DESIGN AND INSTALLATION OF A NEW LOW COST AGRICULTURAL PRODUCT DRYER

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Abstract  
This paper deals with the design and fabrication of a low cost agricultural crops dryer. In the current scenario the cost of such dryers are significantly high so that only large scale industries having substantial revenue can afford such dryers. By the implementation of our newly designed furnace we were able to reduce the capital cost of the dryer to a great extent.  
Keywords: newly designed furnace, low cost, economically feasible, household purpose

Introduction  
Many of the third world countries produce large quantities of fruits and vegetables for local consumption and export. According to the Food and Agricultural Organization (FAO, 1991), the estimates for 1990 were approximately 341.9 million metric tons. In Asia, India produces 27.8 million metric tons or 8.1%, while China has a production capacity of 21.5 million metric tons or 6.3% of the total world production. Many of these fruits and vegetables contain a large quantity of initial moisture content and are therefore highly susceptible to rapid quality degradation, even to the extent of spoilage, if not kept in thermally controlled storage facilities. Therefore, it is imperative that, besides employing reliable storage systems, post harvest methods such as drying can be implemented hand-in-hand to convert these perishable products into more stabilized products that can be kept under a minimal controlled environment for an extended period of time. Many food industries dealing with commercial products employ state-of-the-art drying equipment such as freeze dryers, spray dryers, drum dryers and steam dryers. The prices of such dryers are significantly high and only commercial companies generating substantial revenues can afford them. Therefore, because of the high initial capital costs, most of the small-scale companies dealing directly with farmers are not able to afford the price of employing such high-end drying technologies that are known to produce high quality products. Instead cheaper, easy-to-use and practical drying systems become appealing to such companies or even to the rural farmers themselves. It is also useful to note that in many remote-farming areas in Asia, a large quantity of natural building material and bio-fuel such as wood are abundant but literacy in science and technology is limited.

Objectives  
- To reduce the capacity of the dryer to a smaller value so that it can be used for household drying purpose
- Utilize the by-products as fuel.
- Improve the agricultural returns of the farmers.
- Designing a low cost dryer that small industries and farmers can afford it
- Making the whole system compact

furnace  
The biomass heater is made up of 4 mm thick mild steel plate and it has four main parts namely, inner and outer shell, cross pipe, chimney, inlet and outlet openings for air circulation. The inner shell is in cylindrical shape and located above the base. The base of the furnace acts as combustion chamber. A gate with locking arrangement is provided in the combustion chamber for loading of fuel and disposal of ash. The outer cylindrical shaped shell surrounds the inner shell. It has two manifolds, one act as inlet for ambient air and the other acts as outlet for hot air. The top part of the outer shell is conical shaped, above which chimney is attached. At the middle of the inner shell a cylindrical MS cross pipe is located and
connected by welded joint. The main purpose of the cross pipe is to direct the flame towards the outer periphery of inner cylindrical shell.

**Drying chamber**

The drying cabinet consists of four important parts namely the basic frame, drying chamber and loading doors. The chamber is designed by Galvanized iron sheet of 1mm thickness with length, breadth and height of 0.9m x 0.9m x 0.3m and with mild steel frame. A door with locking facility is provided for loading and unloading of coconut at the front side of the drying chamber. To regulate the air flow a sliding door is provided at the top of the chimney.

**Recirculation duct**

The recirculation ducts are used to regenerate the excess heat left at the exit side of the drying chamber. By doing regeneration the efficiency of the drying process can be increased and the amount of fuel used can be reduced significantly.

**Blower**

The blower is used for the effective flow control of heat flow through the drying chamber. The blower is of 0.5HP and it is placed before the furnace. The heat is regulated by controlling the speed of the blower.

**Temperature control unit**

The temperature control unit is a combination of a temperature sensor and a regulation circuit unit. The circuit is a set of programmers that keeps the temperature at a specific temperature.

**Methods**

In the present investigation the dryers in the market are of high capacity and high cost. So the cost of such dryers is very high. Also considering the high capacity of the dryer, high amount fuel is required to run the dryer. Due to the high cost, small scale industries can’t afford them. If they do due to the large size, the small scale industries won’t be running the dryer in full capacity. So a large amount of energy loss occurs.

Taking this to consideration, a new dryer design is made. A low cost dryer with small capacity and introduction of new furnace which is suitable for small dryers is the aim.

