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Design and Analysis of Semi -Automatic Cheese Melting and Supplying Device

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Abstract - A food truck is a large motorized vehicle, such as a van or trailer, equipped to cook, prepare, serve, and/or sell food. Some, including ice cream trucks, sell frozen or prepackaged food; others have on-board kitchens and prepare food from scratch, or they heat up food that was prepared in a bricks and mortar commercial kitchen. Sandwiches, hamburgers, French fries, and other regional fast food fare is common. In recent years, associated with the pop-up restaurant phenomenon, food trucks offering gourmet cuisine and a variety of specialties and ethnic menus have become particularly popular. Food trucks may also sell cold beverages such as soda pop and water. Food trucks, along with portable food booths and food carts, are on the front line of the street food industry that serves an estimated 2.5 billion people every day. Out of that, we are making a cheese supplying device which will suffice our specific application. There are different cheese melting devices available in the market but there is no sufficient capacity of cheese melting available. We are making a device that will fulfil company's requirements. The main requirement of the company is to maintain constant temperature of cheese is melted state

1. INTRODUCTION

Now-a-days, the concept of Food Truck is developing at a faster rate to meet the requirements of modern culture. The whole food truck is made up from various equipment like food oven, griller, cheese melting device, cutters, bakers, others. Out of that, we are making a cheese supplying device which will suffice our specific applications. The main aspects of this topic are: Maintaining a temperature (50-70 ℃) in the cheese compartment to ensure smooth melting of cheese. Providing a better and safer process to provide heat. To design a tap system for smooth outlet of cheese in the required amount using solenoid time delay valve. To make the design as compact as possible for a given requirement. The main motive of his project is to provide easy solution for automatic food supplying unit for better productions in food industries and food trucks. To provide efficient control system to easily manage a certaintemperature of the semi liquid food without any human interaction. To maintain the quality and a certain quantity of the cheese and chocolate every time using automated machine.

PROBLEM STATEMENT

Design, analyze and manufacture of an automatic cheese supplying device for food truck application. To design control system to maintain a certain temperature in the cheese or chocolate compartment.

1.1 LITERATURE REVIEW

Prem Kumar et.al [1] have been worked for ohmic heating technology. For food processing applications, ohmic heating may be defined as a process where an electric current is passed through the food with the main purpose of heating it. Under these circumstances, heat is internally generated due to the food's electrical resistance and this simple fact is responsible for the particular characteristics of this technology.

M. I. kuo et.al [2] Cheeses are popularly used as ingredients in many prepared, ready-to-eat foods in which the cheese often undergoes melting. Use of Cheddar cheese on toasted sandwiches and Mozzarella cheese on pizza are some familiar examples. Consumer acceptance of these foods depends on the melting quality of the ingredient cheeses. Therefore, the meltability of cheese is an important factor in determining the quality for particular product applications. The effect of heat treatments on the meltability of cheese was investigated. Cheese samples were heated to 60°C and held for 0,10, and 20 min before allowing the melted cheese to flow.

Lennatech [3] The Heco Auto-line® MLR-E filter is designed specifically for the filtration of hot and highly viscous melt, re- work or processed cheese. The filter is used when an automatic continuous cleaning process is required. As the oversize impurities are concentrated in the filter until it is drained away while the filter is still in operation, the loss of saleable product due to draining is minimal. Drainage of the filter takes place through a bottom valve which can be controlled individually (manual or automatic operation). The filter is used when an automatic continuous cleaning process is required. As the oversize impurities are concentrated in the filter until it is drained away while the filter is still in operation, the loss of saleable product due to draining is minimal. Drainage of the filter takes place through a bottom

valve which can be controlled individually (manual or automatic operation). liquid filters are manufactured from stainless acid-proof steel EN 1.4404. The filter meets current standards and norms for pressure vessels, it complies to all relevant EC directives and is CE labelled

1.2 METHODOLOGY

Analytical approach to design melting container, heating and tapping mechanism, different container for different volumes. Design regarding optimum design.

For fabrication of melting device, we are going to make container made of stainless steel sheets and give shape into required size and covered with helical copper coil for providing heat.

Design of cheese melting and supplying device by using software like solidworks.

