DESIGN AND FABRICATION OF LOW COST FOOD GRAIN DISINFESTATION SYSTEM

PROJECT REFERENCE NO.: 40S_BE_1770

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Keywords: Solar energy, Food grain, Moisture, Disinfestation.

Introduction:
Issues such as rapid urbanization and environmental pollution, and urbanization are causing agricultural land to reduce day by day. The yield is twice or thrice a year but consumption is continuous and is ever increasing. Losses are high in food grains due to insects, rodents and moisture etc during storage. Produce gets spoilt during various stages such as while seeding, growth, harvest and storage. It is found that, about 30% of this spoilage occurs during the storage of the produce. Solar energy, which is abundant in nature, can be economically employed for disinfection of food grains. The main advantage of this system is that the food grains are not treated chemically and are only exposed to sunlight, which heats up air in the machine thus heating and disinfecting the grains. This system will help the farmers, food processing industries and agriculturists in preservation by disinfesting and drying of food grains by removing moisture at low-cost, and is energy efficient. Disinfection or disinfestation is a classical method of food preservation, which provides longer shelf life and lighter weight for transportation and small space for storage. In this method, microbes are killed and moisture content is reduced (which would support the microbial activity), by using means such as heat, ultraviolet rays, or microwaves.

Objectives:
Objectives of this project are as follows:
- To attain disinfection by reducing moisture using solar energy, and hence the pathogens present, to obtain optimum results.
- To determine optimum exposure time, required temperature and rate of travel of food grains for disinfestation of food grains.
- To reduce the equipment cost, and make it affordable to the farmer.
- To reduce the time required for disinfecting the grains, and also make it user friendly.
- To analyse the results obtained and present the outcome of the experimentation.

Methodology:
Initial literature survey was carried out by referring to different journal papers to understand ideas incorporated by others in the agricultural field of disinfestation. Problem was defined and a detailed model was developed. Design was based solar water heater of 100lpd.
configuration and detailed drawings were prepared using Unigraphics NX 10.0. Fabrication process involved different materials, according to design specifications. The first to be fabricated were the copper trays (24G). Edges were brazed to avoid leakage, and tray was painted black. The second material was galvanized iron (24G), used for fabrication of hopper, hopper feeder and grain collector. GI is food grade and economical comparatively. Next was MS sheet metal work (1mm thick). Sheet metal components such as collector body, fan mounting, etc were cut in a CNC plasma cutter, and folded in NC machines. L angles and flats were welded on for strength. Auxiliary fittings were welded on. Frame was fabricated according to the design by using 40*40 MS square pipes. Electrical work for exhaust fans and electronical wiring for vibrator motors were done. The machine was assembled as in design, tested and any issues that arose were sorted out. Trials were done and tabulation of results was done along with analysis. The trials involved different grains, and their temperature, and moisture content, before and after the tests.

**SCHEMATIC DIAGRAM AND WORKING:**

Grains, fed through hopper, flows down onto the five copper trays, in a zig-zag fashion, as they are inclined, assisted by vibration. Exposure to sunlight heats up copper trays, enclosed within the sheet metal body and toughened glass on top and reach high temperatures. Exhaust fans (two in number) creates flow of air from bottom to top, which is also heated similarly. The combined heating by convection (counter flowing air), conduction from copper trays and direct solar radiation, removes the moisture, which is carried out by the flow of air and also microbes are killed.

**Results & conclusion:**

It can be seen from experimental data that moisture is removed in a shorter interval of time, compared to the conventional sun drying. It can also be seen that good amount of temperature is obtained on copper trays, even with moderate amount of sunlight. Grain Moisture Meter and IR camera were used for testing. This is also indirectly shown by loss of weight of the grains. Micro organisms are also killed due to the heat. Various parameters are plotted to understand the results graphically.
Conclusion:
The equipment discussed is a cost effective method, which uses minimal amounts of electrical energy. This equipment can be effectively used, even in cloudy conditions. The application of counter flow principle and insulation used makes the equipment more efficient. If the moisture removed is not sufficient, then the flow rate of grains or air can be varied, or multiple passes can be used to obtain the required moisture content. Lack of chemical processes involved, can make the food safer for consumption.

![Graphs showing temperature variation and incident radiation vs time of the day](image)

<table>
<thead>
<tr>
<th>Sl #</th>
<th>Grain type</th>
<th>RH before drying</th>
<th>RH after drying</th>
<th>Weight before drying (gms)</th>
<th>Weight after drying (gms)</th>
<th>Drying time in (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rice</td>
<td>13.4</td>
<td>11.2</td>
<td>150</td>
<td>145</td>
<td>62</td>
</tr>
<tr>
<td>2</td>
<td>Paddy</td>
<td>9.4</td>
<td>8.9</td>
<td>150</td>
<td>146</td>
<td>28</td>
</tr>
<tr>
<td>3</td>
<td>Whole Bengal Gram</td>
<td>13.1</td>
<td>12.8</td>
<td>240</td>
<td>232</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Split Bengal Gram</td>
<td>5.7</td>
<td>5.5</td>
<td>254</td>
<td>250</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Maize</td>
<td>30.4</td>
<td>26.5</td>
<td>200</td>
<td>154</td>
<td>68</td>
</tr>
<tr>
<td>6</td>
<td>Hyacinth Bean</td>
<td>7.5</td>
<td>7.4</td>
<td>255</td>
<td>250</td>
<td>47</td>
</tr>
<tr>
<td>7</td>
<td>Wheat</td>
<td>11.8</td>
<td>11</td>
<td>1000</td>
<td>995</td>
<td>40</td>
</tr>
<tr>
<td>8</td>
<td>Soya beans</td>
<td>10</td>
<td>9.8</td>
<td>200</td>
<td>198</td>
<td>25</td>
</tr>
</tbody>
</table>

Scope for Future work:
This project can be further automated to achieve higher accuracy and the outputs can be displayed digitally. More effective mechanism for flow of food grains can be introduced. Cost of the copper trays can be reduced by redesigning the trays, and leakages of air and heat may be further minimized. Temperature can be controlled to an extent, by controlling the amount of sunlight through glass, using a cover. The application may be extended to dry food items other than grains, such as grapes, chilies etc. Heat can be further utilized by storing it in the chamber, by using specialized material beds. An auxiliary heating source can be provided, to be used in absence of sunlight. Solar cells can substitute for electricity used. Further process of removing dead microbes, and cleaning of grains, may be provided with the equipment.