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Design Development and Analysis of Cadbury/Chocolate Pulp Melting Tank

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ABSTRACT

Melting is the most important process in industry in order to prepare a final product. While preparing that product it is necessary that to melt a pulp in proper amount as well as the required condition. During melting of wax or pulp because of high temperature more amount of thermal stresses are developed and when that thermal stresses are exceeds certain limits then the welding section get weak and because of that there will be leakages problem at joint so that loss of thermal energy through joints. But if we design the tank for wax melting by applying the seamless welding process we are easily avoid those leakages at the joint. So there will be a need to design a tank by seamless welding process to avoid the thermal loss and reduce the thermal stresses. So in this paper we try to complete the design according to actual design dimensions and try to prepare the designed model with the help of catia software. After preparing that tank with that software I try to complete whole analysis with the help of ansys software . This analysis will be carried in order to get equivalent stresses, maximum principle stresses and the total deformation of the assembly. Also from the design and analysis it is clear that it is clear that the selected wall thickness of 5mm will be on safe side so there will be a optimization of thickness.

Keywords: Pulp Melting, Analysis with Ansys, Thermal stresses. Principle stresses

I. INTRODUCTION

In all over the world, food is an essential for human in day to day life. Cadbury,chocolate and many other foods. While preparing such food the basic raw material is wax and it is very important to prepare a final product. For converting that raw material in to final product the device required is that melting tank. Melting tank is the device which is used to melt the wax under high temperature. Now in industry to melt the wax a pressure vessel are used. but the drawback of pressure vessel is the high thermal stresses are developed inside the vessel and the leakage problem at the joint, and because of that there will be a loss of thermal. So to avoid that we try to design and developed a wax melting tank for melting the wax. First we are try to check the design and then developed a tank according to the requirements of end users. Now my aim is to design a tank with some software like catia, pro-e, hyper mesh etc. because of my simplicity I select catia to design wax melting tank. In this design I try to complete design of tank. This tank include the different ports like inlet, outlet, inspection, manhole and drain along with left and right hand flange. As the seamless welding is provided so there will be no any leakages problem at the joints.

Firstly, the wax passed through the inlet to inside the tank after heating it will be collect through outlet section. Drain will be provided in order to remove unwanted material along with them manhole is provided for inspection purpose.

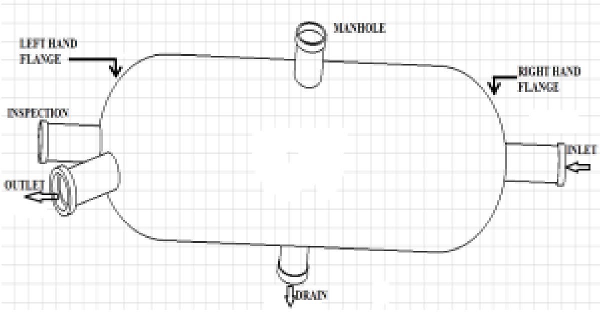

Figure 1. Pulp melting tank

A. Problem Statement

Melting a wax is a serious task in any food industry. Now in industry they referred a cylindrical Pressure vessel for wax melting but the problem is that during wax melting high temperature are developed inside and due to that high thermal stresses are developed . Because of that there should be leakages of wax through welding joint and there will be a loss of thermal. It create serious problems at the time of working in site, to remove this we must assure about vessel design.

B. Methodology

In order to design a wax melting tank we try to replace it with the help of pressure vessel. Methodology consists of application of scientific principles, technical information and imagination for development of new or improvised wax melting tank to perform a specific function with maximum economy and efficiency. This project work will relate to design of tank, Optimization of stresses, and selection of proper method at joint to avoids leakage at the joints including:

1. Problem Definition
2. Literature Review
3. Finding out Design Parameters of Tank
4. Design and Calculations of Tank
5. Design of tank in catia software (2D and 3D)
6. Ansys analysis
7. Analysis by FEM Software
8. Result and Discussion
9. Conclusion.

