International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

ELECTRIC HORIZONTAL COOKING APPLIANCE WITH SEMI AUTOMATION

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ABSTRACT- *Pressure cooking is the process of cooking food at high pressure, employing water or a water-based cooking liquid, in a sealed vessel known as a pressure cooker. High pressure limits boiling, and permits cooking temperatures well above 100 degrees Celsius (212-degree Fahrenheit) to be reached. Pressure cookers work by expelling air from the vessel, and trapping the steam produced from the boiling liquid inside. This raises the internal pressures and permits high cooking temperatures. This, together with high thermal heat transfer from the steam, cook's food far more quickly, often cooking in between half and a quarter the time for conventional boiling. After cooking the steam is released so that the vessel can be opened safely. Almost any food that can be cooked in steam or water-based liquids can be cooked in a pressure cooker*

1. INTRODUCTION

After the industrial revolution people started to use various cooking devices. These devices are used to simplify process of cooking. Currently in the market kitchen appliances like electric tandoor, electric barbeque, roti maker, microwave oven, air fryer, electric rice cooker etc. are available.

1.1 Problem Statement

The traditional use of gas stove is not preferable in modern kitchens due to smoke, heat loss, less efficiency, time consuming for cooking. The traditional gas stoves can not be used for grilling, roasting and barbequing meat. The problem with gas stove, electric tandoor, electric barbeque is that food cannot be cooked evenly from all the sides. The person who is cooking needs to stir it continuously. The cooking is very complex process. Cooking requires continuous monitoring. For barbequing and grilling of food, for evenly cooking it requires to be rotated manually. Some recipes require continuous stirring and sautéing. In order to reduce the efforts and time required for proper cooking, the semi automation like temperature control will definitely enhance cooking appliance ability.

1.2 Objectives

(1) Our aim is to make an electric, semi- automatic kitchen appliance which can cook
food evenly.
(2) It should not require to be monitored continuously because of temperature control.
(3) It should be able to perform few operations like stirring, mixing, sautéing by automation.

1.3 Scope

This device will be an alternative for various kitchen appliances like electric tandoor, electric barbeque etc. This could be used in commercial kitchens as well as domestic kitchens. This device could be used for performing various operations like stirring, mixing, grilling, roasting, barbequing etc. It will enhance the cooking facilities by reducing time and efforts with semi- automation.

1.4 Methodology

The device would consist of: A cooking vessel which is rotating continuously will be mounted on the shaft of motor. Cooking vessel is inclined to 12 to 13 degrees with the horizontal and supported by bearings. The heating element is located under the cooking vessel inside the casing. Motor, PID controller, ends of heating element and wires are mounted on a wooden stand. When device is turned on, the cylindrical vessel starts rotating with a constant velocity. Heat transfer by convection is set up from heating element to cooking vessel. The temperature of vessel will be sensed by thermocouple. PID controller maintains the vessel temperature at set value. Food is inserted from the open end of cylinder. This can be done after the device is started or before it is started. The food inside the cylinder comes in contact with the heat from the surface. As the cylinder is continuously rotating, the food keeps on turning. So, it is cooked evenly from all sides.

2. DESIGN

2.1 Material selection

Selection of materials for construction of prototype
(1) For body
Material Thermal conductivity
Wood 0.22 W/mK
(2) For Insulation
Material Thermal conductivity
Ceramic 0.9 W/mK
(3) For Bearing stand
Material Compressive strength

Cast Iron 400 MPa
(4) For Cooking Vessel
Material Thermal conductivity
Aluminum 205 W/mK

