Hybrid Solar - Electric Drier

Abhishek S R
UG Scholar,
Dept. of Mechanical Engineering,
PES Institute of Technology and Management,
Shivamogga-577201

Gowtham V
UG Scholar,
Dept. of Mechanical Engineering,
PES Institute of Technology and Management,
Shivamogga-577201

Dinesh Kumar Bishnoi
UG Scholar,
Dept. of Mechanical Engineering,
PES Institute of Technology and Management,
Shivamogga-577201

Swathi P
UG Scholar,
Dept. of Mechanical Engineering,
PES Institute of Technology and Management,
Shivamogga-577201

Manjunath Patel G C
Assistant Professor
Dept. of Mechanical Engineering,
PES Institute of Technology and Management,
Shivamogga-577201

***Abstract*— Areca nut is considered being the major commercial crop grown in large areas. The drying of boiled areca nut is considered as major problem during rainy season, due to cloudy weather (lack of continuous sunlight). The natural method of drying and existing dryer is found ineffective due to prolonged drying time leading to poor quality control. The main objectives is to reduce the time and produce hygienic and quality dried crop. Dried areca nut (Areca catechu) is widely used as a component of the betel leaf chewed in India. The areca nut processing industries are currently drying the nuts after boiling of nuts by open sun drying for 5 to 6 days. The moisture content of processed areca nut is reduced from 40 to 11 % during drying operation for safe storage and to maintain food quality. The results showed the system to have a capacity to increase air temperature by 15-20°C above. In addition, the organoleptic evaluation reveals that the areca nut being dried in the Hybrid solar electric dryer system was completely protected from rain, insects and dust. The dried areca nut was of higher quality in terms of flavor and color compared to open sundried product, besides saving of time.**

Keywords—Hybrid drier, Need for Areca nut drier, Working principle and construction.

I. INTRODUCTION

Solar dryers are the devices that extensively make use of solar energy to dry the substances, especially crops. Another application of solar energy is a solar dryer and it is used extensively in agriculture and other food industries like manufacturing and food processing.

Although the sun is still used as the direct source for drying food and other items in some parts of the world, it is not very effective. The solar power can be harnessed extensively for the same purpose in the form of a solar dryer.

The major drawback with open drying system is contamination, animals, birds, insects, pest sand spoilage. There is also a risk of sudden change in weather conditions like wind or rain. The sun is the prime source of heat and light focus. In the olden times, for daily activities sun was the only source of the heat and light due to the absence of electricity. With the ever growing consumption of fossil fuels and thermal electricity, there is a greater risk of global warming [1].

If we continue to use the non-renewable sources at the rate that we are using right now the future generation will not be left with many resources to rely on. All this has led us to look towards the alternative sources of power. Among all the alternatives the solar power is most reliable and renewable than any other sources [2].

Among this hydro and the wind energy is being harnessed in the recent years. But it is the solar energy that stands as favor able in the regard to its extensive availability and afford ability.

Sunlight based radiation is an elective tool acts as the solar thermal energy for drying of organic by-products, vegetables, horticultural grains and different kinds of items, for example, wood. This strategy is specifically relevant in the supposed "sunny belt" around the world, i.e. in the locales where the power of sun based radiation is high and daylight length is lengthy. It is evaluated that in developing nations there is huge postharvest misfortunes of farming items, because of absence of other conservation methods for the agricultural products. Drying by sun oriented energy is somewhat practical methodology for farming items, particularly for medium to little measures of items. It can be utilized from household to the small business estimate drying of harvests, rural materials and food products, such as organic products, vegetables, fragrant herbs, wood, and so on contributing in this way essentially to the economy of small agrarian groups and homesteads [3].

The largest amongst drying techniques is convective drying, i.e. drying by blowing warmed air flowing from the upper side besides from base side or both, or over the items. Heated air warms up the item and passes on discharged dampness to environment. In coordinate solar powered drying called ``sun drying'' the items are warmed straightforwardly by the sunlight and dampness are expelled by regular dissemination of air because of differences in the density.

