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Design and Development of Humidity Controller for Prevention of Microbiological Spoilage in Vegetables

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Abstract - *Is the application of different sensors and hot air is gaining momentum in food processing. A hot air heating system was developed for drying vegetables. An Air heater boiler is used for heating of isolated cabin. In an isolated cabin, two fans are used which are connected to temperature sensors such as thermocouple and RTD. The mixing fans are used for proper circulation of hot air inside the panel and the exhaust fans is used to maintaining the temperature inside the panel. By using this system time required for drying is minimized as compared to the conventional process. We achieve the humidity level from 70% to 15% in 7 to 8 hours but the conventionally same process required 3 to 4 days*.

1. INTRODUCTION

The traditional sun drying process is common and widely embraced by all, however, the process is shown and sometimes incomplete under unfavorable climate conditions. Often the drying products are subjected to noxious effects of dust, dirt, and insect infestation. As a result of inadequacies of the open sun drying process, research efforts on drying agricultural produce have been on the increase over the years in order to develop and produce an economically effective, and systemized method of drying.

Owing to the higher level of exhaustion in the conventional energy sources such as chemical energy, thermal energy, and petroleum energy, saturated air energy is rapidly becoming the main alternative source of energy. The availability and accessibility of saturated air heat energy have greatly assisted in improving the techniques for the preservation of agricultural products.

Drying is a simple technique for preserving crops at a very low cost that might be otherwise spoilt. Although the saturated air collector is a very important component in the saturated airdrying system, much attention has not been drawn to dryer design previously. In principle, the performance of a saturated air dryer does not depends on the several operating conditions such as the climate condition, collector orientation, the thickness of the cover material, wind speed, length and depth of the collector, and the type of material used for the absorbers (ISHRE 2019) For this reason, this research has dealt with the optimization of the design, material selection, and required parameters to enhance the efficiency of the designed saturated air dryers.

2. PROBLEM DEFINITION-

Nowadays, there is a lack of awareness of the significance of humidity in our life. A suitable humidity level is needed to stabilize our environment and the world ecosystem including ourselves.

The relative humidity in the air should be monitored in order to maintain an ideal environment. Too high or too low humidity level condition can affect the quality of Fruits and Vegetables which needs extra care in dry condition all the time.

In day-to-day life, we need food products that have to be stored or preserved for more time. There are some food industries that try to preserve food items for long-term use, but these small-scale industries and agricultural poly houses cannot afford such expensive machinery for the preservation of food. Certain industries such as chickens eggs hatching or even the incubation of immature newborn chicks also need a controlled humidity condition.

Hence we would like to propose this device that can read the humidity level and the temperature in order to help us be aware of humidity conditions around us.

3. OBJECTIVES:

1. To resolve a problem related to the preservation of food in agriculture poly houses by reducing the effect of microbiological spoilage.

2. Getting more output for a unit of input. For example, reducing the energy costs of a facility.

3. Design and development of an affordable system for agricultural poly houses.

4. Maximum use of the already existing system and available material, connecting things and getting them working together.

4. METHODOLOGY -

The proposed work involves the following steps:

1. Collecting the theoretical specifications related to the problem in the plant.
2. Discussion with HVAC-based companies for finding out a solution for the obtained problem.
3. Designing the system model in SOLIDWORKS.
4. Purchasing required parts as per the requirements of the system.
5. Making the actual model.
6. Taking trial of the designed system.

5. EQUIPMENT AND INSTRUMENTS:

Air heater (air boiler):

An Air boiler was used to suck the atmospheric air with help of a blower and store it in a tank also tank will be heated by a wooden flame and the air will be rapidly heated to reach a saturated state.

MS Ducting:

Ducts are ways or passages used in heating, ventilation, and air conditioning (HVAC) to deliver and remove air. Ducts commonly also deliver ventilation air as part of the supply air. In our system ducts are used to supply air from the boiler to the dryer.

Insulated Panel:

An insulated panel is a form of thermal insulation consisting of a gas-tight enclosure surrounding a rigid core, from which the air has been evacuated. It is used in building construction, refrigeration units, and insulated shipping containers to provide better insulation performance than conventional insulation materials for resisting atmospheric air.

Fans:

In our system, two fans are required for circulating air throughout the system. The fans rotate in opposite directions to each other.

Exhaust Fan:

An exhaust fan is placed at top of the isolated system which is used to throw out the used air, which is used to maintain the temperature of the system.

IC 555:

This is an integrated circuit used in a variety of timer, delay, pulse generation, and oscillator applications. It is used as a timer.

Thermocouple:

A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming an electrical junction. A thermocouple produces a temperature-dependent voltage as a result of the See beck effect, and this voltage can be interpreted to measure temperature.

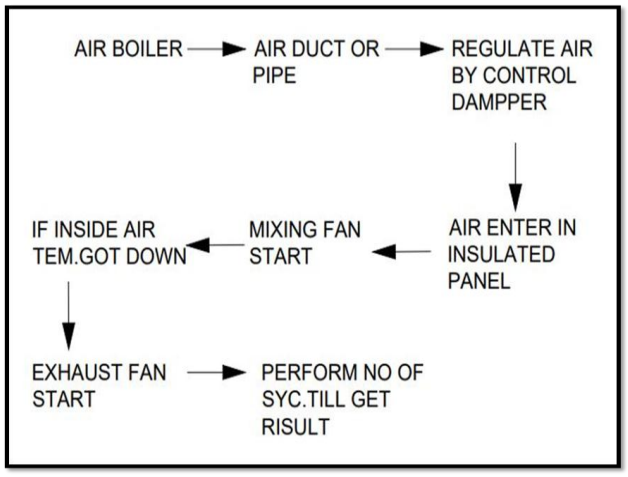
Air Damper:

An air damper is a device that is used in our system for regulating the flow of air from the duct to the isolated panel. By adjusting the damper, you can reduce or increase the amount of air entering the system.

