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Development of Solar Dryer System For Seed Drying Purpose with Automatic Heat Lamp using XH W1209 12V Digital Temperature Controller

Lokesh Sapkale[1], Sandeep Ghodake[2], Vyankat Shinde[3] , Vitthal Yede[4], Sambhaji Gavali[5], Prof. Vijay Kharade[6]

[1,2,3,4,5] BE Students, Dept. of, Mechanical Engineering, JSPM Jaywantrao Sawant College Of Engineering, Pune, Maharashtra, India
[6] Professor, Dept. of. Mechanical Engineering, JSPMs Jaywantrao Sawant College Of Engineering, Pune, Maharashtra, India

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Abstract - *Small-scale farmers cannot afford large fully automated controllers found on the majority of dryers now in the market. As a result, as mechanical engineers, our job is to reduce the amount of labor required for manual drying of seed. To this end, this study emphasis a construction of a solar grain dryer project that reduces labor requirements while increasing productivity, dependability, efficiency, and utilization of resources. The design and development of a solar seed dryer with an integrated external heat lamp, specifically designed to tackle the difficulties presented by wet and cold seasons, is shown in this paper. A XH W1209 12V Digital Temperature Controller Module is integrated into the system to precisely regulate temperature, guaranteeing ideal drying conditions for seeds. Furthermore, a conveyor system with a motor enables effective seed extraction when the drying process is finished. This inventive dryer provides a sustainable way to improve seed preservation and productivity even in bad weather by using solar energy augmented by an external heat source and cutting-edge temperature control technology.*

Key Words: Solar Seed Dryer, Heat Lamp, Temperature module, Conveyor Mechanism.

1. INTRODUCTION

Spreading the food out and putting it outside in the sun are the traditional techniques of drying food. Sun drying is an excellent method for modest amounts of food. The amount of food required for sun drying increases with its quantity, and because it is exposed to the elements, it is readily polluted. Consequently, one of the main reasons sun drying larger amounts of food is difficult is because it gets harder to monitor and keep an eye on things as the amount of food increases. [1]

1.1 Proposed System

The design and development of a solar seed dryer with an external heat lamp, temperature control using the XH W1209 12V Digital Temperature Controller Module, and a conveyor mechanism for seed extraction are essential in areas where wet and winter seasons present difficulties for seed drying processes. The goal of this integrated system is to lessen the negative effects of bad weather on the preservation and effectiveness of seed drying. The dryer achieves ideal drying conditions by using solar energy supplemented by an external heat source and using precise temperature regulation. At the end of the drying cycle, the conveyor mechanism improves the effectiveness of seed extraction. By using less non-renewable energy, this creative method not only solves the seasonal constraints but also encourages sustainable agriculture practices.

1.2 Problem Statement

The challenges of manual seed drying include uneven moisture removal and inconsistent drying rates, which can result in mold formation and decreased viability of the seed. When seeds are dependent on the weather, they are subject to variations in humidity and temperature, which lengthens the drying process and raises the possibility of spoiling. The risk of over- or under-drying is further increased by manual methods' imprecise monitoring and control of drying parameters including temperature and airflow. Furthermore, manual drying methods' labor-intensiveness raises production costs and restricts scalability, which reduces the effectiveness of seed processing activities. These drawbacks collectively highlight how crucial it is to have automated and regulated drying systems in order to maximize seed quality and raise agricultural output.

1.3 Aim &Objective

1. To study automation as per time required for food dryer.
2. To manufacture sophisticated electronic solar driven dryer for few grains.
3. Reduced time required for food dryer.
4. To study different mirror and check the difference in temperature.
5. To Design and develop an agricultural food product dryer which can be able to do dryer operations carried out in agricultural field.

6. To control of this dryer, we used controller and energy required to run this system we take from solar panel.
7. To propose a low cost but effective real time dryer system.

