Portable Automated Solar Seed Dryer

Dr. Prof. M. V. Walame[1], Shraddha Dhaybar[2], *Rashmi Dhongade*[3],

Sameer Dhurate[4], Dimple Naik[5], *Divya Kamalskar*[6]

Vishwakarma Institute of technology
Department of Mechanical Engineering

***Abstract* — To dry food and other grains Solar heating systems are used it can improve the quality of the product and can minimize conventional fuels and wasted generate.**
The aim of this work is therefore focused on the design and construction of a portable solar seed dryer for drying watermelon seeds, sesame seeds, flax seeds, and jackfruit seeds.
In designing the solar seeds dryer, proper design considerations such as functionality, cost, and availability of materials were taken. The solar seeds dryer
consists of the following major components; Solar panel, Solar charging controller, Battery, and heating element: PTC heater (12V, 4 A), heat sink, and Exhaust fan.

Keywords-
Solar dryer, moisture content, solar charging controller

I. INTRODUCTION

In India, drying is one of the most effective methods of preserving food and maintaining the quality of farm products. The objective of drying is to reduce the moisture content from the product and achieve the final moisture content needed as early as possible.

The seed dryer reduces the seed moisture content to ensure its quality. Due to improper drying and storage conditions, seeds suffer from major retarding effects such as

1. Loss of viability
2. Discoloration
3. Toxin production
4. Growth of fungus

Drying is a complex heat and mass transfer process in which water is transferred by diffusion from inside the food material to the air-food interface and by convection from the interface to the air stream [3].

As compared to open-air drawing or direct compare drying methods the indirect drying methods show more advantages such showing capacity, efficiency, better humidity release, etc. [4]

Seed conservation through efficient processing and storage is important to factor Therefore seed dryers provide an efficient, user-friendly, portable, and cost-effective solution to the drying problems faced by seed processors. [2]

Objectives are

1. Utilizing solar systems for agricultural applications
2. Quickly dry the wet seeds
3. Manufacture portable solar-driven dryer for few grains
4. Designing and developing the low-cost agricultural food product dryer.

II. LITERATURE REVIEW

[5] The paper focuses on the design of solar seed dryer. The main objectives are to utilize solar

system for agricultural applications, manufacture sophisticated electronic solar driven dryer for few grains and designing and developing the agricultural food product dryer. The problem associated with present farming is to preserve the cultivated crop as many products have very small life without processing is being solved in this paper.

[6] This paper presents the design and construction of a solar dryer for drying an agricultural product. The dryer is composed of solar collector baffles and a solar drying chamber containing rack of four net trays both being assimilated together.

[7] The technical performance of the dryer was tested for drying of different grain seeds and seed quality was evaluated during the period of 2010-2011. The reflected solar radiation was 53% of global solar radiation. Uniform temperature was found all places in the drying chamber. Time required for drying of 250-300 kg of paddy, 250kg of wheat, 350kg of maize and 200kg of groundnut were found to be 17, 12, 16 and 20 hrs.

[8] The goal was to build the second-generation prototype of a grain dryer and design the rest of the system needed to dry again on a full-size operation. This system needs to be designed and fitted around a refrigeration system and components determined by the client.

[9] It focusses on the design and construction of a solar dryer for drying maize seeds. Few considerations such as functionality, cost and availability of materials taken. The solar dryer can raise the ambient temperature to a considerably high value of increasing the drying rate of maize seeds. It required 24 hours split within three days for a successful drying of the maize.

