Original Research Paper

Volume -10 | Issue - 3 | March - 2020 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Physics

DESIGN AND CONSTRUCTION OF TWO PASS SOLAR AIR HEATER USING EVACUATED TUBES

B.Pandeeswari — PG And Research Centre of Physics, Jayaraj Annapackiam College For Women (Autonomous), Periyakulam, Theni.

A. Clara Dhanemozhi* — PG And Research Centre of Physics, Jayaraj Annapackiam College For Women (Autonomous), Periyakulam, Theni. *Corresponding Author

ABSTRACT The sun is the source of all energy. The heat energy obtained from the sun is known as solar energy. It finds various applications. 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 application of solar energy is solar air heater. Solar air heaters are used for drying and space heating. The use of drying has been demonstrated as an application of air heaters. Villagers are mainly involved in agriculture and drying is one of the important processes in it. There are many problems in direct drying. Solar air heater is one of the best methods of drying products in a hygienic manner. We have planned to design and construct a solar air heater with evacuated tubes, which increases the efficiency of the air heaters to a greater extent. Air is passed through the evacuated tubes and gets heated by the collector unit and circulated through the crop in the drying unit. Many agriculture products such as coffee, pepper, cereals, cardamom, potato slices and pappads were dried with it and its efficiencies were calculated.

KEYWORDS :

INTRODUCTION

The sun is the source of all energy. The heat energy obtained from the sun is known as solar energy. It finds various applications. Application of solar energy is commercially available and used by millions of people in various parts of the world. One of the promising areas of solar energy is solar air heater. Solar air heaters are used for dying and space heating. The use of drying has been demonstrated as an application of air heaters. Villages in our district are mainly involved in agriculture and drying. Solar air heater is one of the best methods of drying the products in a hygienic manner[1]. We have decided to construct a novel and simple solar air heater with evacuated tubes, which increases the efficiency of the air heaters to a greater extent. Many agricultural products such as coffee, pepper, cereals, cardamom, potato slices and pappads will be dried with it and its efficiency calculated.

EVACUATED TUBE COLLECTOR

Evacuated tube consists of two glass tubes made from strong borosilicate glass. The outer tube is transparent and allows sunlight to pass through with minimal reflection. The inner tube is coated with an AI/N/AI coating. This selective surface is excellent for absorbing solar radiation with minimal reflection losses.

To increase the useful energy, we can use the selective surface, which reduces the radiative heat loss, but a further reduction in the convective loss is required in order to fully utilize the potential of such surfaces. This can be achieved by removing the air over the absorbing surface, i.e. by evacuation. Air is removed completely between absorber and glass cover. The only heat loss mechanism remaining is radiation. Advantages of evacuated tubes are

- Enhanced ability to capture sun light as they have more surface area exposed to the sun
- Up to 163% more efficient in heat transfer as demonstrated in Australian conditions [1]
- Can be used in sub-zero temperature
- Greater durability; and yet, should a tube break, it can be replaced easily and very affordably
- Excellent performance in overcast conditions
- Require a smaller roof area
- Less prone to corrosion

CONSTRUCTION OF SOLAR AIR HEATER

Solar air heater fabrication consists of

- INPUT UNIT
- COLLECTOR UNIT
- DRYING UNIT

INPUT UNIT

Input unit is the unit through which air a can be sent. Battery operated fan is used as input unit, to pass the air.

COLLECTOR UNIT

The collector unit set up was made up of wooden box. Inner side of wooden box was pasted with aluminium foil sheet which acts as a conducting material. It is used to reduce the heat loss. Aluminium pipe was connected with evacuated tubes and drying unit. Evacuated tubes are used as collectors to conduct and transfer the heat to the passing. When the air gets heated, it moves up, passes through aluminium tube and goes directly to the drier. The inlet and outlet temperatures are measured with sensors.

DRYING UNIT

The drying unit is made up of wood, is insulated from the external radiation and also avoid thermal loss. There are perforated trays of different hole sizes. The crops to be dried are kept in the trays and heated air from the aluminium tube is made to pass directly to the products. The solar air heater constructed is shown in fig. 1.

