Design And Fabrication Of Solar Air Dryer

R. Karthikeyan, A. Krithik, C. Jaya Prakash, S. Arun, A. Hari Prasad

Assistant Professor, UG Student

Department of Mechanical Engineering,
Sri Shakthi Institute of Engineering and Technology,

Coimbatore, Tamil Nadu, India

1. INTRODUCTION

When a solid is dried experimentally, data are obtained relating moisture content to time. When these data are plotted graphically, it results in what is known as a drying curve. If the moisture content is plotted versus time, the first portion of the curve (BC) will indicate a constant rate of drying.

The remainder of the curve will indicate a falling rate of drying (C - D). A - B is that portion of the curve where internal heat is still causing evaporation and ends when the surface temperature of the solid reaches the wet bulb temperature (dew point) of the air.

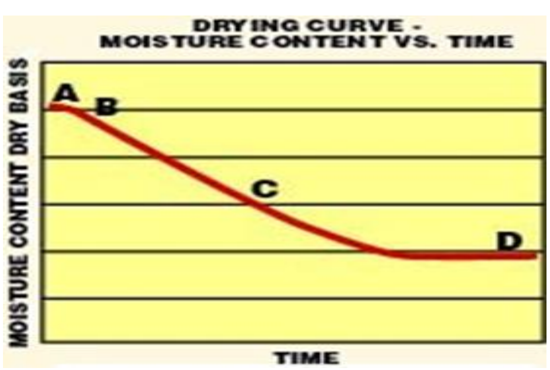

Fig.1 Graph between Moisture content

2. ABSTRACT

Solar air heating technologies use only free, renewable, and clean energy, and can help defray the rising cost of conventional energy. Solar air heating systems absorb thermal energy from direct sunlight to heat air; this heated air can then be circulated through buildings to provide heat. Active solar air heating systems, a more recent development, use fans to draw in, circulate, and exhaust air. The perforated cladding system is a bare plate solar collector that uses fans to draw air through thousands of tiny holes in a layer of unglazed dark metal plating, which acts as the solar absorber. Replacing the siding on a wall, the absorber, when exposed to direct sunlight, transfers heat to the air as it passes into the building. Working on similar principles, a glazed panel air heating system consists of a metal case in which a dark metal sheet, covered by a layer of clear plexiglass, absorbs heat from direct sunlight. Fans draw fresh air from the plate, which emerges heated and proceeds through the ventilation system or directly into the building.

3. Materials

The materials used in this setup of the Solar Air Dryer are :

1. Body MS sheet 1mm thickness
2. Aluminium sheet 1mm thickness for Absorber plate
3. Paraffin wax
4. Fan DC 12V
5. Lithium-ion battery (3)
6. Glass 4mm thickness

4. CONCEPTUAL DESIGN

The design of the Solar Air Dryer is modified in terms of adding paraffin wax as a phase change material so we can use the heat occurring during the phase change of the wax and can be used when there is no solar energy. Air stream is heated by the back side of the collector plate in flat plate collector. Fins attached to the plate increase the contact surface. The back side of the collector is heavily insulated with mineral wool or some other material. If the size of collector is large, a blower is used to draw air into the collector and transmit the hot air to dryer. The most favorable orientation of a collector for heating only is facing due south at an inclination angle to the horizontal equal to the latitude plus 150. The use of air as the heat transport fluid eliminates both freezing and corrosion problems and small air leaks are of less concern than water leaks

