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DESIGN OF AN ELECTRICAL DRYER FOR PLANTATION CROPS

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Abstract: Sun drying of plantation crops becomes impossible during rainy season and so artificial drying has to be resorted to. The electrical dryer developed by CPCRI is an indirect type dryer suitable for all seasons to dry coconut, cardamom and pepper. It is tray type dryer with mixed flow and forced hot air circulation. Heating unit consists of 6 numbers of 1K W strip heaters and hot air blower with 0.5 HP motor. Thermostatic / electronic temperature control is provided to set the maximum drying temperature to suit the requirement of different crops. This dryer can be used to dry 1000 coconuts / batch in 32 hours and 75 kg of cardamom (wet) in 25 hours. The cost of drying per kilogram of copra and cardamom is calculated to be Rs 1.83 and Rs 1.96 respectively.

1. Introduction

Coconut is an important source of vegetable oil, used for both edible and industrial purposes. It is estimated that nearly 50 per cent of the total production of nuts in India is consumed raw, while the remaining quantity is converted to copra, in order to obtain coconut oil. The drying from October to May can be performed in the open sun by conventional sun drying or by using solar dryers. But this method cannot be resorted to during rainy season. Coconut kernel being a

very good substrate for micro-organisms, gets infested if not subjected to drying within four hours after splitting (Thampan, 1981). Also, for safe storage and for extraction for good quality oil, the copra must contain less than 6% moisture (w.b) (Madhavan, 1987).

Cardamom capsules when harvested, contain 80 per cent moisture (w.b). These are processed in two ways to obtain two different kinds of products, namely bleach cardamom and green cardamom. Both the processes involve the

operation of drying the capsules to the safe storage level of 8 per cent moisture (w.b). Harvesting of the capsules commences in September and continues till January. The peak harvest coincides with the north-east monsoon, when about 68 per cent of the total production is harvested. Cardamom, after harvesting should be processed within 24 to 36 hrs to avoid deterioration (Patil 1984). The colour of cardamom is bleached if exposed to sun light. Hence, artificial, drying in the absence of sun light (green curing) is resorted to.

Direct and indirect type dryers are being used for coconut drying. The direct type dryers are known as kiln dryers where cups are exposed to flue gas from the burning pit eg: Pasearjan type, Saria type, Malaysian cooke kilms, Ceylon type (Grimwood, 1975)

In the indirect type of dryers the flue gas is passed through the chimney and fresh air is heated to the required temperature by heat exchanging / distributing unit. eg: Samoaan dryer, Comoro dryer, the New College copra dryer, Indonesian hot table dryer, CPCRI Small Holder's Dryer (Patil, 1991). The hot air is circulated either by natural convection or by power operated blower.

The mechanical dryer using electric energy for drying of copra, developed by CPCRI is an indirect type forced air circulation dryer (Patil *et. al.*, 1984). The main drawback of this model was that it incorporated a large and expensive heating system and it required about 10m² area to house this dryer (Anonymous, 1988).

Keeping these points in view, the CPCRI has developed an electrical dryer using the same drying chamber of the CPCRI mechanical dryer, but with a more efficient heat exchange system and control.

2. Materials and Methods

This dryer consists of a drying chamber, plenum chamber and air distribution unit and blower cum heating unit (Fig. 1).

Table 1. List of materials required for the fabrication of the dryer.

Description of the material	Quantity
GI/MS sheet 22G	9.4m ²
-Do- 14G	1.0 m ²
Weld-mesh 35 x 25 mm	10.0m ²
MS Hinges 75 x 25 mm ²	6 Nos
Aluminium angle 25 x 25 x3 mm	50.0 m
Electric strip heaters - 1 KW each	6 Nos
Blower 300mm ϕ	1 No
Electric motor with starter	1 No
0.5 HP, 1440 RPM	

Table 2. Specification of the dryer

Type	- Tray
Heating mode	- Electric energy
Air circulation	- Forced hot air
Capacity	- 1000 coconuts / 75 Kg cardamom
Area of housing (m ²)-	1.2
Overall dimension	
Length (m)	- 1.15
Width (m)	- 1.02
Cost (Rs)	- 12,500

The drying chamber is made of jackwood planks lined with 22 gauge GI sheet. The air distribution chamber is provided in the centre of the drying chamber. On both sides of the distribution chamber, welded wire mesh trays of 92 x 45 cm size are kept on aluminium angle runners. The drying chamber accommodates eleven trays on each side. An adjustable exhaust is provided at the top of the chamber. When cardamom or pepper is to be dried, the welded mesh trays can be replaced by suitable wire mesh trays. The list of materials required and the specifications of the dryer are given in Table 1 and table 2 respectively.