C. Objectives

The main objectives of this project work are as follows;

1. To design the tank with ASME code same as the pressure vessel.
2. To optimise the thickness of tank so that material cost saving.
3. To replace the welding method by seamless welding to avoid leakages at the joints.
4. To do the analysis of tank with ansys software.

II. LITERATURE SURVEY

Various researchers have worked for the development of wax melting with pressure vessel

Sumit V Duplet. **[May-2014],** conducted a study of "Review on Stresses in Cylindrical Pressure Vessel and its Design as per ASME Code".They found that different stresses which are exerted on the pressure vessel. The total design will be done on the basis of ASME code this analysis will give the exact values of the different stresses like maximum principle stresses, Equivalent stresses based on American society of mechanical engineering.[1]

AntonioRamos [2014]"The melting process of storage materials with relatively high phase change temperatures in partially filled spherical Vessels". In this paper they studied that the different melting processes of storage material with relatively high phase change material when temperatures in partially filled spherical Vessels.[2]

S Ravinderet.[Feb.-2013], "Design and analysis of pressure vessel assembly for testing of missile canister sections under differential pressure". This paper give the information about Design and analysis of pressure vessel assembly during the working on site for testing of missile canister sections under differential pressure and this testing will be carried out for different pressure conditions.[3]

Apurva R. Pendbhaje [March-2012], "Design and analysis of pressure vessel". This paper states that to carry the design of pressure vessel to melt the wax and total analysis will be carried out with the help of analysis.[4]

III. FINITE ELEMENT ANALYSIS

We selected the material for tank is Structural steel 304.With the help of FEA analysis it gives the information about equivalent stress, maximum principle stress and the total deformation of the tank. with the analysis of total deformation it should be clear that without application of pressure the minimum deformation will be 0 and by the application of pressure we get the maximum deformation 0.75285.

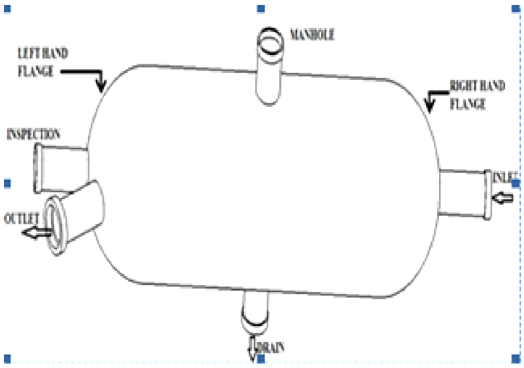

Figure 2. Catia 2D model

A. Meshing

One of the purposes of meshing is to actually make the problem solvable using Finite Element. In case of tank body having 49 faces and it is divided in to 133658 elements from that 268217 nodes are formed.

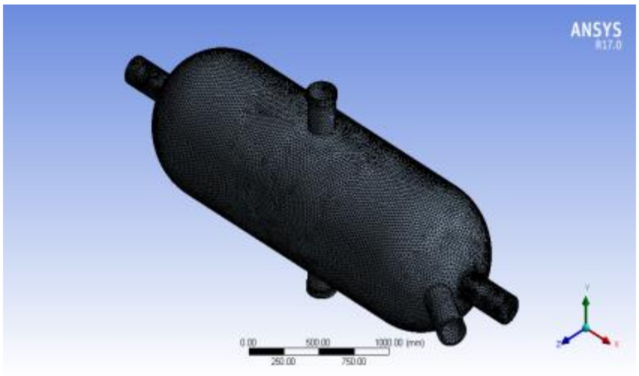

Figure 3. Meshing

B. Boundary Condition

Applying forces to single nodes may cause irritating effects, especially while looking at the stresses in this area. Typically concentrated loads (i.e. forces on a single node) impose high stress gradients. Even though the high stresses are correct (i.e. force applied to an in intestinal small area) one needs to ask whether this kind of loading is reasonable at all.

