1290

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# A MODIFIED SOLAR CUM-SMOKE DRYER FOR SHEET RUBBER

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ABSTRACT

**Conventional method of drying sheet rubber is in smoke houses using firewood as fuel. In view of the scarcity of firewood, the renewable and eco-friendly aspects of solar energy and its use in drying sheet rubber has been investigated with the development of a 600 kg solar dryer assisted with firewood backup. The performance of the dryer was also evaluated.**

## INTRODUCTION

A large portion of the natural rubber produced in India is by small plantations and contribute to 60% of the total production of sheet rubber. In order to produce better quality sheets, awareness is being created among small farmers about the need for raising the quality of their produce to acceptable standards in the international market. To ensure better quality of rubber group processing centers are being explored. Drying is the important process in the making of sheets. The energy requirement for the drying operations is firewood and has become a scarce commodity. Utilization of solar energy as an alternative source, being renewable and eco-friendly was attempted for drying of sheet rubber. Various types of small dryers have been developed suiting to tropical climate by Lurtz *et. al.* (1987) and Muller *et. al.* (1989). A dryer for crepe rubber was suggested by Walpita *et. al.* (1984). A solar drier of 800 kgs capacity for sheet rubber was developed by Radhakrishnan Ñair *et. al.* (1988). After use for some time the drier developed some difficulties in operation. The present study envisages the modifications of the above drier to get rid of the difficulties in operation of the drier and its functioning and evaluation.

The drier was originally designed for drying 800 kgs of raw sheets. The drying performance was satisfactory but many inadequacies were observed during continuous operation which were identified as follows.

1. Blower supported combustion (2) Corrosion of connecting ducts (3) High temperature damaging the blower bearings (4) Recirculation of smoke tarnishing the glazing, (5) High heat losses (6) Defects in trolley design (7) Manual switching of the blower (8) Damage of sheets due to high heat near the flue gases entry.

## MATERIALS AND METHODS

The following modifications were carried out on the dryer, to overcome the above identified defects.

(1) Construction of a separate furnace for firewood backup (2) The concealed ducts were replaced with new ducts (3) A new blower capable of handling air at 100°C was installed (4) Recirculation of air was abandoned (5) A second brick wall separated by a stagnant air column was constructed to reduce heat losses

(6) One of the trolleys was experimentally modified for improved arrangement and easy handling of sheets. (7) A solar activated switching of the blower was introduced (8) For protecting the blower from hot ambient conditions the blower compartment was isolated with an additional brick wall. (9) The collector area was increased for more effective drying.

### Evaluation

The dryer after modification was evaluated for studying its performance. The solar radiation was measured using a hand held solar intensity meter. The meter was placed horizontally and the intensity of the radiation was measured directly as $mW/cm^2$. Drying trials were carried out with solar energy alone and also with firewood backup. Sheets were dried under partial and full loaded conditions.

## RESULTS AND DISCUSSION

The blower was accommodated at the short end of the chamber. The space around the blower was not utilized for placement of troleys due to insufficient height. In view of the corrosion of the ducts concealed in the brick wall polyvinylchloride pipes were provided for better insulation. The blower sucks air from the hot panels and delivers into the chamber.

### Furnace

In original construction the fire place was linked to the blower inlet. To avoid damage to the firewood burning furnace was constructed separately which could be operated independently. The capacity of the fire box was around 30 kgs. The burning of the wood was regulated by controlling the airholes in the front as in conventional smoke houses. By burning a filled furnace in 3 to 4 hrs the temperature of the chamber could be to about 65°C.

### Blower

The end of the ducts from the heat collectors was connected to a centrifugal blower rated for handling 100°C. The hot air was sucked from the collectors so as to avoid loss of heat in case of a leakage in the collectors or at the joints. The details of the blower and the motor are given in Table I.