II NEED FOR ARECANUT DRIER

Areca nut or Betel nut is considered as the major commercial crop grown in major areas of Shivamogga, Davangere, Chitradurga, Chikmagalur and Dakshinakannada districts. The annual production of areca nut is approximately around 279,000 Tonnes in the key areas of the state (Fig. 1). The crop usually yields during rainy season. The traditional drying process of boiled areca nut requires approximately 5-6 days (i.e. 40-48 hrs) of continuous sunlight (approximate average temperature is 35^0C) and require large area of space.

The drying of processed Areca nut is a major problem during rainy season, due to cloudy weather (lack of continuous sunlight). Further, non-uniform transfer of heat for the racks containing areca nut which are arranged parallel require tedious task for human labour to change the racks manually. Manual changing of racks containing areca nut leads to loss of heat dissipation to surroundings, energy wastage and time consuming. Thereby, a significant scope to design and fabricate the areca nut drier for agriculture use.

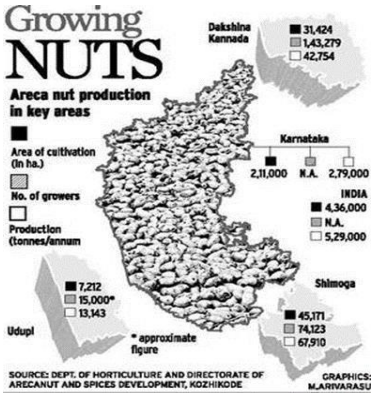

Fig.1 Growing areas of areca nut in different regions of Karnataka

III. CONSTRUCTION AND WORKING PRINCIPLE OF HYBRID SOLAR-ELECTRIC DRIER

In this process the components used are Insulated GI steel box, centrifugal blower, Dehumidifier, electric heater and Fresnel lens. From the above Fig.2 represents the working of the hybrid solar electric drier. First place the substance which is to be dried inside the heating chamber it contains number of trays. The heating chamber is insulated by GI Steel which does not allow the heat to escape from the chamber.

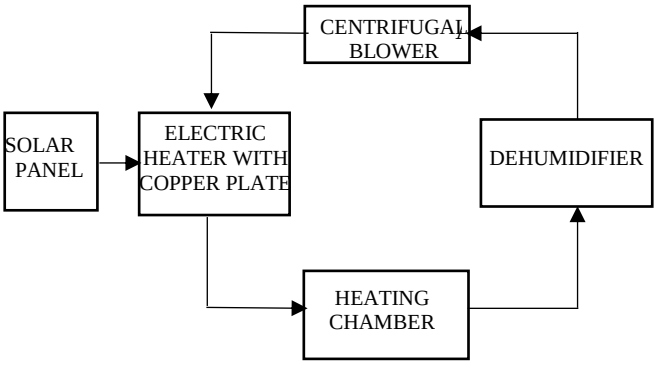

Fig.2 Schematic diagram of hybrid Solar-Electric drier

The first process is by using solar Fresnel lens to heat the copper plate. When the sun radiations fall on the Fresnel lens, it can focus light on a small spot. That light falls on the copper plate and it starts to heat the air inside the tube. Then the hot air circulates through the pipes in to the heating chamber.

The second process is by using electric heaters which is placed on the M.S tube. The copper plate is place between the two electric heaters. When the both electric heaters starts to heat the copper plate will also get heated. Then the air circulating through the pipes get heated.

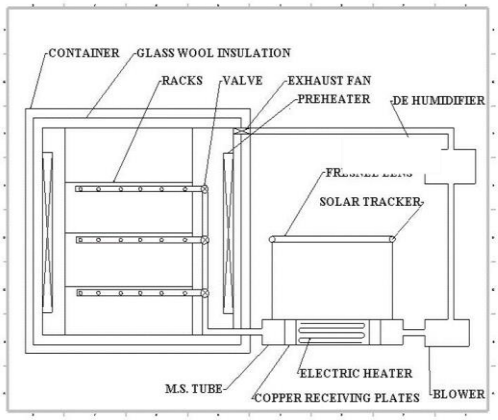

Fig.3 Hybrid Solar-Electric Drier Setup

The presence of hot air inside the chamber will removes the moisture content from the substance and settle at the top of the chamber. Dehumidifier is used to suck the moist air from the heating chamber and circulates air to centrifugal blower. Centrifugal blower receives the air from dehumidifier and re-circulate again into copper tube.

