Design and Fabrication of Digital Puffed Rice Maker

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Abstract: The project work tells us about development of a digital puffed rice maker without actually polluting the surroundings and making it in a hygienic manner. As we know that subcontinent countries like India, China, Japan consume rice as the main staple diet food. They also consume a type of rice known as "puffed rice" in their diet. The reason for developing such kind of device is because of the way the "puffed rice" is being prepared. The puffed rice is prepared in a very unhygienic manner. This has very adverse effect on the workers' health and also troubles the environment by altering the temperature of the surrounding places where they are working. The product that is being designed has a critical parameter related to temperature operated within; which indirectly affects the quality of the puff and crispiness of the final puffed rice product. The main ingredient used in making the heat source for the product is sand which is unhygienic and harmful for consumption as it leaves traces behind. To replaces and, salt is being used as the heat conducting source for the puffing process. Salt has enhanced heat conducting efficiency than sand and is also not harmful for consumption.

Keywords: Puffed rice, Hygienic

I. INTRODUCTION

Puffed rice is a type of puffed grain from the Indian subcontinent, made from rice, commonly used in breakfast cereal or snack foods and served as popular street food in India, Bangladesh, Korea, China etc. It is usually made by heating rice kernels under high pressure in the presence of steam, though the method of manufacture varies widely. In the subcontinent it is usually known as "Mamra, Purri, Arsi Purri or simply Murri".Currently in the modern process of making puffed grains was invented by Dr. Alexander P Anderson. Currently in India as evolved from century's preparation of puffed rice happens with age old method of heating the grains in sand medium. Sand is heated using fuel which is basically a mixture of waste rubber tires and bio-residues like rice husk, wood shavings from plywood industry and others depending on the availability at affordable prices. The combustion method used is inefficient and highly polluting. The pollution levels were so high that, in earlier days the production sites were banished to areas away from cities. Health concerns by local residents and hired operators became paramount and this prompted the local administration to issue eviction orders to the manufacturers leading to other social problems.

Puffed rice is formed by the reaction of both starch and moisture when heated within the shell of the grain. Unlike corn, rice kernels are naturally lacking in moisture and must first be conditioned with steam. Puffed rice can be created by heating the steam conditioned kernels either with oil or in an oven. Rice puffed in this way is known as crisped rice.

Puffed rice is basically prepared in sand, which on consuming daily leads to health hazards. As the survey has been conducted most of the puffed rice plants do not maintain hygiene, the place is filled with dust, dirt and puffed rice is thrown on the floor once it is prepared.

Rubber tyres have been used for burning to maintain a constant heat. They are cheaply available and the heat obtained by burning remains for a longer duration. But this cause adverse effect on the people who consume the employee, and the environment. The gases emitted by burning tires are carbon monoxide, sulfur oxides, oxides of nitrogen, Polynuclear Aromatic hydrocarbons (PAH), Poly Chlorinated biphenyl's (PCB), arsenic, cadmium, nickel, zinc, mercury, chromium, etc. The symptoms caused by burning of tyre are irritation of skin, eyes, mucous membranes, respiratory effects, central nervous system breakdown, dizziness, nausea etc. This also causes effect on the environment; the area surrounding the plant will have after effects of burning tyre. Tyres are not subject to spontaneous combustion. However, as a tyre fire grows in intensity it generates higher temperatures, allowing the fire to spread and the generation of large plumes of dense smoke and other combustion products. The pile composition affects the rate and direction of fire spread.

II. LITERATURE REVIEW

Following are the overview of the relevant work done related to preparation of puffed rice. It gives the description of literature review from various research papers published in international journals proceeding of various conferences and books.

[1] "Biomass combustion device for puffed rice conversion" by H. V. Sridhar,

Describes the development and implementation of a biomass combustion device for producing puffed rice. The stove was designed keeping in mind the following parameters – emissions, ease of operation, power level, and efficiency. The critical parameter in the design is related to the stable power requirement in the pan with high transfer rate to the pan. The product quality, quantified by the puffed volume, is enhanced due to consistency in the pan temperature, yielding higher returns. Presently a mixture of waste tire pieces and biomass is used in conventional stove to achieve high pan temperatures necessary for the operation. The new design, however, uses a user-friendly feed system, controlled supply of air for combustion, recuperation of heat from the exhaust by preheating the air delivered for combustion and a combustion chamber sizing to ensure high heat transfer to the pan.