Anemometer:

This device is used for measuring the rate of flow of air which is towards the system.

6. BLOCK DIAGRAM:



7. DESIGN OF ISOLATED PANNEL:

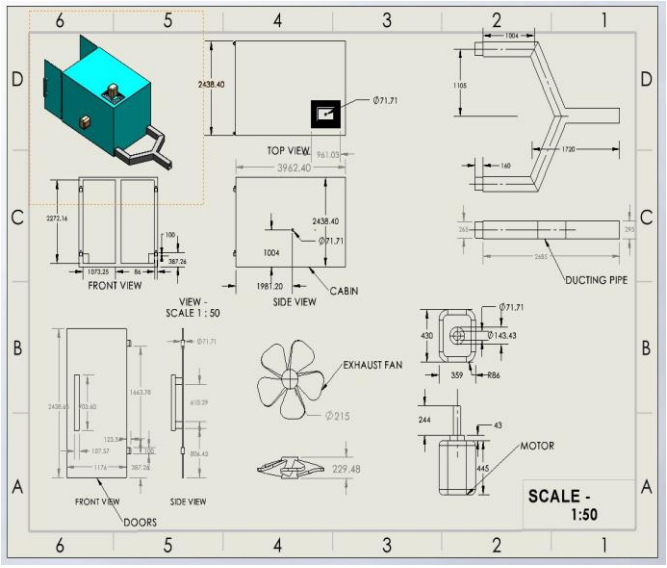


Fig- Drafted sheet of Cabin

3D MODELLING -

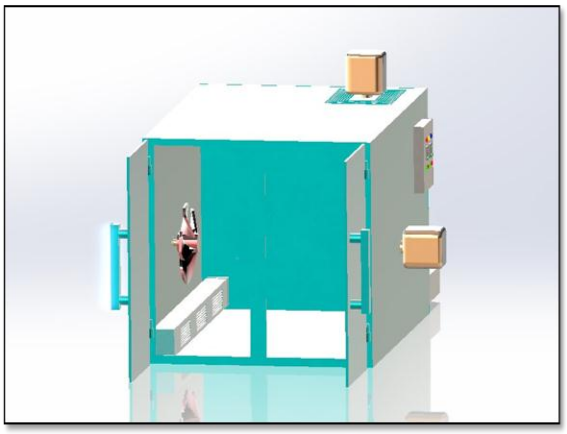


Fig- Front view of cabin

Fig- Side view of cabin

Fig -Tray

8. CALCULATION -

As per the requirement, we are designing 200 Kg material dryers in time. So they have a 40 tray having 5 Kg capacity so, we design a 13x8x8 size panel.

Using continuity equation,

$$Q = A \times V$$
$$Q = 104 \times 1200$$
$$Q = 866 \text{ CFM}$$

As per calculation required air to fulfill the volume of drier is 866 CFM

For duct design, we use the same equation,

$$Q = A \times V$$
$$866 = A \times 1100$$
$$D = 10.55 \text{ inch} \cong 11\text{inch}$$

11inch diameter converting into a square,

i.e 11 x 11 inch

also for detail calculation, we will use carrier hap for heat load calculation and duct sizer application for duct design.

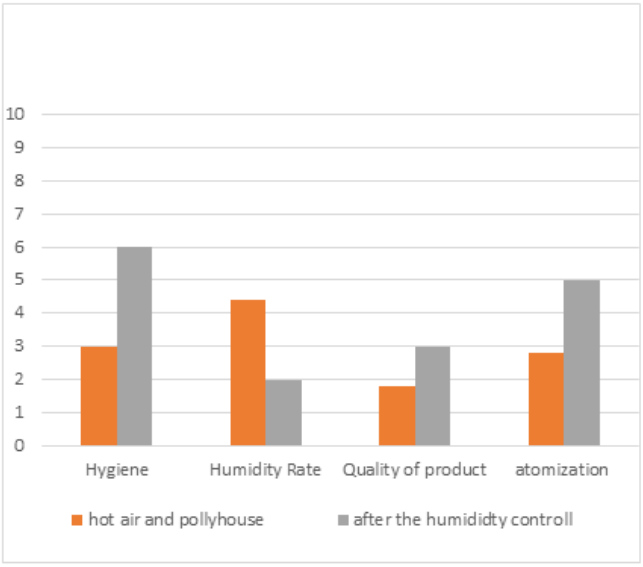
9. TRIAL AND RESULT –

WE TAKING TRAILS IN DIFFERENT WEATHER CONDITIONS

SEASON	DRYING VEGETABLE	R.H MAINTAIN	TEMP. MAINTAIN	REQUIRED TIME	RESULT
WINTER	TOMATO	45-55%	80°C	7 HR	PASS
	GINGER	45-55%	65°C	6 HR	PASS

9.1 RESULT IN THE FORM OF A GRAPH:

After the analysis of the Traditional Method of drying and after the humidity control hot air dryer we got this Result as shown below.



10. CONCLUSIONS

A hot air dryer was developed for vegetables. When processed under hot air rapidly heated the material resulting in a higher rate of mass transfer. The rate of drying time reduces and the efficiency rate increase. The developed system is easy to scale up we taking trails in different weather conditions and also the existing commercial hot air. The dryer could be suitable for modified to accommodate electric heating and drying for combination mode.

11. REFERENCES

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