The heating cum blower unit consists of 6 numbers of strip heaters of 40 cm x 2.5 cm size and 1 K W power and is housed in a conical structure, whose wide opening is connected to the air distribution chamber. The other end of the conical structure is attached to the blower unit consisting of 0.5 HP, 1440 rpm, single phase motor. The blower is of 45 m³ / min. capacity. The air passed over the bank of heaters gets heated up and moves forcefully and circulates in the drying chamber. The motor operation is controlled by a direct on-line starter and the temperature is controlled by using a thermostat and also by adjustment of the inlet and exhaust to the drying chamber.

2.1 Testing of the Dryer

Hundred cups were loaded on each tray with the cups facing side ways. During loading, the blower is switched on with the exhaust lid partially opened. After loading, the heaters are switched on. Desired temperature of the hot air is achieved with the thermostat setting and by adjusting the inlet valve and exhaust lid openings. The temperature of the inlet air is kept at 60°C for copra. The air velocity parallel to and through the material was 22 meters / min. and 10 meters / min respectively. The dryer was operated continuously for 12 hours initially and then switched off. The trays were taken out and the shells separated from the kernel. Then the rays with the kernel cups were reloaded in the dryer with the cups facing up and the dryer was switched on again. The drying

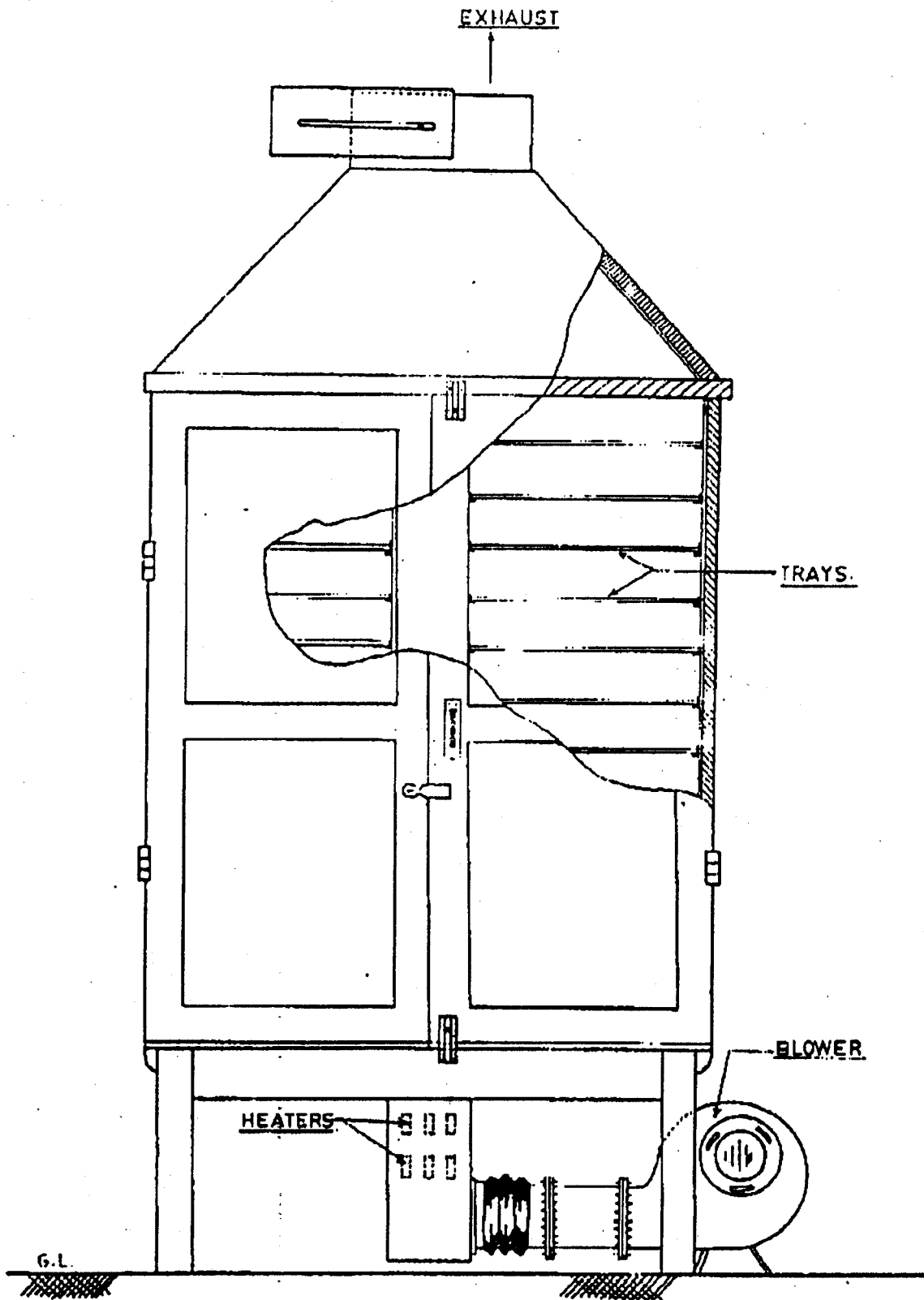


Fig 1. Electrical Dryer

was continued for another twenty hours by which time, the desired moisture level of 6 per cent was attained.

