

Design of Domestic Multi-utility Dryer

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Abstract - This Paper is relates to Multi utility Domestic dryer. A unit of this project can be located anywhere in the house and one can change the position of unit depending on availability of space. There are numerous other locations which would be desirable for the apparatus of the invention such as, Bakery, small scale industries, or any other places that have enough space and need of prolong drying period, it has benefit from environmental conditions.

Drying means moisture removal from the product. Drying is helpful in preserving food product for long time; it prevent product from contamination. Direct solar drying, indirect solar drying, and mixed mode solar drying these are different solar drying methods. Primarily open to the sun or direct sun drying technique is used. However, this technique has some disadvantages. These disadvantages can be eliminated by indirect type of dryer which is used for drying food products and cloths as application of electrical and solar energy.

The dryer is container which is powered by electricity or fuel as source of heat, design for house product like cloths or agricultural product and used air for drying the products is called as mechanized form of dryer. This is dryer is fast, but it needs large initial cost of various equipment as well as for fuel.

Key Words: Food Dryer, Cloth Dryer, Solar Mode.

1. INTRODUCTION

Drying means preservation of food, fruits and vegetables for long time with good quality. It is a process of moisture removal due to simultaneous heat and mass transfer. Agricultural products, especially fruits and vegetables require hot air in the temperature range of 45–60°C, and for cloths drying they require temperature range is 35–45°C safe drying and. When any agricultural product is drying under controlled condition at specific humidity as well as temperature it gives rapid superior quality of dry product. Drying involves the application of heat to vaporize moisture and some means of removing water vapour after its separation from the food products. It is thus a combined and simultaneous heat and mass transfer operation for which energy must be supplied. The removal of moisture prevents the growth and reproduction of microorganisms like bacteria, yeasts causing decay and minimizes many of the moisture-mediated deteriorative reactions. It observed that reduction in weight and volume, minimizing packing, storage and transportation costs and enables storability of the

product under ambient temperatures. These features are especially important for developing countries. Drying process takes place in two stages first one happens at the surface of the drying material at constant drying rate and is similar to the vaporization of water into the ambient and second stage is according to properties of drying product with decreasing drying rate. Previously open sun drying is used for drying product. In this method, the crop is placed on the ground or concrete floors, which can reach higher temperatures in open sun, and left there for a number of days to dry. Capacity wise, and despite the very rudimentary nature of the process, natural drying remains the most common method of solar drying. This is because the energy requirements, which come from solar radiation and the air enthalpy, are readily available in the ambient environment and no capital investment in equipment is required. The process, however, has some serious limitations.

The most obvious ones are that the crops suffer the undesirable effects of dust, dirt, atmospheric pollution, and insect and rodent attacks Because of these limitations, the quality of the resulting product can be degraded, sometimes beyond edibility. All these disadvantages can be eliminated by using that dryer. The purpose of a dryer is to supply more heat to the product than that available naturally under ambient conditions, thus increasing sufficiently the vapour pressure of the crop moisture therefore; moisture migration from the different product is improved. The dryer also significantly decreases the relative humidity of the drying air, and by doing so, its moisture-carrying capability increases, thus ensuring sufficiently low equilibrium moisture content.

The dryer is container which is powered by electricity or fuel as source of heat, design for house product like cloths or agricultural product and used air for drying the product is called the product is called as mechanized form of dryer. This is faster dryer.

