

Solar Powered Rice Puffing Machine

Sujan K S, Madhusudhan



Abstract- Today our Earth is facing severe problems such as global warming, air pollution and ozone layer depletion etc. One of the reasons for this problem is increased usage of fossil fuel in the recent years by humans. The renewable source of energy hence turns out to be indispensable source of energy for the present and future generations. Solar energy is one of the renewable sources of energy which can be used for various applications. The newly designed rice puffing machine is likewise powered by solar energy. The solar powered rice puffing machine is designed and developed based on the general principle of rice puffing method. Solar rays are collected from open area using solar panels and used to charge the battery thus converting the solar energy into electricity which powers the rice puffing machine. The main aim of the project is to reduce the human effort and number of labours required involved in the rice puffing process. Mechanical energy of the motor is used to drive the shaft which is welded with mesh. The rotational movement of the shaft accomplishes the mixing of rice with hot sand to puff the rice. The electric blower flushes out the puffed rice. The heat energy required to heat the sand is provided by Bio-Gas operated burner.

Keywords- Bio-Energy, Design and Fabrication, Rice Puffing, Solar Energy

I. INTRODUCTION

Puffed rice making industry is one of the largest food preparation industries owing to high demand as a snack food. One of the rice puffing methods includes roasting the raw rice manually in a hot sand bath in a large steel vessel. Production of puff rice is occupation for many families in village regions who depend on this job to earn their livelihood. Many giant machineries are available to produce puffed rice in large quantity but it isn't affordable by all because of high cost involved.

The intention of the project is mainly to apply mechanical advantage on the present food preparation process and to provide convenience on both physical strain as well as health of the worker. Presently the manual process includes the firewood or wood shavings as source of heat [1]. Bearing the smoke and heat produced during rice puffing process is one of the greatest challenge for the worker.

produced by easily available manure, kitchen waste and agricultural waste etc. Since the machine is designed to operate with Bio-gas as source of fuel to heat, hence no harmful emission produced as that of conventional fuel.

The Bio-gas apparatus is commonly available in every house of village. Machine is designed to avoid the problems mentioned above and to provide the eco-friendly machine at much lower cost than the present machines. The gas is Everyday production of puffed rice is a must work to earn one's living. This process requires three workers to accomplish the different jobs such as pre-heating the raw rice in the meantime pouring the salt water, withdrawing the pre-treated rice and dropping it into the hot sand bath. These jobs cannot be handled by single person simultaneously, hence the intention is to reduce the number of labours which ultimately increases profit. The next challenge faced by workers is to sit in front of the furnace that releases heat waves as well as smoke which is harmful for the health of the worker. The newly designed rice puffing machine can avoid interference of worker closer to the fireplace and exposure to harmful smoke. The machine is smaller in dimensions hence portable. The main objectives of the project are to design a compact and portable domestic product and to find solutions to improve the productivity of the machine.

II. EXISTING METHODS TO PUFF THE RICE

There are different ways to produce the puffed rice. Each method is different from one other and has a unique process. Some of the methods of rice puffing process are listed below.

A. Puffing by Hot Sand Bath:

Here the sand is heated in a large wok up to 200-220°C. Usually the rubber wastes, rice husk and wooden wastages are used as fuels. The rice is puffed within a short span of 10-12 seconds after being roasted in that hot sand. Later the sand and puffed rice are bifurcated. The packed puffed rice is sent out. This is the conventional method practiced in India from time immemorial.

B. Puffing by Cannon Gun

Here a pressure chamber made of steel is heated enough. Later the treated whole rice grains are placed in a sealed vessel, with steam. Once the seal is broken the entrained steam flashes and bloats the endosperm of the substance. Then comes the largened puffed rice. The high volume of booming sound of release of the pressure declares the completion of the process. The packing is done to market it. This process is normally seen in Japan & China [2].

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C. Puffing by Machine

It is an advanced process. The worker doesn't have to face the heat of the furnace. The machine is pretty huge which consumes a good space of the room. Here, a cup conveyor carries the grains into a small cylinder. The salt water is sprinkled there. The rice is next moved to a rotating cylinder filled with heated sand. The rice gets puffed by surpassing the hot sand. A sieve puts the sand and grains out. Later rice is separated and collected.