**The strategic planning process**

**DESIGN ALTERNATIVES**

**Design 1**

This was the preliminary design for the chamber that we have considered. Both the chamber and the furnace are made to close as possible to avoid the heat loss. There where horizontal pipes are provided on the chamber which will carry out the hot air to the chamber. A pipe is also provided on the top of the furnace to discharge the smoke generated.

**merits**

- Simple design
- Easy to manufacture
- Compact
Demerits
- Unequal heat distribution.
- Insufficient height

Design 2
Here the chamber has been designed in a conical structure to keep the uniform heat distribution. An additional support has to be provided for the chamber to carry out the load. The hot air spitted before entering into the furnace has again joined by means of a connector and then it is supplies to the chamber. Exhaust chimney has provided as similar to that of the previous designs.

Advantages
- Uniform heat distribution
- Sufficient height of chamber for handling (loading & unloading of crops)

Disadvantages
- Additional support needs for chamber
- Height of furnace is not sufficient to load fire woods

Design 3
- Position of the chamber is shifted to top of the chamber to make the dryer more compact.
- Unwanted flow of air through pipes has eliminated.
- But we have to provide a support for the chamber to hold the load since the pipe alone is not sufficient to withstand the load.

Design 4
- Unwanted flow of air through pipes has eliminated.
- Sufficient height and volume have provided for the furnace and chamber
- Blower is placed close to the furnace to maximum utilization of the heat generated

Merits
- Low cost
- Compact
- Payback period is small
- Maximum utilization of heat generated
- Easy to clean & maintain
- Additional blower is not required to blow air into the furnace

Demerits
- Capacity is limited to 100kg.
- Large wood pieces cannot be directly fed into furnace as other commercial dryers.

Results And Discussions
The drying tests were carried out using the biomass dryer due to unfavorable weather conditions and when solar radiation was not available at the said area. The biomass furnace heater
was used for drying of 100 kg/batch of coconut. By burning waste biomass (wood pieces) of 1kg, 85°C can be achieved within 24 hours in the system. The ambient air temperature and air temperature inside the drying chamber it is seen that the ambient air temperature varied from 28.8±0.5°C to 31.5±0.5°C. The biomass heater outlet air temperature varied from 80.0±1°C to 85.0±1°C. The average air temperature raised inside drying chamber over ambient temperature was 30°C -35°C during the full load condition. The maximum temperature obtained inside the drying chamber was 85°C. The temperature of the top tray measures 75°C and temperature of bottom & middle tray were 80°C and 79°C respectively. The dryer is able to maintain this temperature, regardless of outdoor ambient conditions. The difference between the furnace outlet and drying chamber inlet air temperature is considered as negligible because of the adequate insulation provided for the duct connecting the biomass furnace and dryer chamber.

Analysis On Air Flow And Heat Distribution
In the figure it shows the graph between time and temperature. In this process the first 60 seconds of the heating is considered. During the first 2 seconds the temperature is rapidly increased to 50 degrees then gradually increases to 80 degree Celsius.

Cost Estimation:
Cost of dryer available in market: 300000
Estimated cost of dryer: 35000
Material: 11000
Labor Cost: 8000
Blower: 5000
Temperature sensor unit: 3000
Installation & Transportation: 8000
- Price for drying copra: Rs.8/Kg
- Amount of wood used per day: 80 Kg
- Cost of wood: Rs.5/Kg
- Cost of running the machine(inclusive of labor cost and wood): Rs.5.5/Kg
- Profit per day from existing dryer: Rs.625
- Profit per day from our dryer: Rs.250

Hence our dryer,s payback period is 140 days and existing one in 480 days

Conclusion
Through this project we were able to meet the objectives which we are extracted from the study of the existing system of drying. The newly developed dryer is of 100 Kg capacity which is focused on the household purpose and the middle class farmers. The total cost for the dryer is Rs. 30000 which is one by fifth of the price of the dryer available in the current market. We were able to do this cost reduction by the redesigning of the existing by a new design. By eliminating the unwanted ducts and spaces the size of the dryer unit is reduced. By the supply of air from the chamber to the furnace for air blow we eliminated the necessity of a blower. As a whole by the proper analyzing and designing we developed a new dryer which can be afforded by ordinary consumer to meet his drying requirements

The expected areas of modifications that can be done with this dryer is on handling and type of fuel used. Instead of using the firewood, renewable energy sources such as solar can be utilized. By implementing such a change in emission of flue gases to the atmosphere can be reduced. By providing proper attachments applications like meat drying can be done with the dryer

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