2 METHODOLOGY

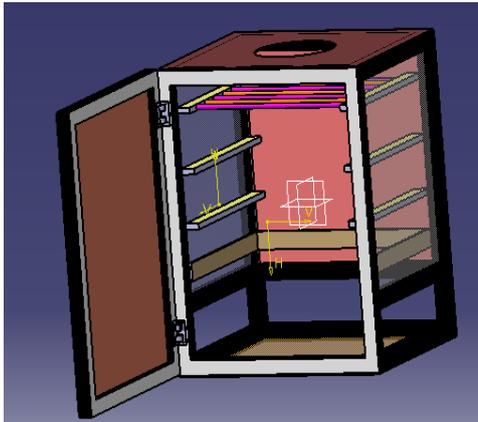


Fig -1.Dryer

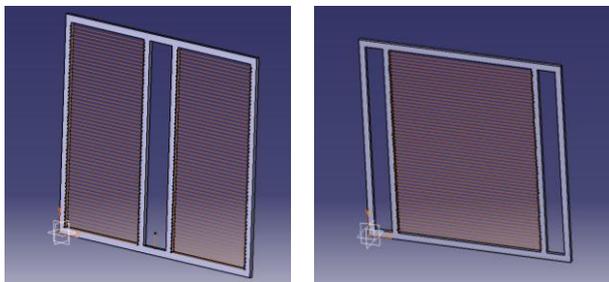


Fig -2.Trays

2.1 DRYER COMPONENT DETAILS

- Heating coil: copper coil are used in the dryer. 0.5 KW coil is used.
- Exhaust fan: the DC fan is used which is 0.615mm.
- Moisture absorbing material: silica gel is moisture absorbing materials.
- Insulation material: toughen glass and plywood is used.
- Tray: stainless steel
- Hanger: stainless steel pipe is used

2.2 MECHANISM OF THE DRYER

The above figure shows the mechanism of the multi-utility dryer it consist of heating coil, fan, moisture absorbing material, hangers, trays, electric circuits etc. the atmospheric air is forced on the coil and due to temperature difference the air is heated and this heated air strike on the cloth and food material similarly due temperature and pressure difference the heat and mass transfer. And moisture will be removed by cloths and the food material. And the air temperature will be reduced and it contains moisture this air will be exhaust. And remaining moisture will be deposited on the bed of moisture containing material.

The following block diagram shows the mechanism of the dryer

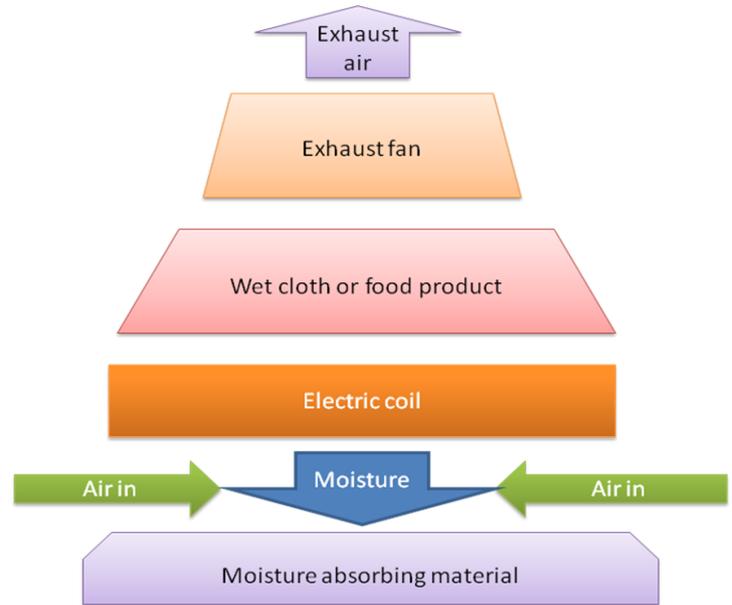


Fig -3. Mechanism of Dryer

2.3 ELECTRIC CIRCUIT

The following electric circuit diagram is consist of temperature sensor which is used to shows the temperature of the dryer and maintain constant set temperature, when temperature will be increased by the set temperature then it closes the heating coil and circulating fan switch. And moisture Sensor is used sense the moisture contains in air when it reaches the set RH then the system will switch off. Micro-controller is used to operate the system.