The major contribution of present work is in achieving reduction of emissions, eliminating use of tyres as a fuel for puffed rice making and built in efficiency. The toxic emissions (dioxins) associated with tyre combustion are completely eliminated by discarding tyre as a fuel. The biomass combustion is also complete due to provision of sufficient combustion volume.

[2]"Effect of paddy parboiling and rice puffing on physical, optical and aerodynamic Characteristics" by S. Kumar and K. Prasad describes Puffed rice is a whole-grain puffed Product obtained from pre-gelatinized milled parboiled rice, generally prepared from preconditioning of grains by hydrothermal treatment, followed by drying and milling. The milled grains are treated with salt water to an optimum moisture content, which is then subjected to puffing by sand roasting method. Consumption of these may thus be been linked to reduce the prevalence of disease risk

[3]Ali, S. Z. and Bhattacharya, K. R. (1976)

Properties of parboiled rice (paddy soaked in water, steamed, air-dried, milled), roasted-parboiled rice (soaked paddy roasted in hot sand, air-dried, milled) and beaten rice (soaked and roosted paddy flaked) were compared. Although outwardly essentially similar, roasted rice had considerably higher equilibrium moisture content on soaking in water than parboiled rice; beaten rice had still higher equilibrium moisture content on soaking in water. In water-uptake and soluble-amylose tests, roasted and beaten rice's gave indications of a high degree of gelatinization but without a simultaneous and corresponding reduction in cooking rate (96 degree C) characteristic of parboiled rice. They were also more easily degraded by dilute alkali than parboiled rice. In isographic behavior, beaten rice in particular and roasted rice to a lesser extent showed a fairly high viscosity for unheated slurry which was absent in parboiled rice. These results are consistent with the hypothesis that starch in parboiled rice is retrograded and in roasted-parboiled rice is reduced due to rapid and simultaneous dehydration. Some additional change appears to take place in beaten rice due to the flaking step.

III. PROBLEM STATEMENT

Puffed rice is widely consumed in all parts of India. Puffed rice in village is generally made using sand as a heating medium. Usage of sand in heating of the rice to be puffed is unhygienic, as sand particles can remain on the puffed rice, which on constant consumption can cause health problems later. The preparation of puffed rice is also not easy as the person has to heat the wok or cooking utensil to 200°C and then has to maintain the heat so that the rice can puff up. This is a time consuming and labour intensive task.

In this project we design and fabricate a digital puffed rice maker, which uses salt a better and hygienic option than sand for the heating medium. We program the heating coil to reach and maintain the required temperature for the rice to puff up.

IV. OBJECTIVES

By researching the modern day problems that the people face the objectives that are derived are,

- To design a product which is smaller in size, compact and portable.
- To design a product which uses traditional and modern method of producing puffed rice with temperature indicator.
- To design a product which is easy to use.
- To provide a healthier option of salt as heating medium than sand.
- To reduce manual work and time consumption.

V. CALCULATIONS

HEATING MEDIUM

(i). Specific heat of rice is between 1.27 to 2.42KJ/K of heat is required. If moisture content is varied either higher or lower; rice grain will not be puffed.

For 1KG of rice 2.42KJ/K is required,
For 200g of rice= 2.42*200/1000=0.484KJ/K of heat is required
At 200°C heat required is 0.484*200=96.8KJ of heat is required.
Considering 20% of excess heat: 1.20*96.8=116.16KJ of heat is required.

Therefore, 116.16KJ of heat is required to make puffed rice.

(ii) Heat required attaining salt temperature of 200C
For 1KG of salt 0.864KJ/K of heat is required.
For 2.5Kg of salt (0.864*2.5)=2.16KJ/K
At 200K 2.16*200 = 432KJ/K of heat is required.
Considering 20% of excess heat: 1.20*432=518.4KJ/K of heat will be required for the salt. 518.4KJ of heat is required to raise the temperature of salt to 200°C**.**

CAPACITY OF HEATING COIL

Heating coil is a medium which is used to attain the required temperature. Based on the container design and dimension heating coil is selected.
The dimensions of the bottom plate: Diameter = 200mm

- Area = 0.0314m²
- Thickness = 4mm
- Inner temperature required is : 200°C (473K)
- Heat required at inner side of container : 518.4KJ/K
- Time required to attain this heat : 300 sec

By heat required and time required rate of heat transfer is

- Approximately 2KW heating coil is required.

