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Design Analysis of Dehydration Trays for Farm Products

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Abstract: Dehydration of fruits and vegetables is one of the oldest types of preservation techniques well known to man and consists mainly of sun drying or artificial drying of fruits and vegetables. Although food preservation is the primary reason for dehydration, dehydration of fruits and vegetables also reduces the cost of packaging, storage and transportation by reducing the burden and volume of the final product.

Due to the improvement in the quality of dehydrated foods, we, along with many, specialize in instant and semi-finished products; the potential of dehydrated fruits and vegetables is greater than ever.

Drying or dehydration is the removal of most of the water contained in fruits or vegetables and the primary stage in the production of dehydrated fruits and vegetables. There are many drying methods commercially available on the market, and therefore the choice of the best methodology is determined by quality needs, material properties and economic factors.

There are three types of drying processes.
1) Sun and solar drying
2) Atmospheric dehydration
3) Sub atmospheric dehydration

I. INTRODUCTION

Fresh fruits and vegetables have a moisture content of more than 80%, and fruits and vegetables are considered perishable products. Fruit and vegetables are dried to increase shelf life, reduce packaging requirements and reduce transport weight. There are only a few dehydrator designs on the market today, and some of these designs require expensive materials that make prototyping expensive and difficult for small manufacturers to obtain. The purpose of this research is to build a low-cost dryer with high energy efficiency based on the previous dryer model. Previously, the optimization of the dryer model was characterized using temperature profiles and drying kinetics to identify voids. Compared to the old model, the results show that the new model has improved.

II. LITRACTURE REVIEW

There is one main drawback of the dryer available in the market, that is, when the material inside the lube that has been loaded, sometimes the material can get hot and burn, sometimes due to low temperature, half of the material is dehydrated and half. it's wet. This is caused by the fan setting, the temperature inside the machine and the air flow. Most of the fans are installed at the top, but the heater is installed at the bottom. In these dehumidifiers, we put the coils on the right and left side of the wall. It also has a rear-mounted blower and fan. Because of this process.

III. METHODOLOGY

To determine the experimental temperature profile of the pre-dryer, to test whether the drying chamber is adiabatic or the relationship between the temperature inside and the distance, the dehydration temperature is measured at several points in the cabinet and on the shelf where the product is stored. camera. Drying kinetics were performed for plum and banana slices. Tests are performed using a set of standard products. Kinetics were performed in triplicate for each fruit.

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A. Component And Specifications

Sr. No.	Part Name	Specification
1	Cabinet	SS 304 Material 120cm x 168cm
2	Fan	45cm
3	Trays	82cm x 41Cm
4	Temperature Controller	TC303
5	Duel Display Digital Timer	XT246
6	Motor	1HP
7	Power indicator	Red, Green, Yellow Light
8	Blower	1000 – 5000 RPM DC Fan
9	Door	Height 168 x Thickness11 cm
10	Heating element (Coil)	7 KV Circular Copper Coil

Table: Parts and Parts Specification.