By Appling pressure 15 Mpa we get total deformation. without application of pressure the minimum deformation will be 0 and by the application of pressure we get the maximum deformation 0.75285.

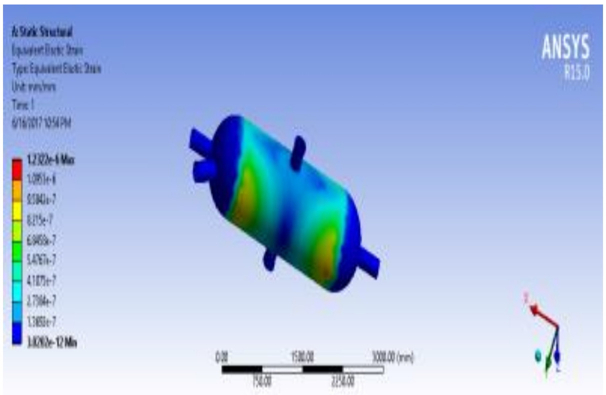

Figure 4. Equivalent elastic strain.

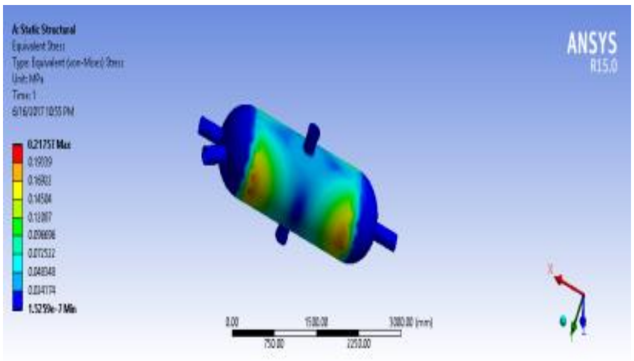

Figure 5. Principal stress diagram.

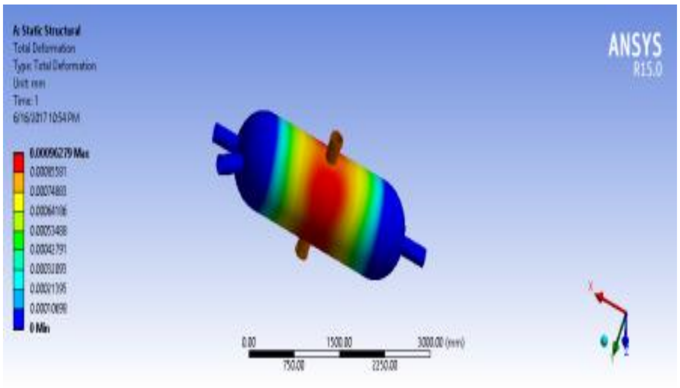

Figure 6 .Total Deformation.

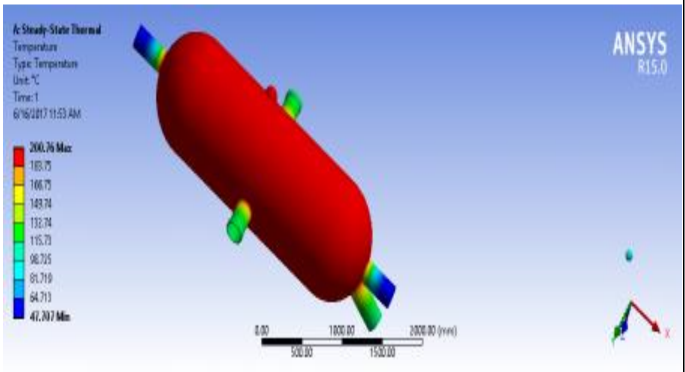

Figure 7. Temperature at Steady State

Table 1. Ansys Result

	Equivalent elastic strain(Mpa)	Von misses stress (Mpa)	Total deformation (mm)
Min.	1.2322	1.5259	0
Max.	3.022	0.21757	0.00096379

IV. EXPERIMENTAL VERIFICATION

To carry out the experimental validation we first take the tank which is to be design with catia software. Basically in this particular validation we perform the seamless welding processes to avoid the leakages at the joints. And finally Hydrostatic test will be carried out for checking of strength of the tank.