III. Methodology

Components Used-

1. Solar panel: solar panel of 18 V and 1.12 A is used for generating electricity. Solar photovoltaic panel is connected.
2. Solar charging controller: It helps in charging of battery, helps to avoid overheating.
3. Battery: Li-ion battery of 2500 mAh is used to give electricity to heating element.
4. Heating element: PTC heater (12V, 4 A) is used as heating element for dryer.
5. Heat sink: Heat sink is used to increase surface area for dryer
6. Exhaust fan: exhaust fan is used for distribution of heat in the dryer

Working-

Drying is the process of removing moisture from a product, in this case, grain. Since grain is a hydroscopic material, depending on the difference in vapor pressure, it can either absorb or desorb moisture from the air or its surroundings, causing moisture to move from one vapour pressure to the next. Grain is heated by solar radiation during the sun drying process, which raises the grain's vapour pressure over that of the surrounding air. Similar to the previous method, hot air drying begins when grain is heated (by conduction) and comes into contact with air. In heated air drying, higher velocity air flow has the advantage of lowering the grain's boundary layer, improving the grain's heat transfer coefficient, and speeding up the transfer of moisture from the grain to the surrounding air. As a result, both air temperature and air flow rate affect how quickly a particular type of grain dries.

Calculations-

Loss of Moisture-

W2= W1- (W1(M1-M2)/100-M2)

W1- weight of the undried seeds (in Kg)

W2- weight of the dried seeds (In Kg)

M1- moisture content of undried seeds

M2- moisture content of dried seeds

We have considered the weight of seeds (W1) of 0.05 Kg for each seed.

1. Pumpkin seeds

M1 = 35, M2= 4

W2= 0.05 – (0.05(35-4)/100-4))

= 0.033 Kg

2. Watermelon Seeds
M1= 12.04, M2=8.29
W2= 0.05 – (0.05(12.04-8.29)/100-8.29))
= 0.047 Kg

3. Sesame Seeds
M1=18.2, M2=6.9
W2= 0.25 – (0.25(18.2-6.9)/100-6.9))
= 0.043 Kg

I. Calculation for Amount of Heat

Cs (Amount of Heat) = W [((100-hi)/100) Cm + ((hi/100) CH2O (te-ta) + [W((hi-hf)/100-hf)] r + p

Cs – amount of heat required (Kcal)
W – inlet weight (kg)
Hi - initial moisture content (%wb)
Hf - final moisture content (%wb)
Cm – specific heat of seed (Kcal Kg^-1 –C^-1)
CH2O- specific heat of water
te- operating temperature
ta- initial temperature of product
r-latent heat of water
p-loss

1. For pumpkin Seeds
Cs = 0.05 [((100-35)/100) 0.25 + (35/100) x 0.25)] (50-27) + [(0.05(35-4) / (100-4)] 568+30
= 39.45 Kcal

2. For Watermelon Seeds
Cs = 0.05 [((100-12.04)/100) 0.47 + (12.04/100) x 0.25)] (50-27) + [(0.05(12.04-8.29) / (100-8.29)] 568+30
= 31.38 Kcal

3. For Sesame seeds
Cs = 0.05 [((100-18.2)/100) 0.47 + (18.2/100) x 0.25)] (5
0-27) + [(0.05 (18.2-6.9) / (100-6.9)] 568+30
= 33.94 Kcal

IV. Calculation of the mass of the water to evaporate

Ma = Mg [(hi-hf) / (100-hf)] x 100

1. pumpkin Seeds
Ma = 0.05 [(35-4) / (100-4)] x 100
= 1.614 kg

2. Watermelon Seeds
Ma = 0.05 [(12.04 – 8.29) / (100 – 8.29)] x 100
= 0.2044 kg

3. Sesame Seeds
Ma= 0.05 [(18.2 – 6.9) / (100 – 6.9)] x 100
= 0.606 kg

V. Heat Requirement
E= (v x d x 60 x cp x dt x SF)/ (3412 x bt)
= (450 x 0.08 x 0.24 x 60 x 80 x 1.2) / 3000
= 16.588 KW

Average Heat = 106 KC
= 443 kJ
= 0.123 Kwh
= 0.0123 KW (for 12 Hrs)

For heater
P=VI
=30W

For Cooling Fan
P = VI
= 12 x 0.5
= 6 W
= 0.006 Kw

Total Power= 0.0186 Kw
= 18.6 W

30 W – 12V – Solar Panel

A. Methodology

Heating device is heated by giving electricity supply , with the help of heat sink surface area is increased and air is spread out in the dryer equally by exhaust fan. Temperature is noted with help of temperature sensor . for electricity solar panel is used, with the help of which batteries are charged.