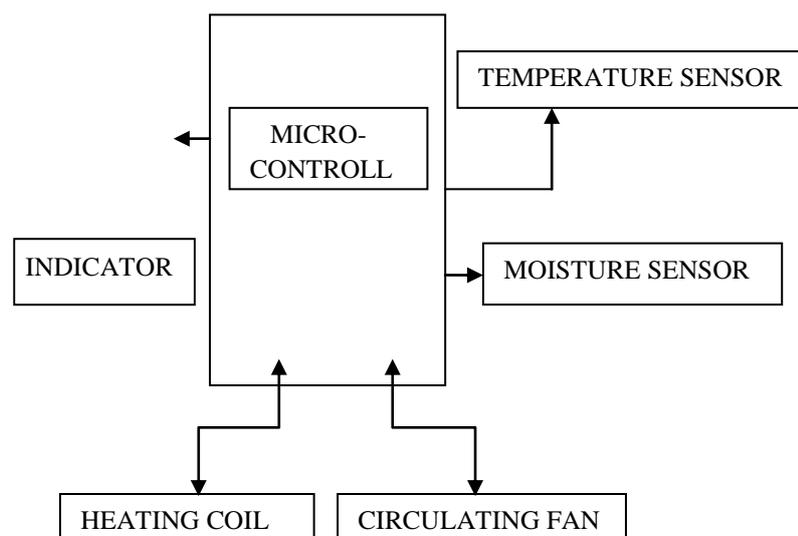


Fig -4: Electric circuit

2.4ELECTRIC CIRCUIT COMPONENT DETAILS

A. Transformer: - A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. A varying current in one coil of the transformer produces a varying magnetic field, which in turn induces a voltage in a second coil. Power can be transferred between the two coils through the magnetic field, without a metallic connection between the two circuits. Faraday's law of induction discovered in 1831 described this effect. Transformers are used to increase or decrease the alternating voltages in electric power applications.

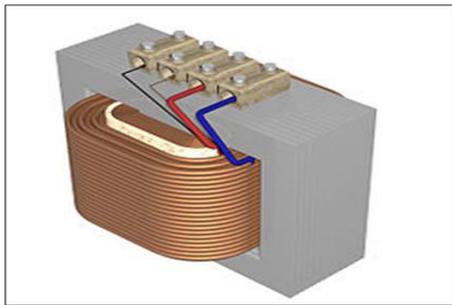


Fig -5: Transformer

B. Diode: - The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking current in the opposite direction (the reverse direction). Thus, the diode can be viewed as an electronic version of a check valve. This unidirectional behavior is called rectification, and is used to convert alternating current (AC) to direct current (DC), including extraction of modulation from radio signals in radio receivers—these diodes are forms of rectifiers

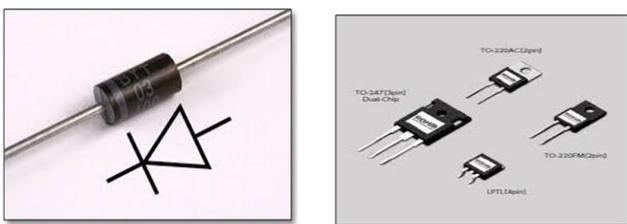


Fig -6: Diode

C. Filter capacitor: -Filter capacitors are capacitors used for filtering of undesirable frequencies. They are common in electrical and electronic equipment, and cover a number of applications

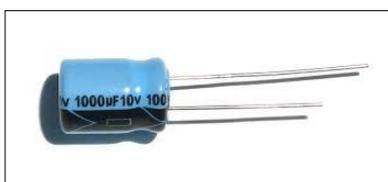


Fig -7: Filter

D. Transistor as a relay: - As one of the significant semiconductor devices, transistor has found use in enormous electronic applications such as embedded systems, digital circuits and control systems. In both digital and analog domains transistors are extensively used for different application usage like amplification, logic operations, switching and so on. This article mainly concentrates and gives a brief explanation of transistor application as a switch.

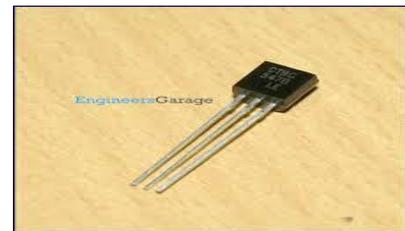


Fig -8: Transistor

E. IC 7805:- Voltage sources in a circuit may have fluctuations resulting in not giving fixed voltage outputs. Voltage regulator IC maintains the output voltage at a constant value. 7805, a voltage regulator integrated circuit (IC) is a member of 78xx series of fixed linear voltage regulator ICs used to maintain such fluctuations.