A. Tank Design

Table 2. Specifications Of Elements:

Melting capacity	:200 kg
Size of tank	:1470*975mm Composition: Fe/<17.5-20 Cr/8-11Ni/<2Mn/<0.45P/<0.3S
Tank material	:S.S. 304
Heating element	:Uniformly heating by electric flat heaters
Design dimentions	:Maximum Possible Static Head,H (mm) = 1500 mm (rounded , considering all (Max. Distance Between Topmost and possible Tolerance) Bottom Most Pressure Parts.) Height for static Head = vessel Height. + Top Nozzle projection + Bottom Nozzle Projection =650+150+150 =950 mm Pa = 15 MPa Minimum Required Thickness t = 3.7 mm <5 mm Required thickness under external pressure (t)=4.66 <5mm Hence shell thickness is safe at 5.00 MM

Formulae:

Cylindrical Shell Thickness

Vessel Height = Shell OD

Shell OD = 650 mm

So vessel height also 650 mm

Height for static Head calculation

Height for static Head = vessel Height. + Top Nozzle projection + Bottom Nozzle Projection

=650+150+150

=950 mm

Maximum Possible Static Head, H (mm) = 1500 mm (rounded , considering all (Max. Distance Between Topmost and possible Tolerance) Bottom Most Pressure Parts.)

Figure 8. Actual Tank Model

B. Replacement of welding parameter/ Seamless welding:

In order to avoid the leakages problems at the joints we should able to replace the welding which provided at joints to the seamless welding method.

Seamless welding is the technology in which no any welding will provided at the joints, directly used seamless pipe/tube so that there will no any leakages at the joints under high thermal stresses.

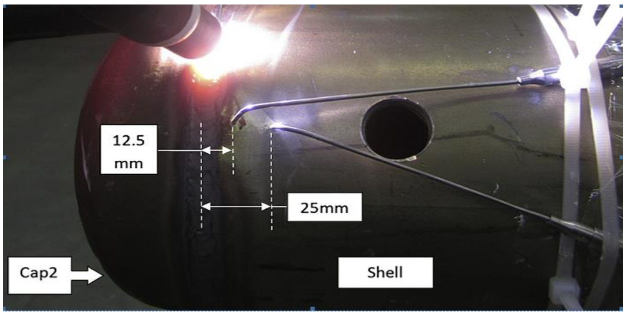

Figure 9. Seamless welding process

In this process especially we observe that no any welding joint will observe on the tank. Directly we stick the seamless tube over the tank. Because of that the strength of the tank also increases. In order to record the temperature during the process the thermocouple is used which are holds at 12.5mm from the welding section. This process will carry out on both the sides of the tank.

After completion of manufacturing we conduct the ultrasonic test for defect checking. i.e.is there any defect will remains present in the wall of the tank or not. This testing can be carried out in three section of the tank which is shown in below figure.

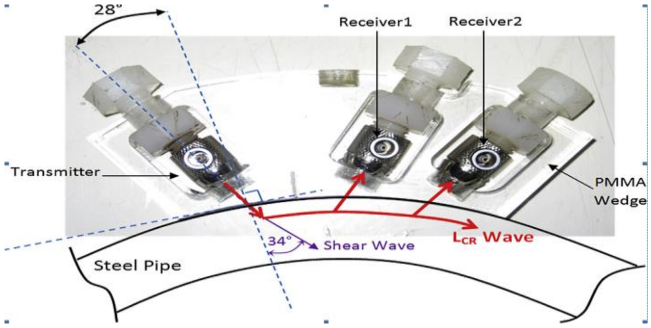

Figure 10. Defect Checking

Working

To check is there any defect present in tank or not we carry out defect checking, in this first hold the instrument over the tank. The setup consist of one transmitter and two receiver the inclined angle for transmitter will be 28 deg. The transmitters send the signal in waveform through the tank up to receiver one. If receiver one not reaches any signal then there will be any defect present in between transmitter and receiver one. If riches the signal then no defect present in this section. Similarly if the same signal will riches up to receiver two then no defect present in between them, but if signal will not receive then the defect will present in the section between receiver one and second. And during this testing we found that whatever the signal send by transmitter one same will rich up to receiver two. So there will no any problem in the tank which we have to manufacturer. The below figure shows the total setup for testing.