### Drying chamber

Volume of the drying chamber after construction of the additional brick wall was 24 $m^3$. A false roof with asbestos provided better thermal insulation at the upper side of the chamber. One of the two doors of the original design was closed and the trolleys were handled through one door on the side. A sketch of the modified dryer is given in Fig. 1. Sheets were loaded on the trolley (1200 x 900 x 1750 mm) with a capacity to hold 1150 sheets and were pushed in and out of the chamber with the help of castor wheels, and this minimized operation time of opening the chamber that reduced heat losses. The total capacity of the

**Table I. Details of the blower unit**

| Motor | Blower |
|---|---|
| 2800 rpm | 2880 rpm |
| 220/230 V | Capable of delivering 600 CFM |
| 3.7 A | 0.5 HP |
| 1 Ph, 60 Hz | |
| 0.5 HP | |

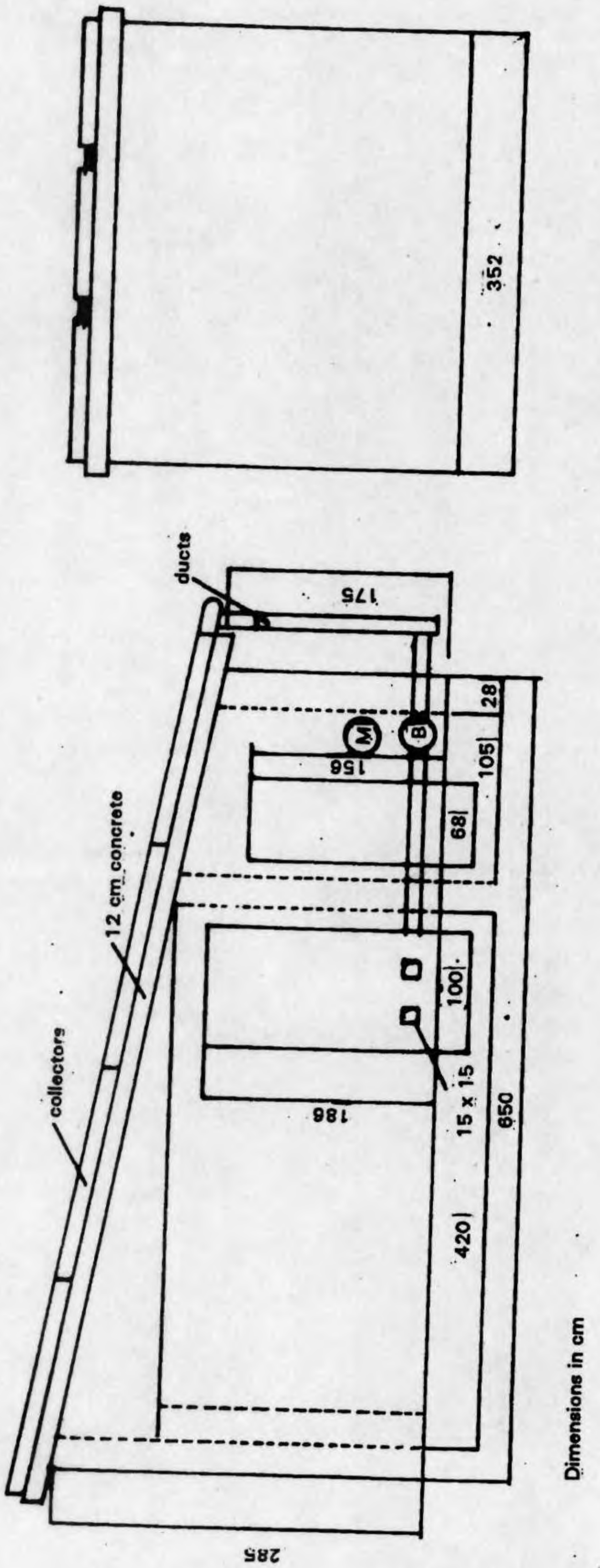


Fig. 1. Modified solar dryer

**Table II. Solar intensity and chamber temperature**

| Time | Radiation W/m² | Inlet air temp. °C | Chamber temp. °C |
|---|---|---|---|
| 9.00 | — | 50 | 40 |
| 9.30 | 600 | 53 | 42 |
| 10.00 | 725 | 56 | 43 |
| 10.30 | 805 | 60 | 44 |
| 11.00 | 880 | 63 | 45 |
| 11.30 | 870 | 61 | 44.5 |
| 12.00 | 960 | 63 | 46 |
| 12.30 | 920 | 68 | 47 |
| 13.00 | 900 | 68 | 49 |
| 13.30 | 900 | 68 | 50 |
| 14.00 | 450 | 67 | 48 |
| 14.30 | 770 | 64 | 47 |
| 15.00 | 690 | 58 | 46 |
| 15.30 | 570 | 53 | 45 |
| 16.00 | 540 | 51 | 45 |
| 16.30 | 450 | 46 | 44 |

dryer was thus 900 sheets. However some trials have shown that the spacing between the sheets could be further reduced to enhance the capapcity to 200 sheets. The total capacity of the dryer could thus be 1200 sheets or 600 kgs.

## Heat collectors

The heat collectors were arranged on the roof of the building. Placement of the collectors on the roof provided with a south facing angle of $10^0$ corresponding to the position of the location on the globe. However for winter optimization the collectors were to be placed with extra slope. But this was not attempted taking into account various constructional and maintenance difficulties. The absorbing surface was selective coated surface applied as stickers on the aluminium substrate. Air was passed under aluminium and heated before it was sent to the drying chamber. The total area of the collectors was 24 $m^2$ .