IV. METHODOLOGY

The present work is attempted to develop an energy efficient system for areca nut drying utilizing the hybrid solar and electrical energy (refer Fig. 4). The following steps are employed as discussed below,

1) The arecanut ready for plucking is separated from tree, followed by peeling the arecanut, boiling and chamber containing the racks are filled with boiled arecanut.
2) Preheater is used in the chamber to quickly attain the uniform temperature.
3) During sunny day Fresnel lens are used to concentrate the sunlight on the heating element.

4) The heating element contain fins which are projected inside the tube so as to increase the surface area to heat the air.
5) The blower attached in line to the tube, which supplies air towards heating chamber and gets heated up. The design is made 2) Preheater is used in the chamber to quickly attain the uniform temperature.

3) During sunny day Fresnel lens are used to concentrate the sunlight on the heating element.
such that the hot air from the heating chamber ensures uniform heat transfer for all the racks containing areca nut that could remove the moisture content in the areca nut.

6) Filters are also provided in line, so as to control moisture content present in the hot air (i.e. after passing the hot air through boiled arecanut which contain liquid).

7) During cloudy (less rays from sunlight) day the electric heater in the system connected to the grid current is used to heat the supplied air. so as to aid in drying the hybrid solar and electric drying system for areca nut.

4) The heating element contain fins which are projected inside the tube so as to increase the surface area to heat the air.

5) The blower attached in line to the tube, which supplies air towards heating chamber and gets heated up. The design is made

8) After conducting trial experiments, the desired flow rate of hot air is optimized with the aid of control valve for each rack containing arecanut.

9) Exhaust fan help to drive out the humid air from the closed chamber to dehumidifier for the next process of circulating fresh air.

10) Check the arecanut whether it is dried and optimize the time required for complete drying process