2.2 Design of Frame

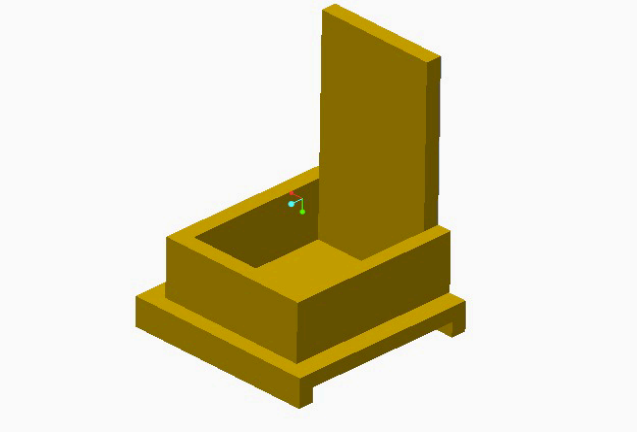

Fig 2.1 Frame

Frame is design by taking appropriate dimension

2.3 Assembly Design

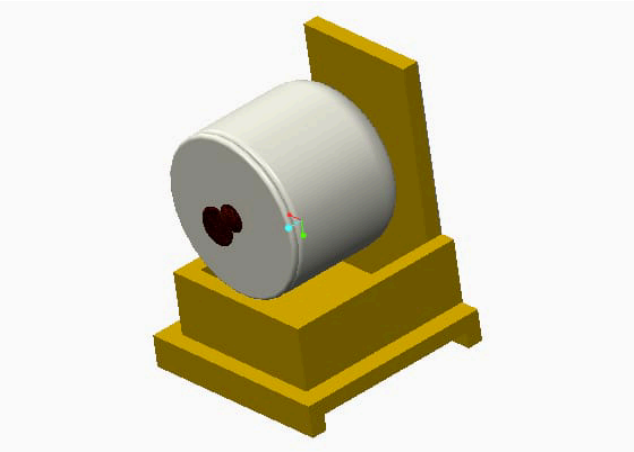

Fig 2.2 Assembly

2.4 Design Calculation

2.4.1 Motor calculation:
Input data:
M = Total mass of vessel (M = 6 Kg)
D = Outer diameter of vessel (D = 20 cm) D = Inner diameter of vessel (d = 19 cm) N =
Rotating speed (N = 5 rpm)
We have mass moment of inertia, I = M (R^2 + r^2) /2
I = 0.057 Kg.m^2
Angular acceleration is given by,a=2N/60t
a=0.5236rad/s^2
Required torque T is given as,T=I
T = 0.057*0.5236 T = 0.3 Kg.cm

2.4.2 Motor shaft calculations
Input data: As material used for shaft is stainless steel so yield strength is 170 MPa m =
Mass of rotating vessel (m = 6 Kg)
L = Shaft length (L = 2.4 cm)
D = Diameter of shaft (D = 0.6 cm) I = Moment of Inertia I =D^4/32=0.01273cm^4
M = Bending Moment of shaft due to mass M = mg*L = 144 N.cm
Y = Position of neutral axis = D/2 = 0.3 cm Using Bending Strength formula, M/I=/y
By simplification, =32M/D^3
Putting above values we get, =68MPa
From above data,
Required strength of shaft is less than the yield strength, so shaft will not be failed.

3.2.4 Nut-Bolt Calculation
Material selected for the nut and bolt is a cast iron which having a shear strength of
400MPa
Factor of Safety FOS = 3
Diameter of nut d = 10mm
Width of nut comes under the bearing for shear is equal to width of selected bearing
W = t = 9mm
We have formula
F/A=St/FOS
Where,
F = Shear force on nut-bolt system
A = dt = 3.14x10x9 = 282.6mm^2
St= Shear strength = 400MPa
FOS = 3
By putting these values, we get value of shear force
Shear Force F = 37.68KN
This value of shear force is much greater than the applied value of force
18.84KN>>>>60N

3. SELECTION OF COMPONENTS

Cooking Vessel
We require a vessel for cooking purpose. It has to be rotated so the shape of the vessel should be cylindrical in shape. Volume requirement is 5litre which is sufficient for cooking 3kg food.
Requirement: Shape – Cylindrical Volume–5L
Material-Aluminum
Selected:
Prestige Clip On Pressure Cooker
Volume - 5L,
Diameter – 22cm, Height – 14cm
Weight- 2 kg

Fig

Heating Element:
For cooking purpose temperature requirement range is 150 – 250 degrees Celsius.
Selected:
Electric stove heating element 2000W, stainless steel, Temprature-573 K
Figure

Fig

Temperature Controller
For cooking different types of foods, we require different temperatures. In order to control and to change the temperature we need to install a temperature controller. There are many methods of controlling temperatures. PID CONTROLLER is one of the most popular method of controlling temperature. PID controller uses proportional, derivative and integrating action. So, it gives very accurate temperature control.