2. DESIGN CALCULATIONS

Volume of small cylinder Given data
Inner diameter = 94 mm Outer diameter = 47mm
Height of cylinder =326-25mm=301mm (25mm is for lid clearance)
Volume of cylinder = □□2L
= □ ∗ 47 ∗ 47 ∗ 301
= 2088873.23 mm3
=0.209 *10-2 m3

Volume of big cylinder Given data
Inner diameter = 154 mm Outer diameter = 77mm
Height of cylinder = 301-25mm = 276 mm (25mm is for lid clearance)
Volume of cylinder = ∏r2L
= ∏*772*276
= 5140914.8 mm3
=0.514* 10-2m3
Density of cheese sauce & chocolate sauce = 1015 kg/m3 Mass
Mass in small vessel = 0.209*1015*10-2
=2.12 kg
Mass in big vessel = 0.514*102* 1015
=5.21 kg
(conical part of cylinder is neglected because volume of stirrer & cone can be take equal)

Volume of vessel
Volume= (Outer –Inner) *L
=∏ (r12- r22)* 0.35
=∏ (0.082-0.0782) *0.35
= 3.4746 m3
Heat Required M= 2.71kg
For SS

Cp = 460 J/kgC
Q= mCp(ΔT)
Q= 2.71*460*(120-20) Q= 2.71*460*(100)
Q= 124.660 Joule

Power Power= (Q/t)
T required is about 90-120mm Power = (124.660/90)
Power = 1385

Power= (124.660/60)
Power = 2077

Power = (124.660/120)
Power = 1038

Induction coil calculations We know that,
Mass of Small Cylinder: 1.92 Kg Mass of Big Cylinder: 3.17 Kg Cp of steel: 490 J/Kg-k
T: 120 – 25 = 95 Degree Celsius For small vessel, Q = 89376 J
For Big Vessel, Q = 147563.5 J
So considering 90 seconds time for heating up from 25 to 120 degree Celsius
P for Big Vessel, P=Q/t
P = 147563.5/90 = 1639.5 W
P fir small vessel, P=Q/t
P = 89376/90 = 993.06 W
From these calculations we can set an induction circuit output value and get heat from it.

2.1 TEMPERATURE AND FLOW CONTROL

Induction heating is a fast, efficient, precise and repeatable non-contact method for heating electrically-conductive materials such as brass, aluminum, copper or steel or semiconducting materials such as silicon carbide, carbon or graphite.
The induction heating power supply converts AC line power to a higher frequency alternating current, delivers it to a work coil and creates an electromagnetic field within the coil. Your work piece is placed in that field which induces eddy currents in the work piece. The friction from these currents generates precise, clean, non-contact heat. A water cooling system is generally required to cool the work coil and induction system. The size of the work piece and the heating application dictate the operating frequency of the induction heating equipment. Generally, the larger the work piece the lower the frequency, and the smaller the work piece, the higher the frequency. The operating frequency is determined by the capacitance of the tank circuit, the inductance of the induction coil and the material properties of the work piece.

2.2 RTD PT100 SENSOR

Resistance Temperature Detectors - are temperature sensors that contain a resistor that changes resistance value as its temperature changes. The most popular RTD is the Pt100. They have been used for many years to measure temperature in laboratory and industrial processes, and have developed a reputation for accuracy, repeatability, and stability.

2.3 DESIGN OF VESSEL

The external enclosure is made up of brass material and it is used to hold the all components in place. It is premanufactured. Stand is used to withstand the load of the system. It is made up of mild steel material.