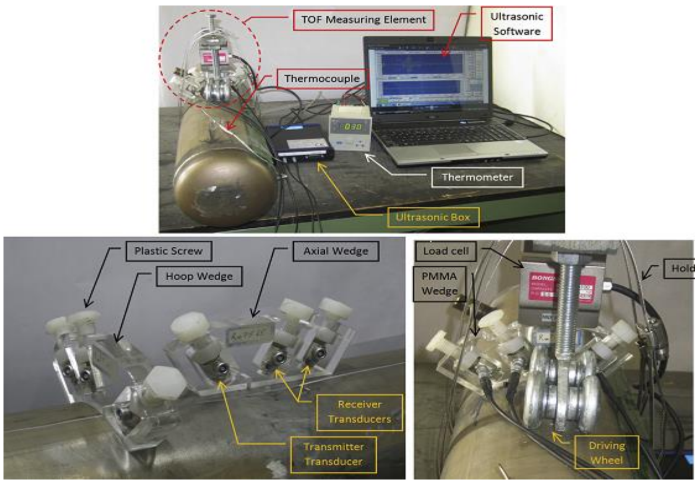

Figure 11. Combined Experimental setup (Hydrostatic Test)

From this we take the hydrostatic test to check whether the prepared tank are able to sustain the contents which are inside and for that purpose we test tank for water which is filled inside the tank under high pressure and we check is there any deformation take place or not. And we observe that tank will able to sustain 15 bar pressure inside without giving any deformation. Also we take the test to check whether any leakages present or not of the tank and we observe that there will no any leakages of the tank so we conducted the test on successfully.

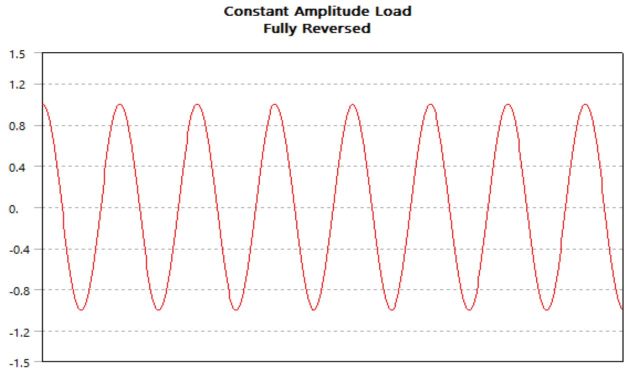

Figure 12. Constant load curve

The above graph plot by the software during testing when we perform the seamless welding over the tank and the for the testing of tank under 15 bar pressure inside the tank and we observe that the flow will be in constant in amplitude and there will be no any problems about deformation.

After completion of all the testing of our wax melting tank, for validation of results we consider first take the testing of tank through defect checking and we observe that the signal will reach to last receiver so no any leakages problems will take place. So whatever the thickness that we provided it should be on safe side. And this can be validate with the ansys software along with mathematical/ design calculations.

