Design and Fabrication of Tray Dryer

[1]Prashant V. Dalvi, [2]Shubham S. Chavan, [3]Ravindra. K. Ambekar
[1]student, [2] student, [3]lecturer
[1]Mechanical Diploma Engineering, Mumbai, India

Abstract - This report presents the design and fabrication of food dryer. There are many dryers available in market which are used to dry or soak different food such as fruits, vegetables, potato chips, biscuits etc. For drying and baking process, the separate dryers are used, but we design unique dryer in which drying and baking process can be done in same machine. It is designed to dry different fruits, vegetables and to bake potato chips, biscuits etc. It is designed for maximum temperature 300 degree Celsius which is very useful for baking process. It consists heater, controller, motor and blower as a main components. It is an electric dryer and works such a way that when the electric supply is on, heater glows red hot and converts the electrical energy into heat, and emits heat inside the dryer in all direction.

Keywords – Dryer, Fruit, Vegetable

I. INTRODUCTION

All variety of food in our day today life need some way of preservation for several reason to reduce or stop spoilage.
To make all verity of food available throughout year, to maintain desired level of nutritional properties of longest possible time there various way of food preservation imposed which include canning freezing, salting, vacuumed packing, freezing in syrup food radiation and may more however the dehydration by thermal means is one of the oldest and most commonly used method of food preservation drying is the most effective way to increase self-life of food product.
drying is an excellent way to preserve food and food dryer is appropriate food presorting technic for sustainable development drying was probably the first ever food preserving method used by man even before cocking it involve removal of moisture from product that can be safely stored for longer period of time.

II. TYPES OF DRYING TECHNIQUES

- Sun or solar drying
- Freeze drying
- Drum drying
- Spray drying
- Convection air & Superheated steam (tray, tunnel)
- Osmotic drying
- Microwave

III. OBJECTIVES

1) The main objective of this project is to design a machine used for dry fruits and vegetables.
2) The objective of this project is to determine the drying rate of the sample using tray dryer.
3) To obtain knowledge about tray dryer.
4) The general objective of this project is to modified electric dryer for better performance.

IV. ADVANTAGES

- Low initial cost.
- Simple in construction.
- Easy to use.
- Less time required for complete drying.
- Rate of heat transfer is high.
- Chamber walls are heated externally to prevent condensation
- Unique single chamber & multi chambers design
- Lowest leakage rate of vacuum.

V .LITERATURE SURVEY

"**Diemuodeke E. Ogheneruona-, Momoh O.L. Yusuf** "Designed and fabricated direct natural convection solar dryer to dry tapioca in rural areas. A minimum of 7.56 m2 solar collector area is required to dry a batch of 100 kg *tapioca* in 20 hours (two days drying period). The initial and final moisture content considered were 79 % and 10 % wet basis, respectively. The average ambient conditions are 32ºC air temperatures and 74 % relative humidity with daily global solar radiation incident on horizontal surface of 13 MJ/m2/day. The weather conditions considered are of Warri (lat. 5°30', long. 5°41'), Nigeria. A prototype of dryer was fabricated with minimum collector area of 1.08 m2. **[1]**

"M. Mohan raj, P. Chandrasekhar" -The performance of an indirect forced convection solar drier integrated with heat storage material was designed, fabricated and investigated for chili drying. The drier with heat storage material enables to maintain consistent air temperature inside the drier. The inclusion of heat storage material also increases the drying time by about 4 h per day. The chili was dried from initial moisture content 72.8% to the final moisture content about 9.2% and 9.7% (wet basis) in the bottom and top trays respectively. They concluded that, forced convection solar drier is more suitable for producing high quality dried chili for small holders. Thermal efficiency of the solar drier was estimated to be about 21% with specific moisture extraction rate of about 0.87 kg/kW h. **[2]**

VI. METHODOLOGY

After choosing the project we started to gather the material and the total cost of requires material and place from where we would get the material. We made the design of the dryer. Also we given the dimensions of the dryer. Then we selected components of dryer which is required i.e. heater, blower, motor, and controller. Also selected required power, temperature, speed, dimensions of insulation about respective product. For making the body we selected the required material for outer body and inner body. For making inner body stainless steel is used and for outer body mild steel is used. After buying the material first we cut the material using sheet cutter and then bended it using bending machine. After cutting and bending we assembled the body also we given the finishing. Then we insert the insulation between outer body and inner body. After inserting insulation we fitted four u type coil heater inside the heating chamber. Electric motor is fitted on top side of dryer. Then blower is fitted for circulation of heated air.

VII. PROJECT (DESIGN)

Fig.1 Tray dryer model in CATIA V5

The working model shown in above image is our project, electric tray dryer.
It consist of mainly four components electric motor, controller, and blower and u type coil heater. It is consists of a rectangular chamber whose walls are insulated. Tray are placed inside the heating chamber. Three tray are placed in the heating chamber. Each tray is rectangular in shape. For heating electrically heated element is used. Electrically heated element like u type coil heater is used. In heating chamber there are four u type coil heater used. For circulation of heat blower is used which is made up of aluminum. Electric motor is used to give rotary motion to the blower.