## Drying trials

Sheets weighing 500 to 600g (dry weight) were prepared from fresh latex. After allowing to drip for 3 to 4 hrs the sheets were loaded on the trolleys and pushed in to the chamber. The blower was controlled with a photothermal switching device. This switched the blower between 8 AM and 9 AM on days of normal sunshine. The control had to be set at a higher temperature to reduce chances of cold air being blown in during the afternoons when the chamber temperature is high. Drying of sheets was carriedout under partial and full loaded conditions of the chamber. But only little differences were observed in the drying parameters and might be due to good flow rate of air (0.22 $M^3$/sec). Further no sign of condensation of water vapor was visible on any part of the chamber. Temperature of 52 to 53$^0$C could be attained during days of good sunshine (Table II). During drying trials under fully loaded condition 200 dry sheets were removed from the chamber and an equal amount of wet sheets were placed in every day. During the trials it was found that for drying 750 kgs of sheet 120 kgs of firewood was consumed. This amounts to 160 g of firewood for every kg. of dried rubber. On an average the blower worked for 8 hours a day and the energy consumed was 0.375x8 = 3KWh. The cost of electrical energy is small compared to normal drying cost of 200 sheets. Alternatively during days of moderately good sunshine it is possible to dry the sheets in 6 to 7 days using solar energy alone. In such cases the capacity of the dryer on per day basis will be lower.

**Table III. Percentage distribution of sheets**

| Grade | Percentage |
|---|---|
| RSS III | 20 |
| RSS IV | 60 |
| RSS V | 20 |

### Quality of sheets

The colour of the sheets dried in the experimental chamber were uniformly light amber. When more firewood was used during cloudy days the sheets appeared darker. Percentage distribution of different grades of sheet rubber obtained in the drying process is given in Table III. Lowering of the quality of the sheets is mainly due to the presence of dirt associated with handling. The drying procedure had no detrimental influence on the sheets.

To conclude, standard sheets of 3mm thickness could be dried in 4 to 5 days time by using solar energy during day time and fire wood backup during the night. The firewood consumption was only 0.16 kg for every kilogram of dried sheets. The dryer will be useful for the medium scale farmers and community processing centres.

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