Fig

Thermocouple:
A Thermocouple is a sensor used to measure temperature. Thermocouples consist of two wire legs made from different metals. The wires legs are welded together at one end, creating a junction. This junction is where the temperature is measured. When the junction experiences a change in temperature, a voltage is created. The temperature of cooking vessel is continuously sensed by K type thermocouple and its output signal is received by PID controller

Fig

Solid State Relay (SSR):
A solid-state relay (SSR) is an electronic switching device that switches on or off when a small external voltage is applied across its control terminals. SSRs consist of a sensor which responds to an appropriate input (control signal), a solid-state electronic switching device which switches power to the load circuitry, and a coupling mechanism to enable the control signal to activate this switch without mechanical parts. The relay may be designed to switch either AC or DC to the load. It serves the same function as an electromechanical relay, but has no moving parts.

Fig

Motor:

The cooking vessel is rotated at a constant speed by means of AC synchronous motor. The velocity of vessel should be as slow as possible. We require constant velocity for cooking. The torque requirement for the motor is high as it should be able to rotate 5kgweight.

Requirement: Speed – 5rpm Torque – 0.3 Kg.cm

Selected:

Generic 12V DC High Torque Geared motor

Speed – 5rpm

Torque – 6.3Kg cm

Requirement: Input- Voltage-230V AC Frequency-50 Hz Output- Voltage-12V Current-

2A Selected: NV SMPS Specifications: Input- Voltage-230V AC Frequency-50 Hz Output-

Voltage-12V Current-2A

Fig

Digital Timer Switch:

In order to achieve time control of appliance we are required to use Digital Timer Programmable

A time switch (also called a timer switch, or simply timer) is a timer that operates an electric switch controlled by the timing mechanism.

Fig

Switched Mode Power Supply

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics.

Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy

Fig

Coupling:

A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both.

Fig

4. OBSERVATION

Following observation table is for cooking time and cooking temperature required for food. The observations are carried out while cooking respective food. The maximum temperature achieved by heating element is around 500°C .Temperature required for cooking is between 100°C to 250°C .Time required for cooking depends on food. Usually time required for cooking is 10 to 50 minutes.

Sr No.	Food	Time (Minutes)	Temperature of Heating element (°C)	Temperature of Cooking Vessel (°C)
1	Carrot	15	400	200
2	Eggplant	6	405	205
3	Potato	40	405	205
4	Onion	10	405	205
5	Potato slice	12	405	205
6	Tomato	4	405	205
7	Chicken	12	400	200
8	Whole Chicken	75	390	195

5. ADVANTAGES

1. It is compact in size.
2. It does not require continuous monitoring.
3. It has ability to turn on/off using timer.
4. This device is environmentally friendly.
5. This device is durable and maintenance free.
6. It cooks food evenly from all sides.
7. It reduces human efforts in cooking.

6. DRAWBACKS

1. Motor produces noise.
2. It has low efficiency
3. It requires more time for cooking then gas stove.
4. Slurry or liquid food cannot be cooked.
5. Quantity of food is limited.

CONCLUSION

A kitchen appliance with semi-automation has been designed and built which can be used to cook food. By using PID controller, time switch and motor many cooking operations can be performed automatically to some extent. It has been shown from testing, it is able to cook food having required cooking temperature up to 200°C. Due to continuous rotation food can be cooked evenly from all surfaces. It can perform cooking operations such as stirring, mixing, sautéing, roasting by automation.
Accomplishing the set target has established the success of the project. All the components in the project have been tested individually and the results are found to be positive.

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