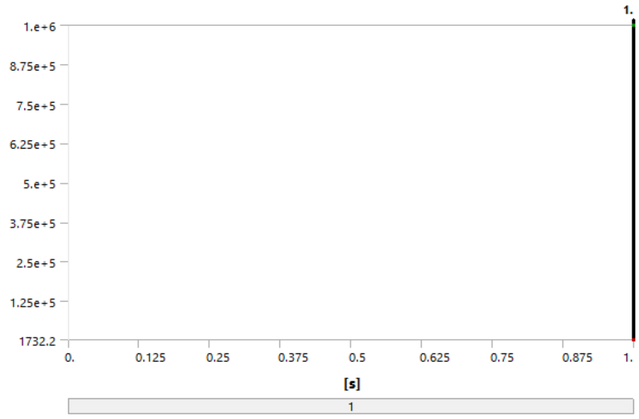

Figure 13. Fatigue life

Table 3. Validation Of Results

Parameters	Theoretical/ Design value	Calculated value	Experimental/ Ansys value
Hydrostatic test pressure	7.5kg/cm3	7.5kg/cm3	2.5kg/cm3
Density	1000kg/m3	1000m3	1000
Design pressure	4.92kg/cm3	4.83kg/cm 3	-
Cylindrical shell thickness	5mm	2.7mm	0-2.2141
Minimum required thickness	5mm	3.7mm	0-2.2141
Governing thickness	5mm	3.13mm	0-2.2141
Required thickness under external pressure	5mm	4.66mm	0-2.2141
Required corroded thickness	5mm	4.67mm	0-2.2141
SF required thickness	5mm	2.9mm	-1.6296 to 1.6337
Fatigue life		1732.2 to 1e+6	1732.2 to 1e+006

The above graph gives the information about fatigue life of our tank and it will be plotted during testing.

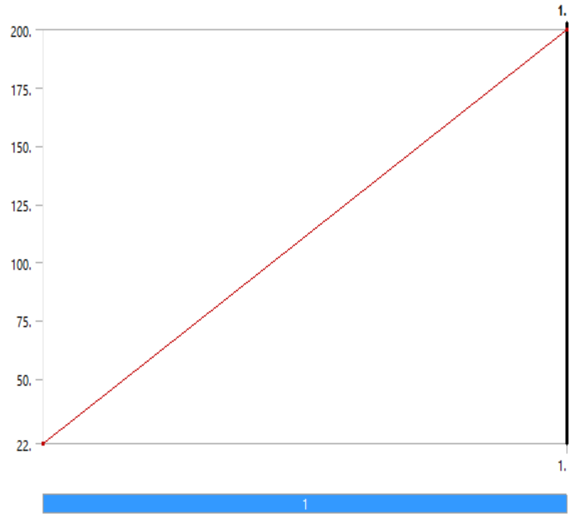

Figure 14. Thermal condition

The above graph give the thermal condition temperature range is in between 22 to 100 deg.c. and working is 80 which is recorded from hydro test.

V. RESULTS AND DISCUSSIONS

From all the calculation it is clear that whatever thickness we provided that should be on the safe side. So there should be the avoid of the leakages problems. Along with them we found that there will be the optimization of thickness. Also we take the hydrostatic test and take the result.

VI. CONCLUSION

From this project work we can conclude that there will be a Required Thickness= 3.139 mm< 5.000 mm (Provided) Thickness is Optimum External Pressure Calculation i.e. it is in safe zone .Also From the external pressure calculation we made the conclusion that there will be Requirement for Cold Forming As Per Ucs- 79 as the calculated thickness will be 9.5mm.From the FEA analysis should be clear that all the design should be on the safe side.

VII. REFERENCES

[1]. Sumit V Duplet. [May-2014], "Review on Stresses in Cylindrical Pressure Vessel and its Design as per ASME Code".

[2]. Antonio Ramos Archiboldet Jose Gonzalez Aguilar, Muhammad M. Rahman, D. Yogi Goswami, Manuel Romero, EliasK. Stefanakos [2014] "The melting process of storage materials with relatively high phase change temperatures in partially filled spherical Vessels".

[3]. S Ravinderet .[Feb.-2013], "Design and analysis of pressure vessel assembly for testing of missile canister sections under differential pressure".

[4]. Apurva R. Pendbhaje [March-2012], "Design and analysis of pressure vessel".