1.4 Scope

The possibilities are endless when it comes to designing and creating a solar seed dryer with an external heat lamp for wet weather and winter, temperature control via the XH W1209 12V Digital Temperature Controller Module, and a conveyor system for extracting seeds. This project promotes sustainable farming practices by providing chances to improve seed preservation and productivity in areas impacted by unfavourable weather. The dryer can lessen the difficulties associated with manual drying procedures by utilizing cutting-edge temperature control technologies and renewable energy sources, guaranteeing reliable and effective seed drying. Conveyor mechanism integration also simplifies seed extraction, saving labour expenses and increasing operational effectiveness. Beyond a single farmer, the potential influence could contribute to greater food security and economic growth. Thus, this project has the potential to transform seed drying procedures and solve agricultural problems in many environmental settings.

1.5 Methodology

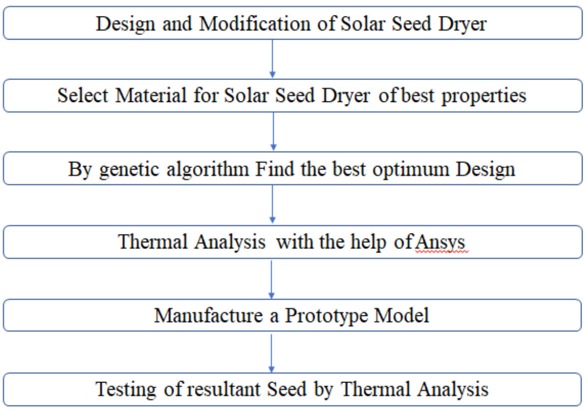

Fig -1: Methodology

2. LITERATURE SURVEY

Effectiveness of the solar biomass hybrid drier by A. Bosomtwe, J.K. Danso, E.A. Osekre, G.P. Opit, and G. Mbata for drying and disinfestations of maize

This essay investigates Because they are generally efficient and reasonably priced, most smallholder farmers in the developing countries prefer to employ insecticides for controlling insect pests. However, there are disadvantages to chemical disinfestations, including the emergence of resistance, worries about worker safety, customer concerns about chemical residues in food, and other environmental issues. Farmers' indiscriminate use of phosphate has led to control failures, pest resistance, and human mortality.

By J. Schemminger, D. Mbuge, and W. Hofacker, Ambient Air Cereal Grain Drying: Simulation of the Thermodynamic and Microbial Behavior

An accurate model to predict the drying behavior has been developed by examining the thermodynamics of ambient air cereal drying processes. Additionally, the development of microorganisms and the generation of toxins have been studied independently. Without the need for expensive, time-consuming tests, the combination of the thermodynamics and biological models enables the description of grain drying processes at room temperature with the goal of preservation. In terms of thermodynamic and microbiological behavior during continuous drying processes, the model's applicability has been confirmed by the agreement of simulated and experimental data. When the amount of maize within the bin dryer was compared between half and entirely filled, the simulation on low-tech bin dryers revealed a production of toxins that roughly doubled during the drying process.

3. Proposed System

The design and development of a solar seed dryer with an external heat lamp, temperature control using the XH W1209 12V Digital Temperature Controller Module, and a conveyor mechanism for seed extraction offers many benefits over manual seed drying methods, even though they may be simpler and require less initial investment. First off, unlike human techniques, which increase the risk of mold growth and seed spoiling, the automated system guarantees uniform drying temperatures. Accurate temperature control also improves the viability and quality of seeds, which maximizes agricultural output. Incorporating renewable energy sources lowers operating expenses while advancing sustainability. Moreover, the conveyor system increases overall efficiency by streamlining the extraction of seeds and reducing the need for workers. In the end, even though manual seed drying is possible, the solar seed dryer's cutting-edge automation and technology offer better results, scalability, and long-term advantages for farming operations.