Fig -9: IC 7805

F. LCD Display: - A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome.[1] LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

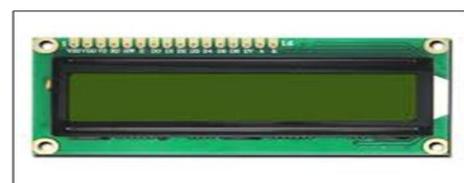


Fig -10: LED

G. Temperature and humidity sensor

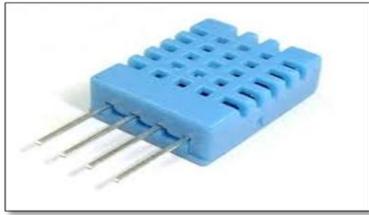


Fig-10: Sensor

2.5 TOUGHEN GLASS PROPERTY

A. Thermal Strength

It offers greatly increased resistance to both sudden temperature changes and temperature differentials up to 200K compared with annealed glass, up to 40K. The stress characteristics of toughened safety glass, of normal soda-lime silica composition, are unchanged for continuing service up to 250°C



Fig -11: Toughen Glass

3. PROJECT DESIGN AND IMPLEMENTATION

A. Thermal design

During rainy season drying cloths coil capacity
Heat load of wet cloths = (wet cloth weight) + (dry cloth weight)

$$\begin{aligned}
 M &= m(\text{wet}) + m(\text{dry}) \\
 &= 3500 + 500 \\
 &= 3000 \text{ gm} \\
 &= 3\text{kg}
 \end{aligned}$$

(Generally the wet cloth weight is 7 times more than the dry cloth weight)

$$\text{Heat required to dry cloth} = M [C_p (\Delta T) + 2257]$$

$$C_p = \text{specific heat of water kJ/kg.k} = 4.187 \text{ kJ/kg.k}$$

$$\Delta T = \text{temp difference} = (T_2 - T_1)$$

$$T_2 = \text{boiling point temp} = 100 \text{ degree or } 373 \text{ k}$$

$$T_1 = \text{wet cloth temp}$$

$$\begin{aligned}
 \text{Heat require to dry cloth} &= 3 [4.187 \cdot (100 - 20) + 2257] \\
 &= 7775 \text{ kJ}
 \end{aligned}$$

B. Coil capacity

$$\begin{aligned}
 &= \text{heat required to dry cloth/time in hr} \\
 &= 7775 / (4 \cdot 3600)
 \end{aligned}$$

$$\text{Coil capacity} = 0.5 \text{ kW}$$

C. Fan capacity

$$\text{Heating coil capacity} = M a \cdot C_{pa} \cdot \Delta T$$

$$M a = \text{mass of air in kg}$$

$$C_{pa} = \text{specific heat of air} = 1.005 \text{ kJ/kg.k}$$

$$\Delta T = \text{temp difference}$$

$$0.5 = M a \cdot 1.005 \cdot (60)$$

$$M a = 8.29 \cdot 10^{-3}$$

$$\text{Density} = P/R$$

$$V =$$

$$V = 1.1462 \text{ m}^3/\text{kg}$$

$$P = \text{atmospheric pressure}$$

$$R = \text{universal constant}$$

$$T = \text{temp of incoming air in Kelvin}$$

$$\text{D. Fan Capacity} = \text{mass} \cdot \text{density}$$

$$= 8.29 \cdot 10^{-3} \cdot 1.1462$$

$$= 1025 \text{ m}^3/\text{sec}$$

$$= 0.6150 \text{ m}^3/\text{min}$$

4. COMPONENT CAPACITY

	Component	Capacity
1	Heating coil	0.5 kW
2	Fan	0.6125 cmm
3	Temperature sensor	20-70 degree

5. CONCLUSIONS

- The multi-utility dryer is faster and efficient drying due to drying at higher temperature.
- Semi-continuous mode Heat of air for removing air only when it has high relative humidity by using automatic humidity controlled fan.

$$\frac{101325}{287 \cdot (35 + 273)}$$

- Higher shelf life of dried product due to lower final moisture content because higher temperature air from the heating coil is used for drying.
- Less area is required as compared to open sun drying. Product dried in dryer is free from dust, bird's excreta and dead insect.

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