This electrical dryer was tried for cardamom drying also. Seventy five Kg of cardamom capsules were loaded in the wiremesh trays (twenty numbers) and kept inside the drying chamber. The temperature of the dryer was adjusted to 50° C-55°C and the drying time taken was 25 hours.

3. Results and Discussion

Table 3. Dryer performance data

Sl. No.	Produce	Qty	Drying air temp(°C)	Initial m.c (w.b.%)	Final m.c (w.b.%)	Total drying hours	Qty. of final product (Kg)	Electrical energy consumed
1	Coconut	1000 Nos	60-70°C	45-50	5-6	32	160	140 units
2	Cardamom	75 Kg	50-55°C	80-82	8	25	16.2	100 units

The drying performance data of the experiments is given in Table - 3. Thousand coconuts could be dried from 43- 50 per cent moisture to 5 - 6 per cent moisture in 30-32 hours and 75 Kg of fresh green cardamom of about 80 per cent moisture (w.b) could be dried in 25 hours to bring down the moisture content to the safe level of 8 per cent. The reduction in moisture content of the produce during drying is shown in fig.2.

It can be seen that the rate of drying of cardamom is faster than that of coconut. But in both cases, the quality was very good. The dried cardamom was green in colour and there was no excessive shrinkage of cardamom capsules. As the copra is dried in a closed chamber, dust and other particles did not contaminate it.

The copra obtained from direct type dryers used to be inferior in quality due to the flue gas directly coming in to contact with the copra (Woodroof, 1978). Moreover, in this type, there was no control over the drying air temperature and so in some cases, hardening of the endosperm also takes place. In indirect type dryers, the flue gas does not come into contact with the product in drying chamber, but there will not be uniform heating in dryers having natural air convection heat exchange system. The CPCRI Electrical dryer is having forced hot air circulation system and so the temperature will be uniform and constant at the set temperature. As the heaters and the blower are fixed just below the drying chamber and the blower is connected to the air mixing distribution unit directly, the heat loss due to radiation is minimised and so maximum heat energy could be used for the drying.

3.1. Economic analysis of the dryer for coconut and cardamom drying

The cost of the dryer was estimated to be Rs. 12,500 and the expected life of the dryer is 10 years. The use of this dryer for copra making is assumed as 240 days and for cardamom drying as 140 dys. With the above consideration the cost analysis was done as shown in Table 4. Accordingly the

Table 4. Cost analysis of copra dryig and cardamom drying using electric dryer

A. Basic details			
1. Cost of the dryer	:	Rs 12,500.00	
2. Expected life	:	10 years	
3. Particulars		Coconut	Cardamom
a. Use of dryer in a year		240 days	140 days
b. Quantity of produce batch ⁻¹		160 Kg.	16.2 Kg.
c. Labor requirement batch ⁻¹		1.5man day	0.5 man day
d. Time required for drying		32 hours	25 hours
e. Energy consumption per batch		140 units	100 units
B. Fixed cost			
1. Annual depreciation @ 10% of cost)			: Rs 1,250.00
2. Annual interest on half of new cost @ 15%			: Rs 937.50
3. Annual maintenance cost @ 10% of initial cost)			: Rs 1,250.00
4. Total fixed cost			: Rs 3,437.00
5. Fixed cost per batch	(a) For coconut		: Rs 43.00
	(b) For cardamom		: Rs 37.00
C. Operation cost			
		Coconut	Cardamom
1. Labour charges @ Rs 120.00/ day		Rs 180.00	Rs 60.00
2. Cost of electric energy		Rs 70.00	Rs 50.00
3. Total operating cost		Rs 250.00	Rs 110.00
D. Cost of drying per batch			
(Operating cost+ fixed cost)		Rs 293.00	Rs 147.00
E. Cost of drying per Kg		Rs 1.83	Rs 1.96

cost of drying per Kg of copra is worked out to be Rs. 1.83 and the cost of drying per Kg of fresh cardamom is Rs. 1.96.

Since the electrical dryer has got forced hot air circulation system, the temperature inside the drying chamber is uniform and the automatic cut off system at the set temperature protects the product inside from over heating or burning. Hence this dryer will be of immense use for quality drying.

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