3.1 Working

The following is how the XH W1209 12V Digital Temperature Controller Module, an external heat lamp for wet and winter months, a conveyor mechanism with a motor for extracting seeds, and temperature control work together to create the solar seed dryer: In order to maintain ideal drying conditions during bad weather, an external heat lamp is added to the dryer's solar panels, which collect sunlight. The internal temperature is precisely controlled by the XH

W1209 12V Digital Temperature Controller Module, which guarantees exact control over the drying process. The conveyor belt is used to load seeds and move them through the drying chamber. The conveyor mechanism allows for consistent exposure to heat and wind while the seeds dry. The seeds are extracted by the motorized conveyor once they have dried, guaranteeing prompt and effective removal. This integrated system provides a sustainable solution for agricultural processing under a range of environmental circumstances, maximizing seed preservation and production.

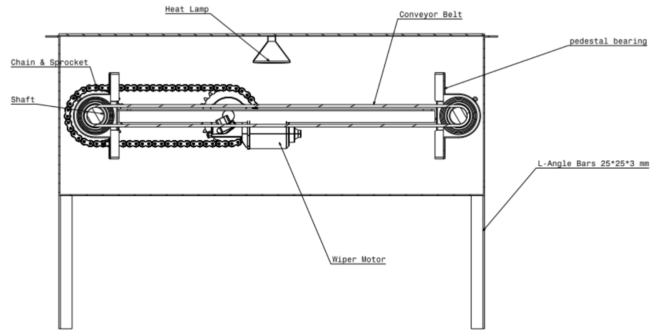

Fig -2: Schematic Working 2D Drawing

3.2 Design

Designing a solar dryer with a heat lamp for grain drying in CATIA V5 involves creating a detailed model that considers various components such as the drying chamber, heat lamp, reflectors, and supporting structures. Below are the general steps you can follow:
Steps for geometry creation

1. Open CATIA V5:
2. Sketch the Solar Dryer Structure:
3. Design the Drying Chamber:
4. Add Transparent Cover (Optional):
5. Incorporate Reflectors:
6. Model the Heat Lamp:
7. Position Components in Assembly:
8. Connect Components:
9. Add Support Structures:
10. Consider Airflow:
11. Add Control Mechanism (Optional):

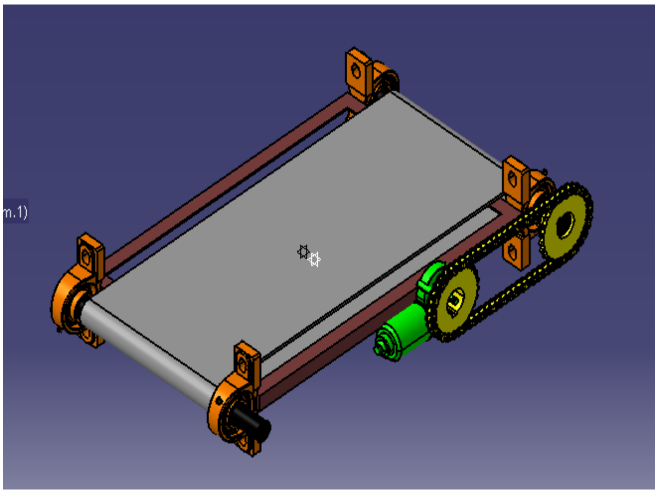

Fig -3: Conveyor System with Bearing, Wiper Motor, Chain Sprocket, and Shaft & L-angle bar

