

Performance Evaluation of Double Flow Solar Air Heater

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ABSTRACT

The heat from the sun, coupled with the wind, has been used to dry and preserve food crops for several thousand years. Some crops, such as Chili, Bananas, Coffee Beans, timber, need to be dried before they can be used effectively. Sun drying has often developed into solar drying, where drying occurs in an enclosed, ventilated area—often using polythene, acrylic or glass covering. Present work deals with design, fabrication of double flow solar dryer. Double flow solar air heater is the advanced modification of single flow solar air heater. In the single flow solar air heater, air flows through one side of copper plate whereas in the double flow solar air heater air flow from both side of copper plate and hence more efficient than any other kind of solar air heater.

Keywords

Solar Air Heater, Double Flow, Solar Energy, Drying.

1. INTRODUCTION

Heat is not the only factor which is necessary for drying. The condition, quality and amount of air being passed over and through the pieces to be dried determine the rate of drying. The amount of moisture contained in the air to be used for drying is important and is referred to as absolute humidity. The common approach to drying fruits, vegetables and grains in many tropical countries is to spread them on mats or cloth just on the front porch. This can be seen in many places in India. In cities, they dry on the terrace floor. What is more, often times the grains are spread on the asphalt roads or sand to dry. One can see chilies and grains dried this way. This is sun--drying.

Solar dryers are faster and more hygienic to dry using the sun. Better quality product can be obtained. The basic principle of these dryers is simple: heat or warm the air above the ambient temperatures to about 50 to 60 deg C and pass the air over the food items. In most cases, a natural convection current is used, the hot air goes upwards. So, keep the trays of food items above a black absorber plate, in an insulated box. There are essentially two types of air heater:

- 1 Box type -direct
- 2 Box type-indirect

In direct type Box, we have a single box which carries an absorber and a tray of food items, with preferably holes in it or a net or matting kept above the absorber. The sunlight falls directly on the food items through the window. A major advantage is that the absorber box can be a large with more area exposed to sunlight and we can control the temperature of the food box with covering of the collector/absorber.

In the indirect type box, there are two boxes one collector box with window and absorber as given above and another box with racks to keep the food items. The drying box is kept at a higher level to provide natural convection. The two boxes are connected by an insulated duct or pipe. Passive dryers are without a fan or blower just the natural convection to push the air out. Active dryers have an exhaust fan or blower to aid flow of air. For large scale drying, a tunnel type of dryer is

used the food items are kept in trays and passed through a tunnel which is covered with glass or plastic sheeting. Tent dryers are large tent like structure with plastic covering or roof, similar to a green house.

2. FABRICATION OF DOUBLE FLOW SOLAR AIR HEATER

Figure 1 shows schematic diagram of double flow solar air heater experimental setup. It consists of:

Wooden Box

The wooden box made up of plywood of thickness of 2.5 cm. it is a designed to provide a space for system for storing various items

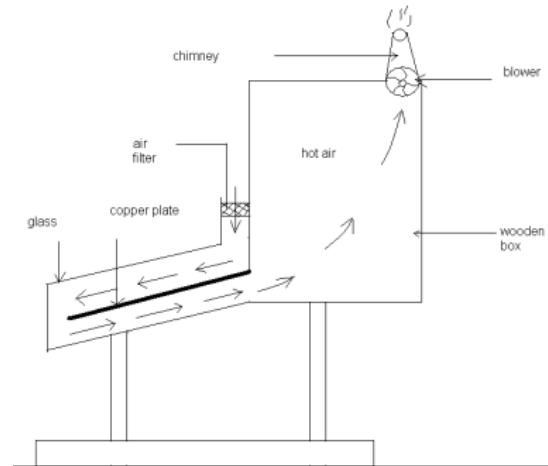


Figure 1: Experimental Setup

2.1 Copper Plate

The copper plate used having dimensioned of 2 mm thick. The purpose of the copper plate is to increase the temperature of atmosphere air to about 20°C-30°C.

2.2 Glass

It is mainly used for allowing the radiation from sun to enter. It is placed above the copper plate at about 15 mm for free circulation of air coming from inlet.

2.3 Blower

It is just like a small fan consists of 3-4 blades having 900 rpm. Its purpose is to suck & circulate the air in proper manner. It also used for exhaust purpose. The hot air from the wooden box is exhaust to atmosphere for recirculation.

2.4 Insulation

Thermo-cole is used as insulating materials which can be used to reduce heat losses from solar air heater. It has thermal conductivity 0.035(w/m°C), density of 16 (kg/m³). It has low thermal conductivity & stability at high temperature.



Figure 2: Experimental Setup



Figure 3: Inner Space



Figure 4: Heating Area

Double flow solar air heater is the advanced modification of single flow solar air heater. In the single flow solar air heater, air flows through one side of copper plate whereas in the double flow solar air heater air flow from both side of copper plate.

Atmospheric air is first entered through air filter which filtered dust particles. Then the atmospheric air passes over & below the absorber plate. Thus the extremely hot air is entering the wooden box which is insulated. This collected hot air creates a high temperature in the wooden box. This high temperature is used for drying the crops, foods, household eatables and even clothes.

3. EXPERIMENTAL OBSERVATION AND CALCULATION

Observations have been recorded at an interval of 15 or 30 min during bright sunshine hours.

Following parameters have been recorded

1. Atmospheric temperature
2. Temperature of copper plate

3. Temperature of wooden block

Sample observation table is mentioned herewith

Table- 1 sample observation

| TIME | ATM. TEMP. | TP1 | TP2 | TP3 | Tb |
|---------|------------|---------|---------|---------|---------|
| 1.30 pm | 41.1 °c | 62.1 °c | 63.1 °c | 61.5 °c | 60.1 °c |
| 2.00 pm | 40.3 °c | 63.3 °c | 62.2 °c | 61.2 °c | 58.8 °c |
| 2.30 pm | 41.4 °c | 63.1 °c | 63.5 °c | 61.3 °c | 58.6 °c |
| 3.00 pm | 40.1 °c | 62.9 °c | 62.8 °c | 60.7 °c | 58.4 °c |
| 3.30 pm | 38.5 °c | 62.7 °c | 62.3 °c | 60.1 °c | 58.7 °c |
| 4.00pm | 37.2 °c | 62.8 °c | 63.3 °c | 59.8 °c | 58.6 °c |
| 4.30pm | 37.0 °c | 63.2 °c | 62.9 °c | 59.9 °c | 57.5 °c |
| 5.00 pm | 35.2 °c | 61.9 °c | 61.5 °c | 60.3 °c | 57.2 °c |

Where,

- Tp1 : Temperature of plate at first hole
- Tp2: Temperature of plate at second hole
- Tp3 : Temperature of plate at third hole
- Tb : Temperature of wooden block

4. RESULT AND DISCUSSION:

The result obtained from double flow solar air heater having efficiency 59.06% and temperature ranging from 50 °C-60 °C which essential for drying purpose.

5. CONCLUSIONS

A Double Flow solar air heater has been developed and its performance in the field condition has been investigated. The air heater is capable of providing hot air of temperature difference (15o C-30o C) on a moderate sunny day. It is a suitable air heater for producing hot air of space heating and agricultural drying applications.

6. REFERENCES:

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