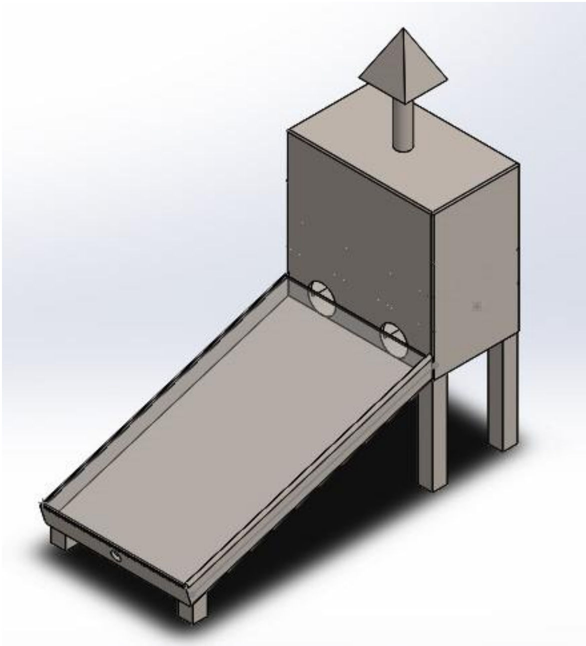

Fig.2 Design of body chamber

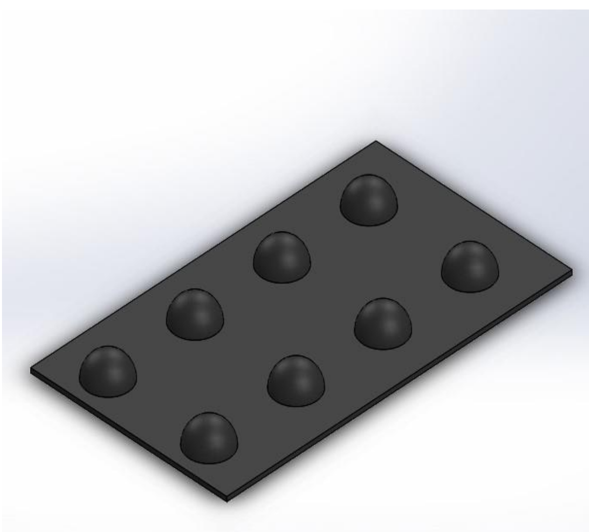

Fig.3 Design of Absorber plate

3.1 Completed unit

The completed unit is shown in the below figure.

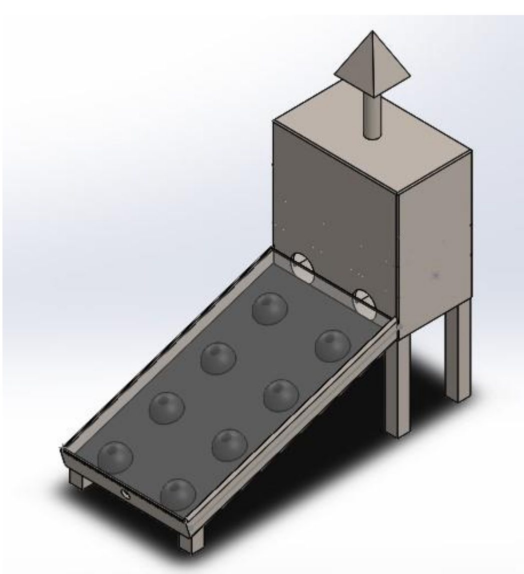

Fig.4 Shows the 3D view of the product

Fig.5 Real-time prototype

3.2Calculation And Performance Evaluation

Inlet and Outlet Temperatures were measured using a thermocouple and digital thermometer

Inlet Temperature:

The inlet temperature is the same as the atmospheric temperature and is measured as 33.5 degree Celsius.

Output Temperature:

The outlet temperature with a time duration of 120 minutes gives an outlet temperature of 63 degrees Celsius.

Insolation on the Collector surface area:

The average daily radiation H on a horizontal surface is H=1350 W/m²

The average effective ratio of solar energy on a tilted surface to that on the horizontal surface R as ;

R=1.0035

Thus, insolation on the collector surface was obtained as

Ic = HT = HR = 1350 × 1.0035 = 1354 W/m2

Determination of Collector Area :

The volumetric flow rate of air V'a = 75 m3 /hr.

V'a = 75/3600 = 0.02083 m3 /s.

The mass flow rate of air: Ma = V’a × ρa

The density of air ρa is taken as 1.21kg/m3 Ma = 0.02083 × 1.21 = 0.0252 kg/s

Therefore, the area of the collector AC

AC = (0.0252 × 1005 × 50)/(0.5 × 1354) = 1.75m2

CONCLUSION

In this paper, a review of the research paper states that the solar dryer is more beneficial than the sun drying techniques. Solar dryers do have shortcomings. They are of little use during cloudy weather. During fair weather, they can work too well. Although solar dryers involve an initial expense, they produce better-looking, better-tasting, and more nutritious foods, enhancing both their food value -and their marketability. They also are faster, safer, and more efficient than traditional sun drying techniques.

The main drawback of the non-porous absorber plate is the necessity of absorbing all incoming radiation over the projected area from a thin layer over the surface, which is in the order of a few microns. The solar air heating utilizing a transpired honey comb is also favorable since the flow cross section is much higher. Crushed glass layers can be used to absorb solar radiation and heat the air. A porous bed with layers of broken bottles can be readily used for agricultural drying purposes with minimum expenditure. The overlapped glass plate air heater can be considered as a form of porous matrix, although overall flow direction is along the absorber plates instead of being across the matrix. efficiency cannot be improved. Too many surfaces and too much restriction to air flow will require a larger fan and a larger amount of energy to push the air through. The energy required for this cancels out saving from using solar energy, particularly if fan is electrical and if the amount of energy which is burned at the power plant to produce the electrical energy is included.

The design, fabrication, and analysis were done and the results were obtained. the dryer took 65 to 75 minutes to dry the paper and the open sun drying took one day to dry the same number of papers. The overall performance of the paper depended upon the atmospheric conditions. The larger the intensity of solar energy larger will be the efficiency of the solar dryer. As the cost of fabrication of the dryer is less it gives a better hand over the conventional solar dryer. The solar drying was compared with normal sun drying and the drying using the solar dryer was very effective and the drying time was very less compared to the normal drying. This technology can be further developed by creating various modifications in the design to increase the effectiveness of drying.

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