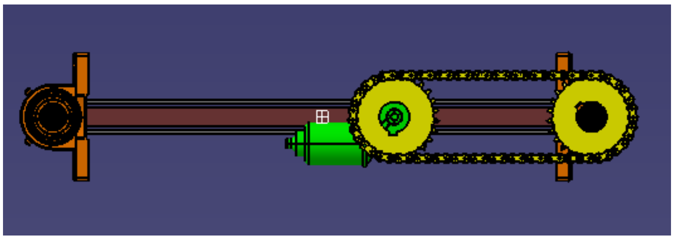

Fig -4: Side view of Conveyor system

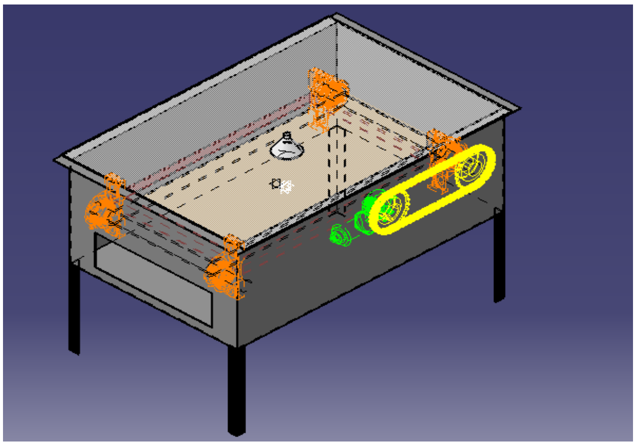

Fig -5: ISO View of Solar Dryer System

3.3 Calculations

3.3.1 Material = C 45 (mild steel)

Take fos 2

$$\sigma t = \sigma b = 540/fos = 270 \text{ N/mm2}$$

$$\sigma s = 0.5\, \sigma t$$

$$= 0.5 \times 270$$

$$= 135 \text{ N/mm2}$$

3.3.2 Motor Calculation

Power of motor = 20 watt
Rpm of motor = 30 rpm
Calculation For Final Speed & Torque

$$P=2\pi NT/60$$
$$20=2\pi x30xT/60$$
$$T = 6.36 \text{ N-m}$$
$$T = 6365 \text{ N-mm}$$

3.3.3 Design of shaft

Now, T2is the maximum torque among all shafts, so we will check shaft for failure here.

$$T=(\pi \, \sigma s \, d^3)/16$$
$$6365=(\pi \, 135 \, d^3)/16$$
$$T = \pi/16 \times 135 \times d^3$$

d = 6.21 mm
3.2 mm welding clearance
But we are using 20 mm shaft, so our design is safe.

3.2.4 Design of bolt for sheer stress failure: -

$$\sigma=P/A$$
$$A=\pi/4d2$$
$$A=\pi/4 \; 82 = 49.98$$
$$P=135x49.984$$
$$P = 6747.84 \text{ N} = 687 \text{ kg}$$

The calculated load is much higher than any applied load, hence our design is safe.

3.2.5 Design of transverse fillet welded joint.
Hence, selecting weld rod size = 3.2mm

Area of Weld = 0.707 x Weld Size x L

= 0.707 x 3.2 x 25
= 56.56 mm2

Force exerted = ---N
Stress induced = Force Exerted / Area of Weld
21 = F / 56.56
F= 1187.76 N = 121.07 kg

3.3.5 Calculation of frame

Let the total weight (P) of our machine be 20 kg, now this 20 kg
Weight is kept on four angles,

$$P = 20 \text{ kg.}$$
$$P = 20 \times 9.8 = 200 \text{ N.}$$
$$L = 350 \text{ mm.}$$
$$M = WL/4 = 200 \times 350/4$$
$$= 17500 \text{ N-mm}$$

Section of modulus = Z= $B^3/6 - b^4/6 \times B$
Z= $20^3/6-17^4/6\times20$ = 1333.3-696.4
Z= 638 mm^3
Bending stress = M/Z = 17500/638 = 27.42 N/mm^2

3.3.6 Design of Sprocket

Distance between sprocket center and piston center = 20mm
Dia. Of small sprocket,
Periphery = π × dia. Of sprocket
10(teeth) × 6.35(pitch) = π × D
D= (10*6.35)/π

D = 20.21 mm

3.4 Proposed Modal fabrication

First, the dryer's framework is built, including locations for the external heat lamp and solar panel attachment. After that, the drying chamber is put together, making sure it has insulation and ventilation to maximize drying effectiveness.

To precisely control the interior temperature, the XH W1209 12V Digital Temperature Controller Module is then inserted and calibrated. The motor is positioned to provide smooth seed extraction, and the conveyor mechanism is integrated into the system.