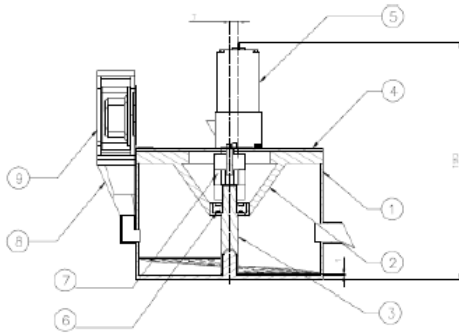


Figure 1: Design of the prototype of rice puffing machine.

Components: 1- container, 2- stirrer mount, 3- stirrer, 4- lid, 5- motor, 6- bearing, 7- coupling, 8- blower duct & 9- blower.

The Working Mechanism of Prototype:

Container: The container is the central part of this equipment in which the whole process of puffing the rice grains is performed. The stainless steel, copper, aluminium, cast iron are the few varieties of food grade materials available in the market. Stainless steel of grade 304 was selected based on its properties [2].

Heating medium: Here the conventional sand is replaced by salt because salt is heat producing is more in salt. Besides the salt is better agent when it comes to output and hygiene.

Heating coil: Heating coil is used as a medium to attain the required warmth. Heating coil is selected in matching with the design and dimension of the container. Here the dimensions of the bottom plate are: Diameter = 150 mm, Area = 0.01767, Thickness = 2 mm.

Motor: Here the brushless DC geared motor is selected. Typical brushless motor uses a rotating permanent magnet in the rotor and stationary electrical current/coil magnets on the motor housing for the stator. Similarly the symmetrical opposite is also possible. A motor controller converts DC into AC. This design is simpler than brushed motors. As per the requirement calculations KGC3448 geared motor is selected which meets the requirement as closely as calculations.

Blower: A centrifugal blower of small size is selected. These blowers help increasing the speed of air stream with the rotating impellers. They use kinetic energy of the impellers or the rotating blade to increase the pressure of the air stream. It also moves them against the resistance caused by ducts, dampers and other components. They are muscular, quite, trustworthy and competent of operating over a wide range of conditions. BCB 30-4-12D 3000rpm, 3.36W, 12V DC, 0.28 Amps is selected.

Working Principle of Prototype:

The fundamental principle of this device is producing the puffed rice. The stirrer shaft & container are press fixed with shaft pin is placed in the bottom of container, inside. The stirrer mount ends are locked in the grooves which are present on the circumference of container, now the shaft and container are fine fit. Lid is closed after filling the salt to the level of stirrer. Once the jaw coupling present on the end of shaft and end of motor shaft is attached lid is completely locked. It is connected to the electrical supply after the whole assembly is placed on the heating coil. As the DC motor is selected it is connected to the adaptor where AC is converted to DC. The stirrer starts rotating when the motor is turned on and the salt gets a continuous stirring. Once the salt reaches 180°C, the processed rice grains are fed into the container through input feeder. At this temperature rice grains will be puffed up within 10-12 seconds, now the blower is turned on for lifting the light weight puffed grains towards the output port. Few constraints are seen affecting the entire process of puffing. The result obtained will not be desirable if any one of the factors is altered. Therefore the below mentioned factors have to be evaluated before going into the detailed design.

Temperature: Temperature is the major constraint in this process. The temperature essential to puff the rice is around 180-210°C. Throughout the whole process the temperature should be maintained constant. Puffed rice will be scorched if the temperature exceeds & it will be undercooked if it is less. Therefore a constant heat supply is needed to maintain this temperature and it should be regulated within the band not to exceed and not to subceed.

Humidity: The rice grains should contain 10-20% of moisture content to be puffed. Hence, first of all, the rice is processed before using it for puffing. Only when there is a right proportion of moisture the volume of the puffed grain will be large and the results will be fair. The salt water is sprinkled on the rice before the rice grains are roasted in the sand bath in order to augment the volume of puffed rice and to maintain the taste.

Time needed for baking: Time taken for baking is an important factor. The temperature maintained inside container is decisive here. Initially the salt is heated upto 200°C. 2-3 minutes are needed to reach this temperature. The rice grains are added to salt mixture once the required temperature is attained. It takes hardly 8-10 seconds to puff up [3].

III. WORKING

The source of energy to operate the machine is solar energy. Electricity is produced by solar light by the basic principle of photoelectric effect. Panel is placed on the open areas where duration of solar light fall is maximum. The electricity produced by the solar panel is used to charge the battery which stores the electricity more than necessary to operate the machine. The motor and blower are powered by batteries to perform respective operations.