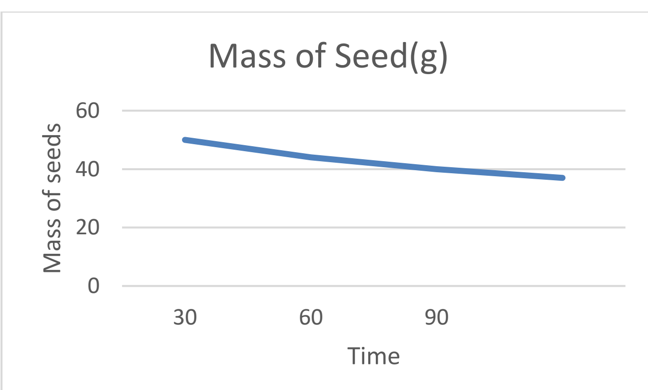
Specifications

A portable seed Dryer was designed and fabricated, with the following parameters. The drying chamber was constructed from wood (10 to 12 mm thickness) inner sides are coated with aluminum foil (13-micron thickness) having the overall dimension of **16’’×16’’×12’’**. One tray with stainless steel net (**diameter 11’’**) were provided inside the drying chamber for loading the seeds to be dried. The dryer is equipped with heating element (12V, 4 A) an axial flow fan (**85 CFM),**

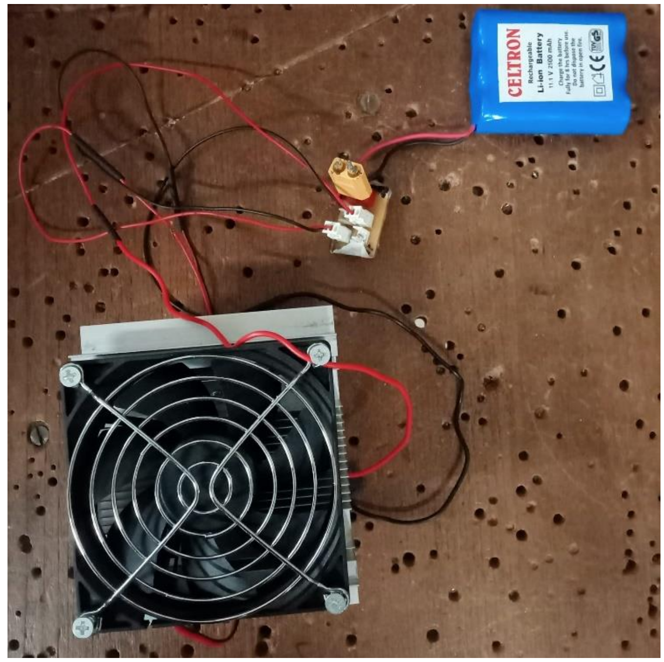
B. Testing

Testing of dryer was performed on pumpkin seeds weight of the seeds was checked after particular time interval. Results are as follows:

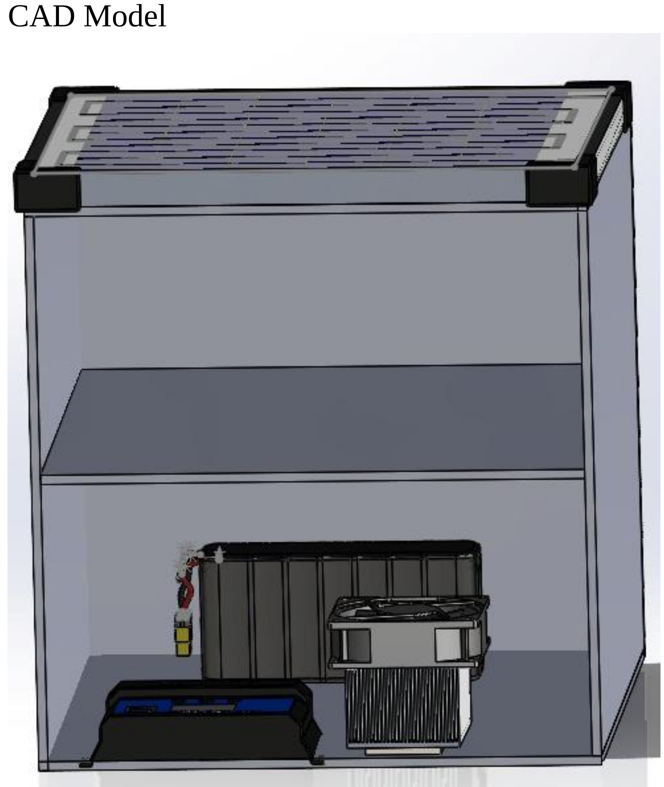
Mass of Seed(g)	Time (min)
50	0
44	30
40	60
37	90