Time	Grapes (%)	Green beans (%)	Butter beans (%)	Potato (%)
10.00a.m	13.21	1.97	12.63	13.89
11.00a.m	15.09	12.41	13.50	14.51
12.00p.m	15.89	13.83	14.01	15.80
1.00p.m	19.63	15.35	14.77	16.34
2.00p.m	16.97	13.57	11.90	14.13
3.00p.m	14.67	10.58	9.51	11.67
4.00p.m	14.04	7.58	8.40	10.51

Time	Ground nut (%)	Yam (%)	Red chilly (%)
10.00a.m	13.58	8.13	14.15
11.00a.m	15.78	9.83	15.32
12.00p.m	17.03	12.19	16.60
1.00p.m	19.84	13.68	20.83
2.00p.m	16.55	9.55	18.72
3.00p.m	15.82	8.59	15.59
4.00p.m	14.45	7.87	14.25

Fig.1 Solar air heater constructed with evacuated tubes.

EFFICIENCY OF AIR HEATER

The Efficiency of air heater is calculated as

$\eta = [mCp(T_0-T_i)]/(Ac\times G)$

Where

m - Mass flow rate

Cp - specific heat capacity of air (J/kg.K)

T_0 - outlet temperature (˚C)

T_i - inlet temperature (˚C)

Ac- area of the drier (cm)

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

OBSERVATIONS

The products to be dried are weighed with the balance.

Readings are taken from 10.00 a.m to 4.00 p.m. during the month of February, 2019.

Maximum Solar Radiation observed is 618 W/m^2

Area of the drier: 0.1316 m^2

Length of the evacuated tube: 150 cm

Diameter of the evacuated tube: 5cm Specific heat capacity of air : 1.00 J/kg.K

Table.1 Calculated efficiency (%) of the different products

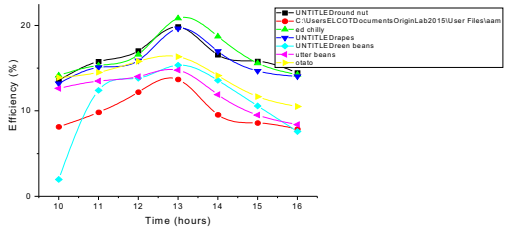

Fig. 2.Graphical representation of Efficiency for different prod ucts

RESULTS AND DISCUSSION

All experiments were conducted in sunny days during the period 10.00am to 4.00pm, which recorded maximum solar radiation ($618w/m^2$)

The commercial products such as ground nut, yam slices, red chilly, grapes , potato, butter beans, green peas were dried using it. The hot air after passing through the evacuated tubes gets heated passed to the products, by which the moisture is removed. The samples were collected periodically and weighed for finding out the moisture content of the samples. The inlet and the outlet temperature were recorded and the temperature difference was calculated. This shows that the temperature difference is one of the major factors that determine the thermal efficiency of solar air heater.

CONCLUSION

Solar air heater is one of the best methods to dry the agricultural products. Based on the experimental data and calculation, it is concluded that this type of solar air heater can be used for dehydration and drying applications of commercial products mainly in the commercial, and agricultural sectors. With these results, it is found that this drying technology can be utilized in the small scale industries and cottage industries. The main advantage is the usage of evacuated tubes. Efficiency of the air heater can be increased with more number of evacuated tubes.

ACKNOWLEDGEMENT

The authors acknowledge and thank Tamilnadu State Council for Science and Technology, Chennai for sponsoring this project under student project scheme.

REFERENCE

1. G. N. Tiwari (2008), Applications of solar energy, P-218, fourth edition, Narosa publishing pvt. Limited. New Delhi .
2. G. D. Rai (2000), Solar energy utilization, Fifth Edition, Khanna publishers, New Delhi.
3. A.Clara Dhanemozhi (2010), Solar Air heater for commercial applications, Journals of modern sciences.
4. E.Santhosh, Mahesh (2019), Solar Air heater using evacuated tubes with parabolic mirror reflector. Department of mechanical engineering , Savitribai Phule une University, pune.
5. A.E.Kabeel , Z.M.Omara (2017),Solar air heater –Design , configurations, improvement methods and applications –A detailed review. Renewable and sustainable energy resources.
6. C.L. Gupta, H.P.Garg, (1996),Performance studies of solar air heater. ELSEVIER Journals, volume 11.