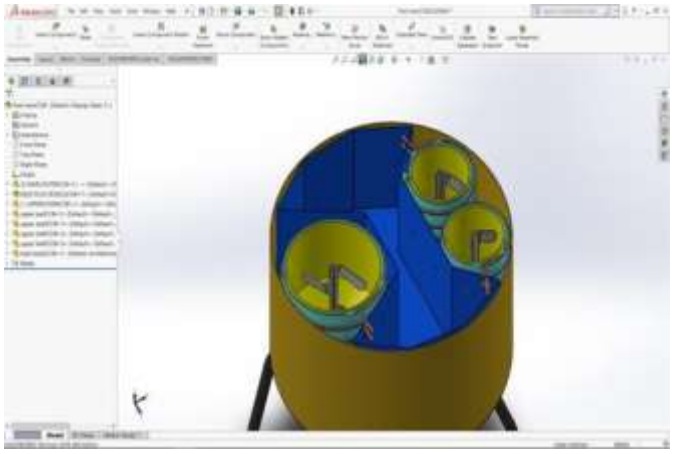

Fig.1 Upper cut Section

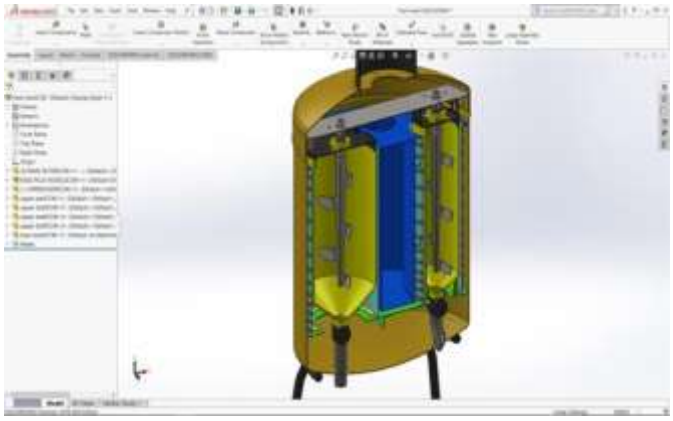

Fig.2 Side Cut Section

2.4 CFX ANALYSIS

Ansys CFX is a high performance, general purpose CFD program that has been applied to solve wide-ranging fluid flow problems for over 20 years. At the heart of Ansys CFX is its advanced solver technology, the key to achieving reliable and accurate solutions quickly and robustly. The modern, highly parallelized solver is the foundation for an abundant choice of physical models to capture virtually any type of phenomena related to fluid flow: laminar to turbulent (including transition), incompressible to fully compressible, subsonic to trans- and supersonic, isothermal or with heat transfer by convection and/or radiation, non-reacting to combusting, stationary and/or rotating devices, single fluids and mixtures of fluids in one or more phases (incl. free surfaces), and much, much more. The solver and its many physical models are wrapped in a modern, intuitive, and flexible GUI and user environment, with extensive capabilities for customization and automation using session files, scripting, and a powerful expression language.

But Ansys CFX is more than 'just' a powerful CFD code: with its integration into the Ansys Workbench Platform, users benefit from superior bi-directional connections to all major CAD systems, powerful geometry modification and creation with Ansys Design Modeler, advanced meshing technologies in Ansys Meshing, and easy drag-and-drop transfer of data and results to share between applications (e.g. to use a fluid flow solution in the definition of a boundary load of a subsequent structural mechanics simulation). Furthermore, a native 2-way connection to Ansys structural mechanics products allows users to capture even the most complex fluid-structure interaction (FSI) problems, in the same easy-to-use environment, saving the need to purchase, administer, or run 3rd party coupling software.

2.5 CFX SUMMARY

According to these results and temp contour, we can say that heat supplied to external surface of cheese sauce is propagated throughout to core within 1-2 seconds. For this we gave temp to considered cylindrical shaped cheese sauce block and put whole block initial temp as 50 degrees.

We put another condition to external surfaces that is cylindrical and conical (expect upper cover) at 80 degrees and run analysis for 1 second of time. So by that as we can see 56 degrees is minimum temp remaining at upper cover side. For that we just decrease pitch of helical coil little bit to increase intensity of heat at top. And at bottom we couldn't hear direct to cone so that we also increase intensity at their also