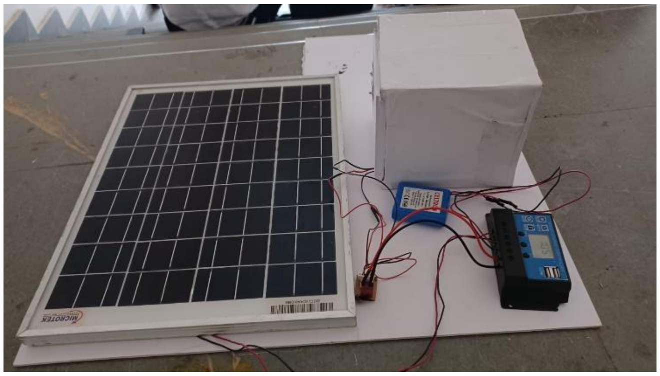
C. connection



CAD Model



Prototype



D. Costing

To Manufacture the part we had bought the components as follows

1. Solar panel: Rs. 2250.00
2. Heat sink : 100
3. Battery : 650
4. PTC heater(912V,4A): 299
5. Exhaust Fan : 380
6. Solar charging controller: 666
7. External cost: 500
8. Total cost: 4900

IV. Results and Discussions

At the starting, water removal rate was faster so less time was required. as time proceeds water content decreases and drying becomes slow.

V. Conclusion

solar seed dryer eliminates problem of large space for drying seeds. final dried products will not have problem of fungi or will not easily decay. we can preserve pharmaceutical characteristic and nutrition of seeds through dryer.

References

[1] MARKET OPPORTUNITIES FOR SOLAR DRYING Ronald G.J.H. Voskens, P.G. Out and B. Schulte Solar thermal, Ecofys energy and environment, P.O. Box 8408, Utrecht, 3503 RK, The Netherlands, +31 30 2808316, +31 30 2808301

[2] SEED DRYING J.P.Lakhani R. Shiv Ramakrishnan Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur

[3] Xiao-Kang Yi, Wen-Fu Wu, Ya-QiuZhang, Jun-Xing Li, and Hua-Ping Luo, “Thin-Layer Drying characteristics and Modeling of Chinese Jujubes”, Hindawi Publishing Corporation Mathematical Problems in Engineering, Article ID 386214, Volume 2012.

[4] 2017 International journal of system science and engineering, Improvement of Conventional Solar Drying System Nguyen Vu Lan.

[6] Mohammed Shadab, Sayed Irfan Mastan, Shah Mo Tarique, Shaikh Mohammed Shoeb Ahmed, Prof.S.S.Suman, “Design and Modification of Solar Seed Dryer”.

[7] Prof.Pravin M.Gupta, Amit S. Das, Ranjit C. Barai, Sagar C. Pusadkar, Vishal G.Pawar, “Design and Construction of Solar Dryer for Drying Agricultural Products”.

[8] Md Salleh HJ. Hassan, M.A.Hossain, “Development and Performance Evaluation of Hybrid Dryer for Quality Grain Seeds”.

[9] Joseph Vanstrom, Jacek A Koziel, “Building of a Prototype Grain Dryer”.

[10] Sule Salisu, Akene Alexander, Oghenevwaire Iyabo Seyefa, “Design and Construction of Solar Dryer for Drying of Maize Seeds”.