS AND DISCUSSION

Agricultural products such as peanuts, grapes, cardamom, coffee, potato slices have been dried using this drier by varying the materials of the absorber plates and its efficiencies were calculated. All the experiments were conducted during the sunny days. The maximum solar radiation recorded was around 600 wb/m^2. Solar air heater was constructed with aluminium sheet and of thickness 0.40 mm and area of 0.75 m × 0.50 m and also with glass of thickness 5 mm and polythene sheet of thickness 0.50 mm. It was mounted outdoors at an angle of 20° from horizontal so as to have normal incident of solar radiation and 3.5 cm above the ground level. Sunlight passes through the glazing and strikes the absorber plate, which is heated up changing solar energy into heat energy. All experiments were conducted in the sunny days during the period 10.00 am to 3.00 pm, which recorded a maximum solar radiation (598 w/m^2). This shows that the temperature difference is one of the major factors that determine the thermal efficiency of solar air heater.

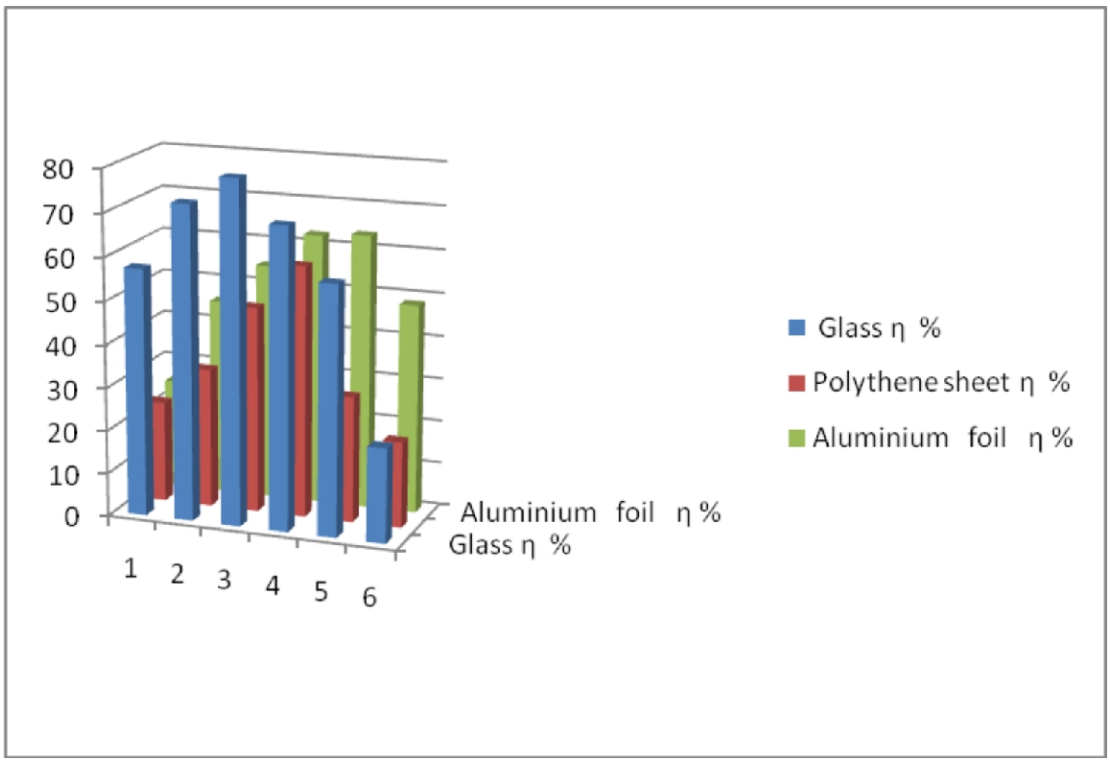

Fig. 1. Thermal efficiency of solar heater for drying pototo slices.