The solar panels, heat lamp, temperature controller, motor, and any other sensors or actuators are connected to the electrical system. In order to guarantee optimal functioning and performance, the complete system is tested and optimized. The result is a sturdy and effective solar seed dryer that can function even in inclement weather.

Fig -6: ISO fabricated view of Solar Dryer System

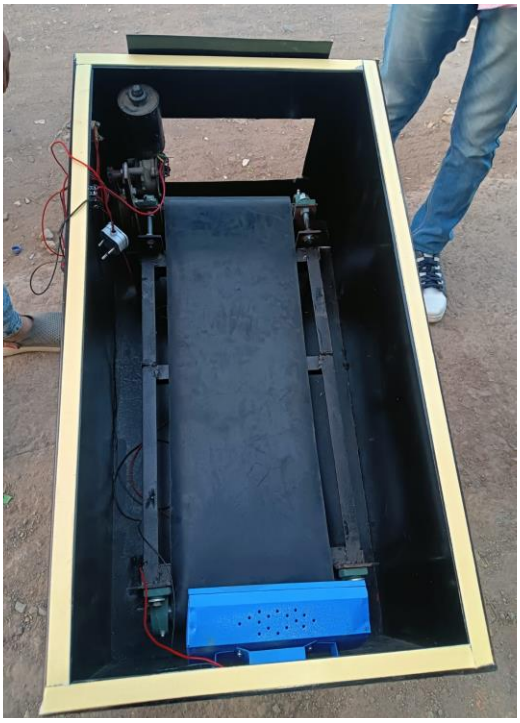

Fig -7: ISO fabricated view of Solar Dryer System top

4. CONCLUSIONS, FUTURE MODIFICATION & COST ESTIMATION

4.1 Conclusion

With this integrated system, you can optimize seed preservation and quality while assuring constant and efficient seed drying—a sustainable response to the challenges presented by unfavorable weather. The dryer solves the drawbacks of manual drying techniques by using solar energy in conjunction with an external heat source and precise temperature regulation. This promotes increased production and sustainable agriculture practices. Conveyor mechanisms reduce labor needs and boost overall efficiency by streamlining the drying process even further. All things considered, this creative solution has great potential to transform seed drying procedures and support food security and economic growth in a variety of environmental circumstances.

4.2 Future Modification

First off, adding smart sensing technologies could make it possible to monitor the dryer's surroundings in real time and make automatic modifications to optimize the drying parameters. Including energy storage devices, such batteries or capacitors, may also make the dryer more resilient to variations in solar energy availability, guaranteeing continuous operation even in the absence of direct sunshine. Additionally, investigating the usage of alternate heat sources, including waste heat recovery systems or biomass, could improve the dryer's sustainability and efficiency even more. Lastly, farmers may be able to remotely monitor and control the drying process by utilizing IoT (Internet of Things) technology, which would increase convenience and flexibility. The goal of these upcoming changes is to significantly improve the solar seed dryer's sustainability, dependability, and efficiency in order to increase agricultural productivity and resilience to shifting environmental conditions.

4.3 Cost Estimation

Sr. No	*PART NAME*	*MAT*	*QTY*	*COST*
1.	*12v Heat Lamp*	*STD*	*1 NO*	600
2.	*Glass*	*STD*	*1 SQM*	300
3.	*Angle Frame*	*MS*	*6 KG*	1100
4.	*Sheet Metal*	*MS*	*2 SQM*	1200
5.	*Chain Sprocket*	*STD*	*1 SET*	950
6.	*Spray Paint*	*STD*	*1 NO*	350
7.	*Temperature Sensor Controller Module*	*STD*	*1 NO*	300
8.	*Wiper Motor*	*STD*	*1 NO*	1750
9.	*Shaft*	*STD*	*2 NO*	945
10	*Belt*	*STD*	*1 NO*	475
11.	*Miscellaneous*	–	–	1500
9.	*Total*			5500

Fig -8: Cost Estimation

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