B. Working

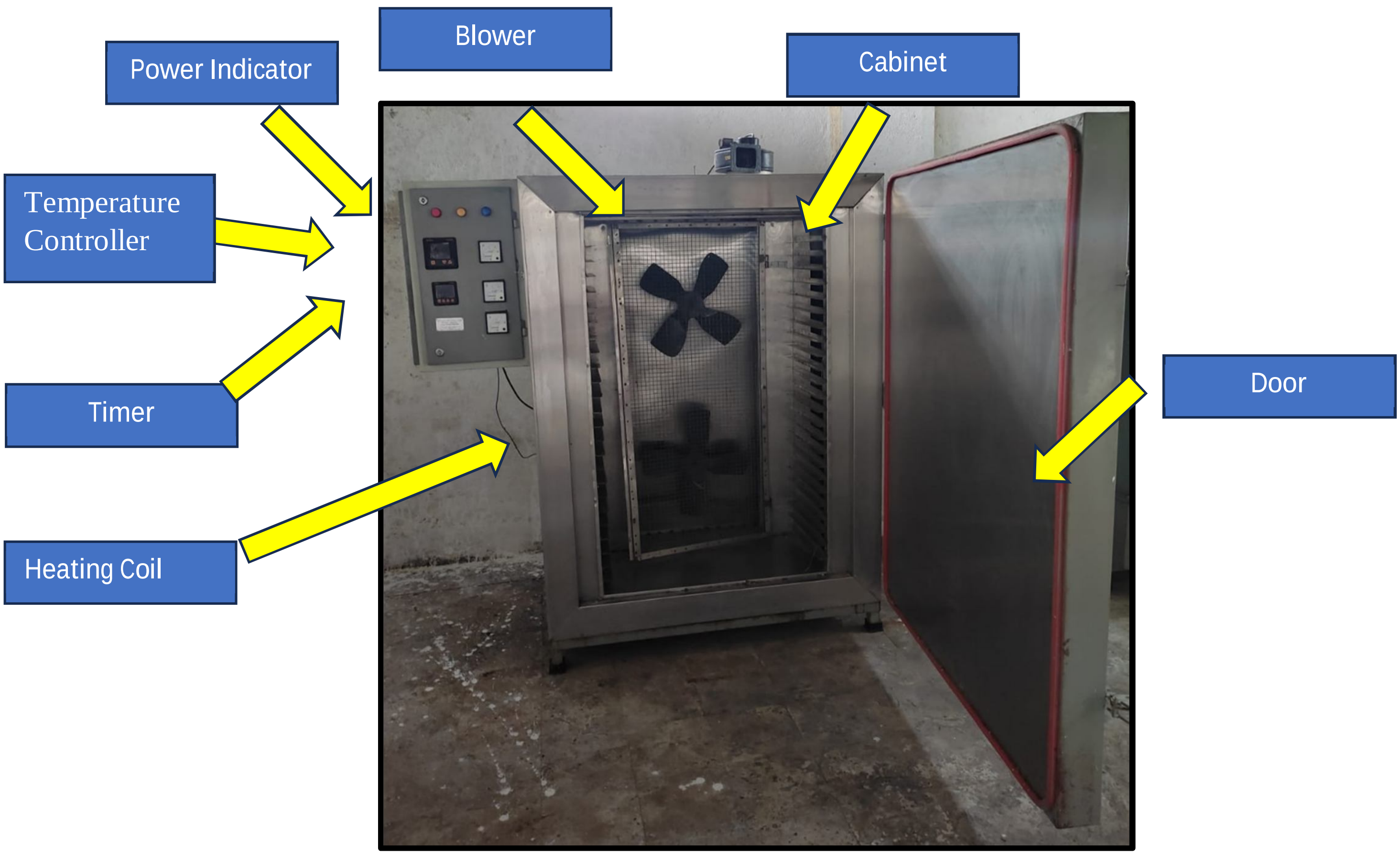

Fig: Working Principal of Dehydrator.

C. Description

The heat is defined as a it is a form of energy which transfers from one system to another system with a across their boundaries., due to the temperature difference. Thermal conductivity is defined as ability of material to conduct the heat. It's based on laws of Thermos Dynamic.

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IV. METHODS OF APPROXIMATE SOLUTION

Conventional machines have heaters fitted at the bottom, and they also don't contain any fans for heat circulation. That kind of machine structure causes the situation like, the product which is near the heaters get extra dehydrated or you can say product damage, so to overcome this situation I redesign the structure and added some functionalities to this structure, which in results prevent the product from getting extra dehydrated/Damage of product. I done this using some simple techniques like, Attached 2 fans in the machine to circulate the heat and put the heaters at the side of the machine cabinet far enough from the product holding tray that product get dehydrated correctly and does not affect the electricity consumption.

The efficiency of the dryer was determined based on the following formula:

$$\mathbf{E = D / T}$$

Where,
E is the efficiency of the dryer
D is the dehydrated fruit (kg)
T is the time (1 h).
several calculations were made with the following considerations taken into account:

(1) Heat loss through convection and conduction in each sample and tray
(2) Drop in air temperature when the air flowed over each sample
(3) Maximum possible temperature gradient in the air between the first and last trays
because the drying rate significantly varied depending on the number of trays in the model and model area
(4) Air humidity when the air flowed on each tray to verify that there was no condensation
(5) Number of trays that could be added to the dryer when the average air temperature was increased in a range of 5–10° C.
(6) thickness of the layer of air separating the sheet. First, the heat loss by convection was calculated as follows:

$$Q = h_c A_s (T_m - T_s)$$

Where,
Q is the convection heat transfer (W)
h_c is the coefficient convective of heat transfer (W/m^2 C)
As is the solid surface area (m2)
Tm is environmental temperature (C)
T_s is the surface temperature (C).
Subsequently, the heat transfer by conduction was calculated using the Fourier equation of heat conduction

$$Q_{cond} = KA \left(\frac{T1}{T2}\right) L$$

where Q_{cond} is the conduction heat transfer (W)
K is the thermal conductivity of the material (W/C)
A is the cross-sectional area (m^2)
T1 is the inlet temperature (°C)
T2 is the outlet temperature (°C)
L is the slice thickness (m)

Based on these findings, the total number of trays in the dryer, dryer area and the tray separation distance was calculated. The most suitable materials to build the cabin providing the least amount of heat loss through the walls were evaluated. The calculations were performed for four different models.

The systematic error (SE) of the equipment was calculated. Material monitored during the drying process. There were taken from different areas of the drying cabin and at different locations in each tray to evaluate the error caused by the position of the pieces regardless of the product. The error was calculated with the following equation

$$SE\ X = \mu - X$$

where SE is the systematic error of the dehydrator
m is the average of all measurements (drying time/slice)

V. RESULT

A. *Microbiological Evaluation*

After successful trail taken at each material sample send to Food Inspection Lab.

Lab Result for Dehydrated Tomato Slice Sample

Physical Parameters	Standard Specification	Analysis Frequency	Reference/Test Method
General Appearance	Uniform, clean, practically free from dirt, sand, pest and other foreign matter.	Each Lot	Sensory
Particle Size	Thickness max 2 mm – Dimeter Max 40 x 60mm	Each Lot	Sensory (Thickness Measure)
Shape	Ring or Slice type	Each Lot	Sensory
Color	Uniform Dark pink to Red	Each Lot	Sensory
Oduor	Normal	Each Lot	Sensory
Texture	Intact skin from tomato bit	Each Lot	Sensory

VI. CONCLUSION

This machine structure redesigning decreases the electricity consumption, also due to heat circulation process, prevent the product from damaging and significantly increase the product quality. Before the machine structure was redesign, machine took 11 to 12 hours to process the product. This change reduces the working hours of machine to, 7 to 8 hours. This in result increase the machine life and also increase the product processing quantity.

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