MOTOR CALCULATION

Salt and rice grains have to be stirred continuously to maintain even temperature. For this purpose speed of stirrer and motor specifications has to be calculated.

Force at the tip of stirrer is considered approximately as 2.5kg-f = 24.525N

20% excess force = 29.43N

- Diameter of the bottom plate is 195mm = 0.195m
- Torque on the ring gear shaft = 29.453*0.195 = 5.74 Nm
- 20% excess torque =6.88N

Shaft speed = 30rpm

= (30*360*π)/180 = 3.14rad/sec

Power on the shaft required = 6.88*3.142rad/sec=21.616W

VI. METHODOLOGY

As per the calculations, in this digital puffed rice maker the following components are used,

- Ceramic heating coil
- Centrifugal Blower
- Arduino Board
- Motor Drive Controller L293D
- Power Supply Board
- LCD Monitor
- Relay
- Temperature Sensor
- DC Brushless motor

Stainless steel of food grade 316 is used to make the container, lid and the stirrer as it is an austenitic stainless steel alloy with a high chromium and nickel content. Like many steel alloys, it has a continuous use temperature several times higher than most food making processes will ever require (more than 800°C, or 1472°F).What makes the grade 316 alloy an ideal food grade steel sheet material is the fact that it has a high resistance to acids, alkalis, and chlorides (such as salt).

Heating Element:

Heating coil is a medium which is used to attain the required temperature. Based on the container design and dimension heating coil is selected. These heating elements are extremely energy efficient converting 96% of the input power to heat with a maximum temperature of 700ºC. Heating elements are capable of generating high, evenly distributed heat. They are considered by many professionals to be superior to wire heating elements because of their higher heat generation capacity and the evenness with which they are capable of distributing heat.

Motor:

DC geared motor is selected. Typical brushless motor use a rotating permanent magnet in the rotor and stationary electrical current/coil magnets on the motor housing for the stator but the symmetrical opposite is also possible. A motor controller converts DC to AC. This design is simpler than brushed motors

Centrifugal Blower:

A small centrifugal blower is selected. These blowers increase 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 which in turn moves them against the resistance caused by ducts, dampers and other components. They are sturdy, quite, reliable and capable of operating over a wide range of conditions.

Temperature sensor:

Temperature is the most often measured environmental quantity. Certain chemical mechanical systems are affected by the temperature. Temperature sensing can be done either by direct contact or by remotely without contact with the heat source. Here in this model the temperature plays a crucial role in making the perfect crisp puffed rice. If the temperature rises more than 200 Degrees then it will result in burning of the rice and causes unnecessary heating up of the instruments used in the project and cause trouble.

Arduino Board:

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users.

VII. DESIGN

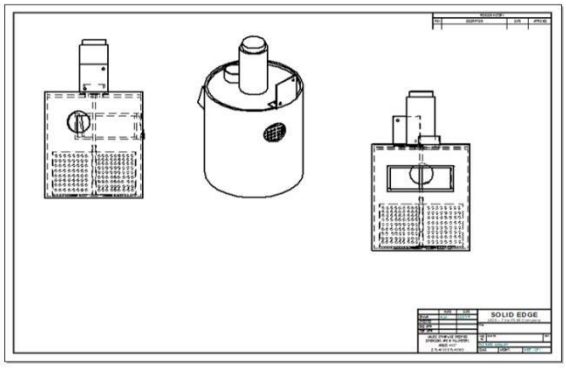

Fig 2: Draft drawing of the model

VIII. WORKING

The heating coil is fixed inside the container, it heats and maintains the temperature of 200°C by programming of the arduino board. A brushless DC motor rotates the stirrer which in turn rotates the salt for uniform heating. A centrifugal blower is attached to blow out the puffed rice through the blower hole, out through the outlet opening when the rice is puffed. After the switching ON the digital puffed rice maker and attaining the temperature of 200°C in the container the puffed rice are added through the opening on the lid to the container and it is heated 8-10 seconds for the rice grains to puff up. After the rice is puffed the blower is switched ON to let out the puffed rice through the outlet opening.

Fig 3: The completed model

XI. RESULT

This project obtains the hygienic cooking of puffed rice, by replacing the traditional way of using sand by salt. This produces puffed rice which is not harmful for consumption as sand is not being used. This project also helps in reducing manual labour and time consumption as it is programmed using arduino board.

Fig 4: Puffed rice obtained from the Puffed rice maker

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