DESIGN OF SOLAR DRYER WITH TURBOVENTILATOR AND FIREPLACE

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Abstract

The author has been using solar dryers for food processing, especially for making *amla* candy, for the last five years. Solar dryer is an innovative design with combined draught, natural, and induced with fan. It works well when fan induces draught. However, when there is no power, the dryer works with natural draught, although the system underperforms because of the drastically reduced airflow. In the rural areas of Maharashtra, power cuts increased to almost 14 hours a day and no power is practically available to run the fan during daytime. So, the author came up with a new design of solar dryer, which uses turboventilator for creating draught. It runs on 'external' wind to create necessary draught and maintains good airflow through the solar dryer, giving excellent performance. As it works on wind, no power is required. So, the unit is truly a renewable energy gadget. The unit is also provided with a fireplace and bypass chimney. This allows the use of the dryer at night and during cloudy days. It also helps to accelerate the drying process when the Sun is available by using some fuel-like waste biomass. Turboventilator was preferred over Solar PV (photovoltaic) operated fan for the reasons of cost and possibility of operation at night or in cloudy period. The results of the new solar dryers are very encouraging.

Introduction

Drying is an excellent way to preserve food, and solar dryers are an appropriate food preservation technology for a sustainable world. Drying preserves foods by removing extra moisture from the food to prevent decay and spoilage. Water content of properly dried food varies from 5%–25% depending on the type of food. Successful drying depends on the following.

1. Enough heat to draw out moisture, without cooking the food;
2. Dry air to absorb the released moisture; and
3. Adequate air circulation to carry off the moisture

Agricultural and other products have been dried by the Sun and wind in the open for thousands of years. The purpose is either to preserve them for later use, as is the case with food; or as an integral part of the production process, as with timber, tobacco, and laundering. When drying foods, the key is to remove moisture as quickly as possible at a temperature that does not seriously affect the flavour, texture, and colour of the food item. If the temperature is too low in the beginning, microorganisms may grow before the food is adequately dried. If the temperature is too high and the humidity too low, the food may harden on the surface. This makes it more difficult for moisture to escape and the food does not dry properly.

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which resulted in good savings on fabrication and painting.

- Improving utilization: It is observed that farm produce is available for a short duration and needs to be processed within that short time. The author has been manufacturing '*Amla* Candy' using solar dryers since last four years. *Amla* is harvested only for a period of one month or so, and all the produce needs to be processed or sold in that short duration of time. Other crops will also face the same problems. The authors added a fireplace and heat exchanger in the design, so that the biomass from the farm can be burnt in this place. Burning biomass in day time will accelerate drying process, and at night, the dryers can run only on biomass, improving the net output from the dryer.
- Maintaining adequate draught: The first system was designed to work on combined natural or induced draught. Induced draught was created with the help of a fan consuming auxiliary power. Whenever there is a power cut, the system will work under natural draught. Dryers under-perform when they run only on natural draught. In rural areas, power cuts are often and hence, no power is practically available in the day time. Running induced draught fan on solar PV array was one of the options, but the authors decided against it because of the high cost and limitations for night operations. The authors made use of turboventilators for generating the induced draught. Turboventilators work on the outside wind and exhaust air from drying cabinet inducing draught.

A fireplace was designed and placed at the bottom of the cabinet in such a way that it did not obstruct air flow from the solar collectors. Finned surface was provided for the interface to increase heat transfer from the fireplace to the cabinet side. Indirect heating is adopted as flue cannot be allowed to pass through the food stuff. Separate opening was provided on the sides for chimney to allow the flue to directly escape into the air.

Figure 2 Photographs of a fireplace with chimney outlet on side

System operation

Three solar collectors of 2 sq m each are connected in series to give effectively 6 sq m collector area in one row. Two such rows are connected to one cabinet. The air heated by the Sun flows upward in the solar collectors, either by natural draught or by the draught created by the turboventilator, and passes through the food stuff arranged in wooden trays with stainless steel mesh, taking out the moisture. The fuel can be burned in fireplace, enabling the flue to escape through the chimney on the sides. The heat is exchanged through a finned partition to the cabinet side in the drying zone when Sun is not available.

Conclusion

The new design of solar dryer, incorporating turboventilator and fireplace, has following advantages.

- Unit does not require external power because of the use of turboventilators. It is possible to use the unit during night time as well, which is not possible with solar PV drive to fan.
- Typical design, which uses solar collector panels as roofing and provides large covered utilisable, are for store and processing units. This feature saves huge cost on the structure of the solar dryer as well as roofing cost of the building under the solar collectors.
- Fireplace adds value to the product as night operations are possible. This permits high product output over small duration, during which vegetables and fruits are harvested and processed. Large amount of biomass is available for free in the farms, which can be effectively utilized in this unit.
- Interest burden of the capital investment is distributed over large production, improving financial viability to a great extent. With large volume of production, subsidies may not be required.

Compared to conventional solar dryer, the new design delivers almost three times more output if used round the clock. A lot of waste biomass is available in the farm, which can be burned in the fireplace. As the unit uses energy from Sun, wind, and biomass, this new design has come out as a genuine renewable energy gadget.