The fuel for source of heat is Bio-gas which is produced enough and stored in Bio-gas chamber. The gas is burnt in a burner fixed at the bottom of the machine container to heat the sand bath. The pre-treated raw rice is dropped into the container which contains the hot sand bath. The raw rice is mixed well by the revolving vane comprising mesh in it. The rice gets roasted and puffs off within 10 seconds of duration. After the completion of puffing process the blower is switched on to flush off all the puffed rice which is filtered and lifted up by the vane that is continuously revolving. The flushed puffed rice is stored in a separate case which is removable and removed once it is full.

IV. MATERIALS AND METHOD

The Rice Puffing machine is designed to be portable and robust in construction to avoid any kind of vibrations. The structure of machine is basically made with materials like Mild steel, Cold rolled sheet and Cast iron. The revolving vane includes- a Shaft made of mild steel and a Wing made of cast iron to carry mesh. The container is made of cold rolled sheet as it is stronger in nature and offers better surface finish. The framework of the machine is made of mild steel since it offers better weldability and remain sturdy [4].

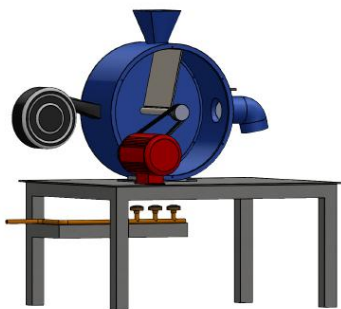


Figure 2: Computer-aided design of Rice puffing machine.

A. Components:

- **Revolving vane-** The Netted Mesh is affixed to a shaft which rotates within the Container to both mix and separate the puffed rice from the hot sand. The base mesh is rigid which gives support to the small pored mesh while flushing the puffed rice.
- **Inlet gate-** Inlet gate is placed on the top of the container to introduce the rice into the container. It is also used to refill the sand if the sand is below the required level.
- **The container access-** The access to container helps to take out the remaining deposits which are left in the container for longer time.
- **The collecting tray-** This is small pored mesh which is placed in front of the container. This component collects the flushed puffed rice from the netted mesh and filters the small sand particles which emanates along the puffed rice.
- **The gas burner-** The gas burner is normal burner which burns the gas to heat the sand present in the container. It has regulator to control the flame quantity according to the requirement.



Figure 3: Actual model of Rice puffing machine

1-Inlet gate, 2-Blower, 3- Collecting tray, 4-Container, 5-Gas burner.

Table 1: Specifications of the components.

Particulars	Measurements
Length of revolving vane	45 cm
Breadth of revolving vane	30 cm
Weight of revolving vane	5.5 Kg
Speed of the revolving vane	36 rpm
Width of the container	45.5 cm
Diameter of the container	61 cm
Power of Motor	350 Watts
Power of Blower	450 Watts

Table 2: Observation of operation.

Power input (Watts)	Duration of Operation (Minutes)	Weight of the sand (grams)	Weight of Output (grams)	Productivity Per hour. (Kilo grams)
350	10	1500	800	4.8

Table 3: List of accessories.

Sl. No.	Component	Quantity
1	Solar Panel	1
2	Battery	1
3	Charging circuit	1
4	Motor (350Watts)	1
5	Blower (450Watts)	1
6	Mounted ball bearing	2

B. Advantages

- Pollution free
- Low cost of construction
- Uninterrupted power supply at day time
- Reduced effort
- Hygienic process
- Easy to maintain
- Portable

C. Application

- Puffed rice machine as household appliance.
- Rural areas where power supply is either unavailable or discontinuous.
- Puffed rice production at house as Home Product.

V. CONCLUSION

In the present world every machine developer aims to maximize the dependency on renewable energy. This approach benefits in many ways like uninterrupted power supply, cost savings and pollution control. Hence this project is designed keeping same ideas in mind and make it user-friendly as well as eco-friendly. The solar powered rice puffing machine avoids dependency on electricity from the board. This machine can be handled by a single person hence reduction in labour cost. The necessity of the worker to sit in front of fire and expose himself to the heat and harmful smoke in conventional method is completely avoidable by using this machine. Since the machine is compact it is easily portable and can be used in rural areas where power supply is unavailable or discontinuous. The machine is working satisfactorily as designed and planned to operate. Different materials can be used in upcoming modifications to reduce the weight of the machine. Though the machine's productivity is comparatively lesser than other procedure, effort to increase the efficiency and productivity by modifying the design of the machine will be made in the days to come.

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