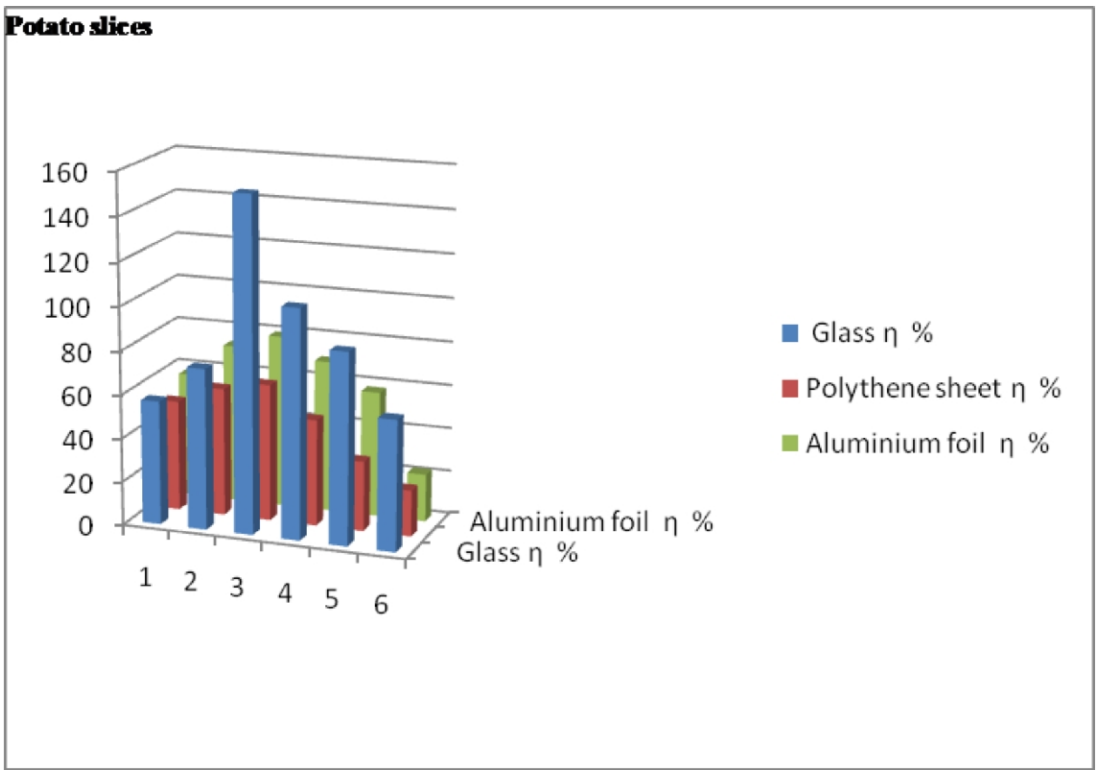

Fig. 2. Thermal efficiency of solar heater for drying Cardamom

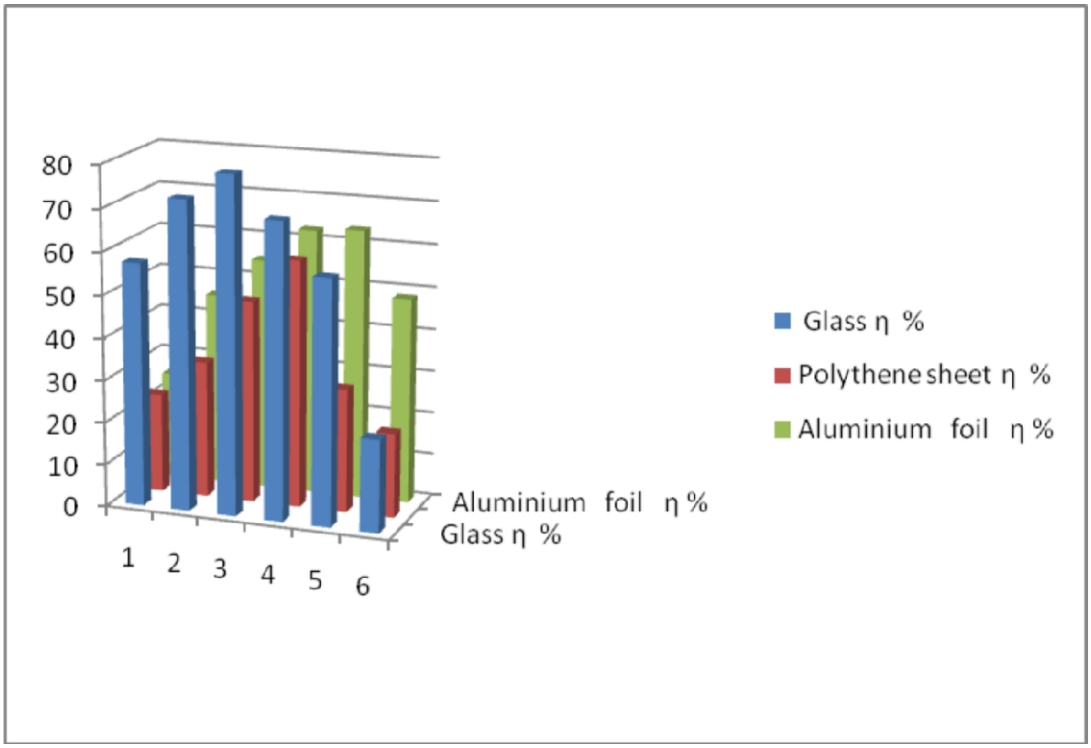

Fig. 3. Thermal efficiency of solar heater for drying Grapes

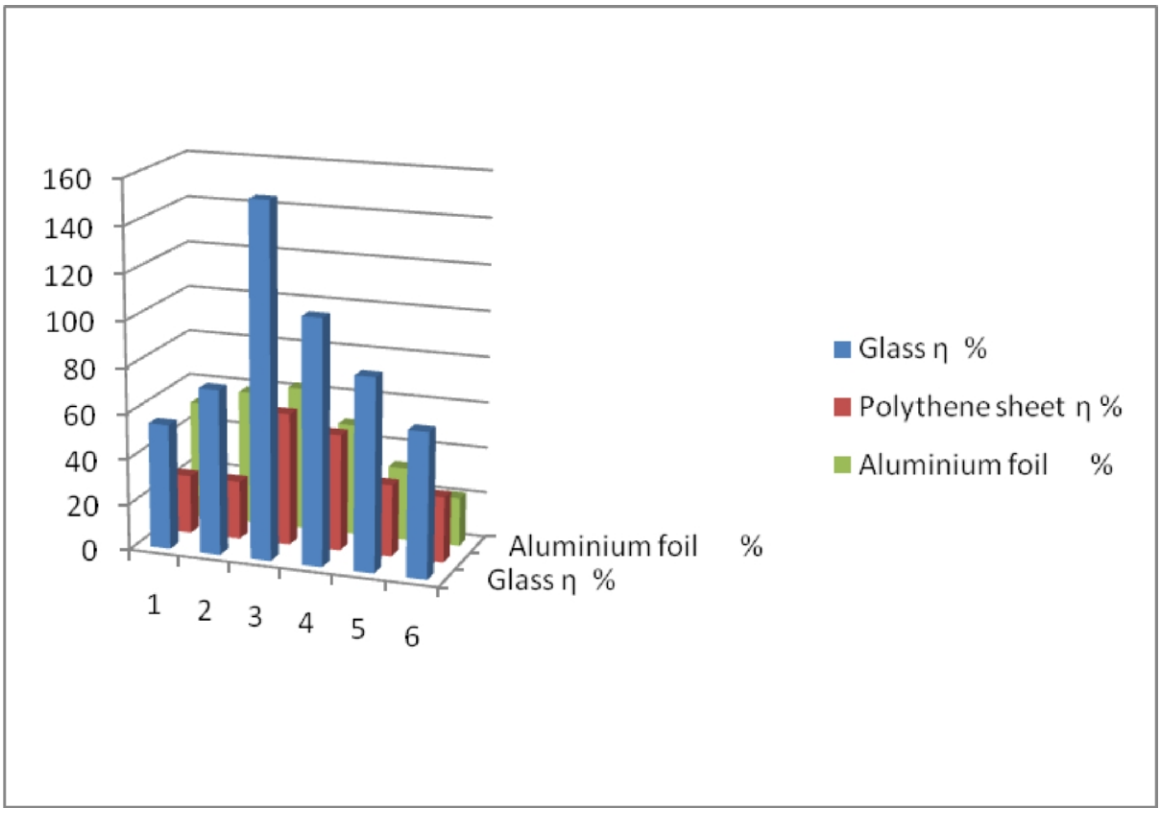

Fig. 4. Thermal efficiency of solar heater for drying Peanuts

The hot air passes through the products in the drying chamber immediately after it leaves the baffles as shown in fig. 1. Efficiency was calculated using eqn. (1) and are given in tables 1-4. The results are also represented figures 1-4. From the calculated values, the efficiencies of the air heater for various materials were compared. From the comparison, it was found that glass as the absorbing material has higher efficiency than other. The various other factors involved are the area of the plates, temperature difference and solar radiation. As hot air passes directly to the drying chamber, energy loss is reduced [3].

V CONCLUSION

With these results, it is found that this drying technology can be utilized in the small scale industries and cottage industries to dry and preserve the agricultural products. From the tables, it was concluded that Glass is the best absorbing material. The main advantage is that no insulation material is needed (which reduces the cost) as air passes directly into the drier [4]. It is compact and can be installed at any places. Based on the experimental data and calculations, it is concluded that this type of solar air heater can be used for dehydration and drying applications of commercial products mainly in the domestic, commercial, industrial and agricultural sectors.

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