Fig. 2 Tray Dryer Diagram

VIII. COMPONENTS OF TRAY DRYER

Fig. 3 Components of Tray Dryer

The components of tray dryer shown in above fig. It includes electric motor, U type coil heater, blower, and controller. When electric current flow through it, it glows red hot and converts the electrical energy passing through it into heat, which it radiates out in all direction.

IX. MATERIAL USED & ITS SPECIFICATIONS

Stainless Steel Sheet:-
Thickness: - 0.8 mm
Type: - 304
2 Mild Steel Sheet: –
Thickness: - 0.6 mm
Type: - AISI 1018

X. Calculations

Heat transfer rate
T1=300℃ = 300 + 273 =537℃
T4= 28℃ = 28 + 273 = 3010k

L_1= 0.8mm = $8*10^{-4}$m
L_2= 76.2mm = $76.2* 10^{-3}$m
L_3= 0.6mm = $6*10^{-4}$m

K_1= 1.9 w/m^0k
K_2=0.14 w/m^0k
K_3=54 w/m^0k

Area = 0.2899 m^2

$Q/A = T_1 – T_4/ (L_1/K_1 + L_2/K_2 + L_3/K_3)$
$Q/0.2599 = 573 – 301 / ((8*10^{-4}/19) + (76.2*10^{-3}/0.14) + (6*10^{-4}/54))$
$Q/0.2599 = 272 / (4.210*10^{-5} + 0.544 + 1.111*10^{-5})$
Q/0.2599 = 272 / 0.5440
Q = 129.96 W

To find interface temperature

$Q/A = T_1–T_2 / (L_1/K_1)$

$129.96/0.2599 = (573–T_2) / ((8*10^{-4})/19)$
$500.0384 = (573 – T2) / (4.210*10^{-5})$
$0.0210 = 573-T_2$
$T_2 = 572.97$ ℃K

$Q/A = T_2-T_3/ (L_2/K_2)$
$129.96/0.2599 = (572.97-T_3) / ((76.2*10^{-3})/54)$
$500.0384 = (572.97-T3) / (1.41*10^{-3})$
$0.7056 = 572.97-T_3$
$T_3 = 572.26$ ℃K

XI. RESULT

1). Drying Of Grapes

Preparation**:** - Leave whole, remove stems (if blanched)
Temperature: - 100℃
Drying Time: - 3 hrs.
Uses**:** - Raisins; use in baked goods, cereals and snacks

Fig. 4 Drying of grapes

2) Drying Of Coconut

Preparation**:** - Remove dark outer skin, slice 3/8” thick
Temperature: -100 ℃
Drying Time: - 1:30 hrs.
Uses**:** - Cakes, cookies, desserts and granola

Fig. 5 Drying of coconut

3) Drying Of Potatoes

Preparation**:** -Peel and slice 3/8” thick Blanch. Rinse and dry
Temperature: -100℃
Drying Time: - 1:30 hrs.
Uses**:** - Stews, soups and casseroles

Fig. 6 Drying of Potatoes

5) Baking Of Biscuit

Temperature: -160℃
Drying Time: - 50 min
Uses**:** -Eating

Fig. 7 Baking of biscuit

XII. SCOPE OF PROJECT

- We can Increase air flow rate.
- If we decrease distance between the tray and bottom plate as drying chamber using two layer of glazing to reduce the thermal loss from the collector.
- We will Increase power of heater for better performance.
- We can increase size of dryer and also increase the number of trays.

XIII.CONCLUSION

It conclude that, the performance of the drier can be said to be satisfactory. Instead of drying for 2-4 or weeks traditionally, this drier will be able to dry vegetables and fruits for 2 to 5 hours without smoke, moisture. Also it is seen that tray dryer takes less time for drying as per food item and also maintains the original color of the vegetable or fruits. It is tested for different food items at different temperature ranges and better results were obtained in drying and baking process. It is more efficient than other dryer.

XIV. ACKNOWLEDGMENTS

I express my deep sense admiration and gratitude to the thesis supervisor Prof**. R. K. Ambekar** Lecturer, Department of Mechanical Engineering, RMP, Ambav, for this invaluable encouragement, helpful suggestions and supervision throughout the course of this work. His willingness patience and optimistic attitude could lead to completion of this research work. I am also thankful to **Prof. Dongare G.U.** for her moral support.

I also express my thankfulness to the encouragement from **Prof. N.B. Bhople** (Principal, Rajendra Mane Polytechnic, and Ambav). **Prof. J. M. Sirase** and faculty member of Rajendra Mane Polytechnic, Ambav, for their valuable suggestions from time and time.

XV. REFERENCES

[1] "Diemuodeke E. Ogheneruona, Momoh O.L. Yusuf":- Designed and fabricated direct natural convection solar dryer
[2] "M. Mohan raj, P. Chandrasekhar":-The performance of an indirect forced convection solar drier integrated with heat storage material was designed, fabricated and investigated for chili drying