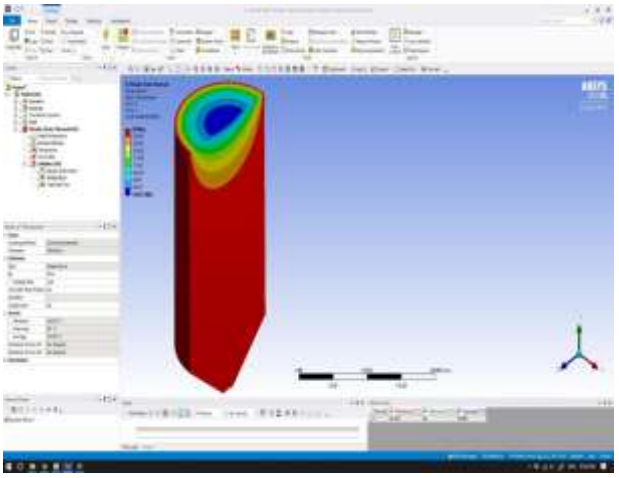

Fig 3. CFX Contour

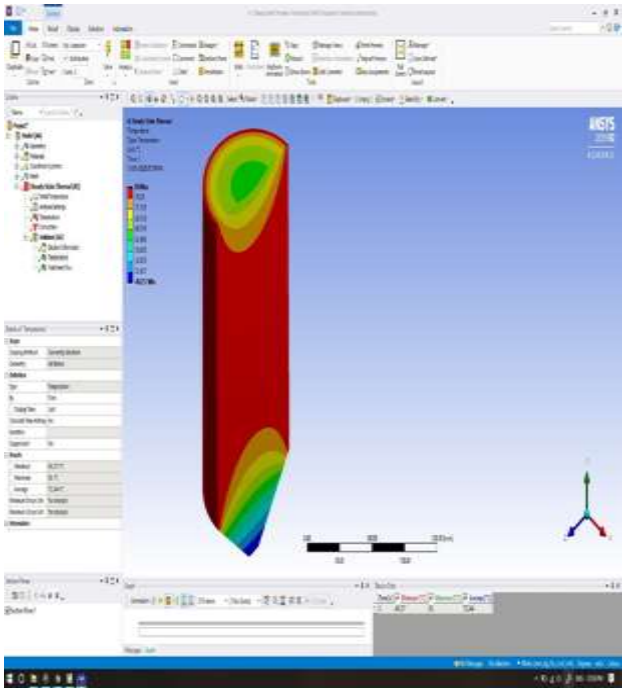

Fig 4. CFX Contour

CFX handles all types of radiative heat exchange in and between fluids and solids from fully and semi-transparent to radiation, or opaque. You can choose from a variety of spectral models to account for wavelength dependencies in a simulation and to account for scattering effects.

Control Unit

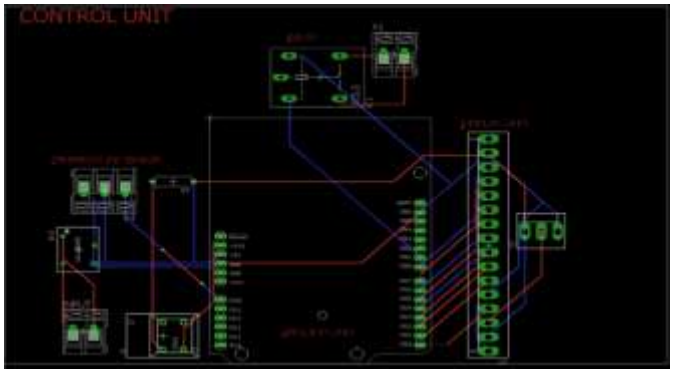

Fig 5. Control unit

Coil Design

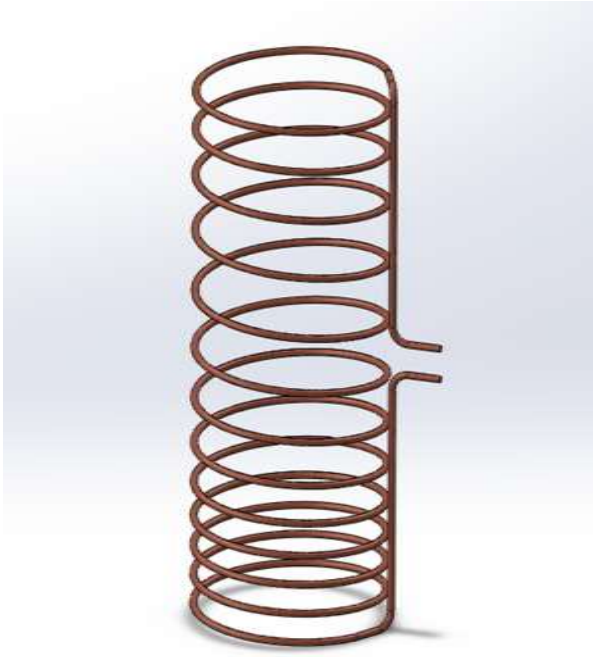

Fig 6 Coil

The coil will heat up the vessel by induction method.

3. CONCLUSION

Here we can conclude that This device is easy to use as it can melt the cheese and pour it in the vessel. Can be used for melting a chocolate by setting a required temperature. It can be more compact in size and lesser weight Automatic temperature control can be possible with use of different sensors. Automatic cleaning of a vessel can be done

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