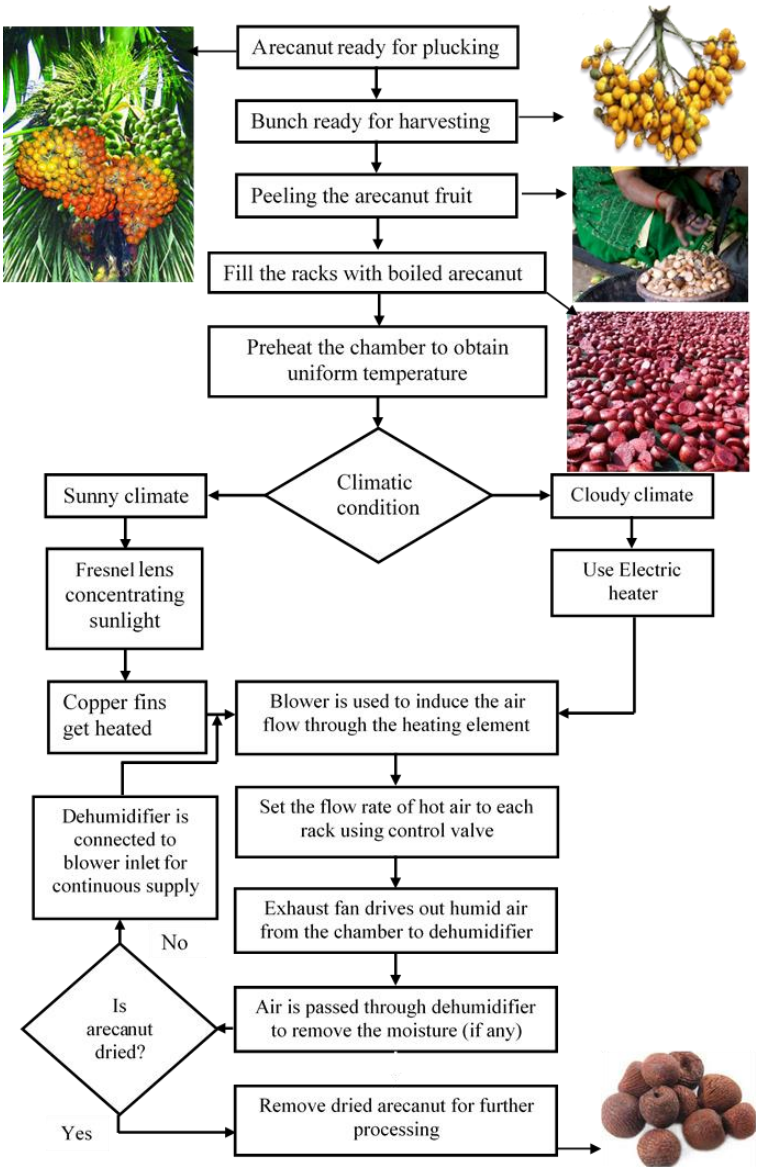

Fig. 4 Methodology employed for arecanut drying process

V. RESULTS AND DISCUSSION

The solar dryer was developed and the performance of the system was analyzed in terms of rise in temperature (refer Fig. 3). The test was carried out in hourly basis compared with atmospheric temperature (refer Table 1).

By considering the analysis based on temperature variation, focal length between the Fresnel lens and copper plate should be set correctly. So that the temperature will increase instantaneously on the copper plate. Average Maximum temperature obtained is 57°C from the solar dryer.

VI. CONCLUSION

Hybrid Solar-Electric Drier setup could help majority of our farmers to work safe, pollution free, economical and save natural resources for near future. Moreover, the solar system is designed so as to use the sun rays as heat directly during sunny day, and on cloudy day the heater in the system can be connected to the grid current so as to aid in drying the hybrid solar and electric drying system for areca nut or any other crop.

Table. 1 Temperature analysis based on hourly basis from the Solar Dryer comparing to atmospheric temperature

Day	Temperature	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM
1	Ambient	30	32	35	37	38	39	39	38	37
	solar dryer	36	46	51	55	59	61	61	58	55
2	Ambient	29	30	33	35	37	39	39	37	36
	solar dryer	33	37	47	54	57	59	58	55	52
3	Ambient	30	31	33	36	36	38	36	35	33
	solar dryer	35	44	50	53	56	59	59	55	53
4	Ambient	28	29	31	34	35	35	35	33	31
	solar dryer	33	46	45	51	54	56	55	53	53
5	Ambient	30	31	31	33	35	37	37	36	35
	solar dryer	35	46	56	58	60	63	61	58	55
6	Ambient	27	28	28	31	33	33	32	31	30
	solar dryer	31	40	47	55	56	58	59	58	55
7	Ambient	30	33	36	37	38	38	38	37	36
	solar dryer	35	45	56	59	62	63	63	59	57

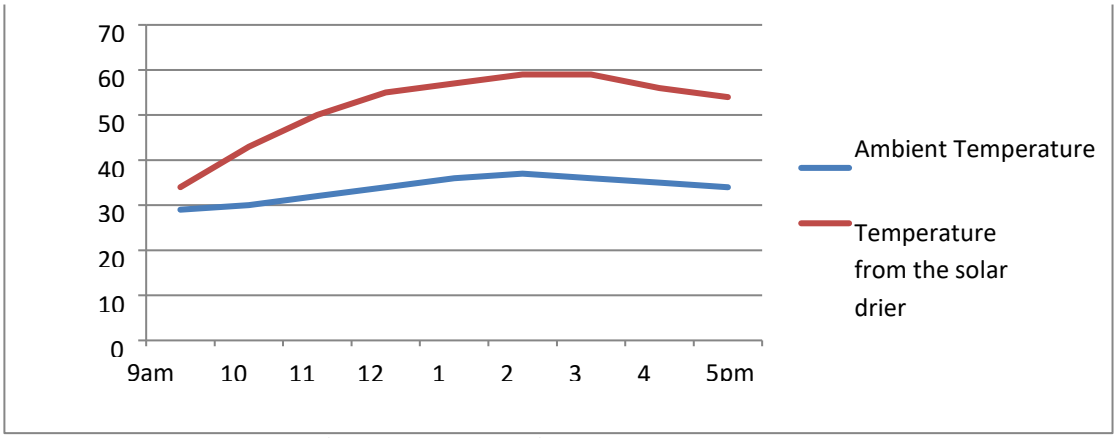

Fig. 3 graph of temperature variation of solar drier with open sun drying method

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