DESIGN AND CFD ANALYSIS OF WAX/PULP MELTING TANK

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ABSTRACT

Wax 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 wax 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 weeak and because of that there will be leakages problem at joint so that loss of thermal energy through joints. For that purpose if we design the tank for application of wax melting then by the design it is clear that there will be a possibility to save the material and do the CFD Analysis on ansys.

Keyword : - *Wax Melting, Analysis with Ansys, tank design, CFD Analysis etc..*

1.Introduction

In all over the world, food is an essential for human in day to day life. Catbari, chocklet 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.

1.1 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 creates serious problems at the time of working in site, to remove this we must assure about vessel design/tank design.

1.2 Objectives

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 do the CFD Analysis of tank with ansys software.

2. LITERATURE SURVEY

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]

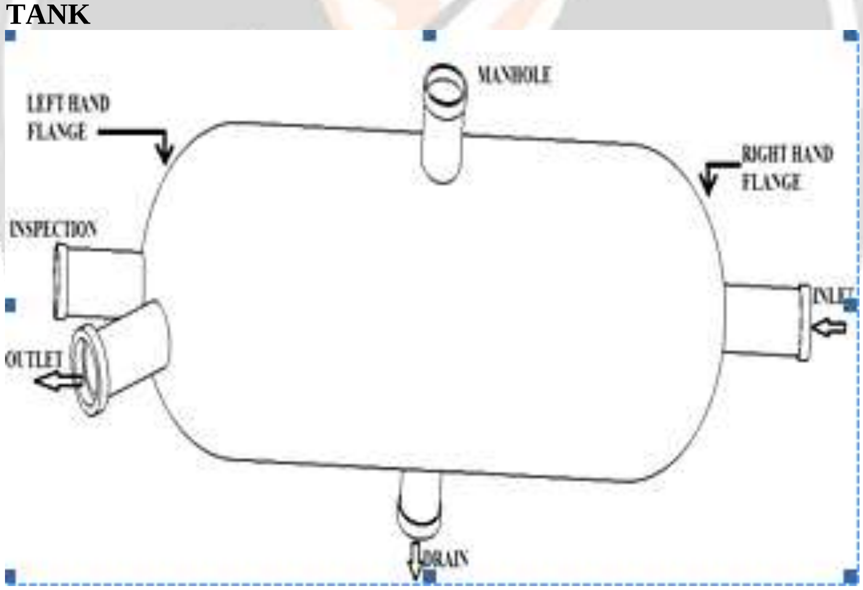
Apurva R. Pendbhaje [March-2012], “Design and analysis of pressure vessel”. This paper states that to carry the design of pressure vessel to melt the wax and total analysis will be carried out with the help of analysis.[4]

M.Rahimi[Jun-2012],“A combine experimental and computational study on the melting behavior of a medium temperature phase changes to rage material inside shell and tube heat exchanger”.this gives the information about experimental and computational study on the melting behavior of a medium temperature phase changes to rage material inside shell and tube heat exchanger”[5]

2.1 Research Gap

From the above review paper it is clear that maximum work will be carried out on the basis of design of pressure vessels,analysis of pressure vessels, different phase change material and its behavior, no work will be done on wax melting tank and its CFD analysis.

3. DESIGN OF TANK



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

Design Internal Pressure including Static Head for Calculations:

Density of Contents, 1000(Kg/$m^{3)}$

Static Head pressure(P)

$P = \rho \times g \times H$

$= 1000 \times 9.81 \times 1500 \times 10^{-6}$

= 0.01471 MPa

= 0.015 MPa

Design Pressure = P + Pressure due to Static Head

= 0.491 + 0.015

= 0.505 Mpa

Cylindrical Shell Thickness=

$$t = \frac{P \times R}{S \times E - 0.6 \times P}$$

$$t = \frac{0.49 \times 44.5}{(815.2 \times 1) - (0.6 \times 0.49)}$$

t = 2.7 mm

Circumferential Stress-

$$t = \frac{P \times R}{S \times E - 0.6 \times P}$$

t = 2.7 mm

Minimum Required Thickness =

$$t = \frac{P \times R}{S \times E - 0.6 \times P}$$

t = 3.7 mm

Governing thickness + Corrosion Allowance = 3.70 + 0.00 = 3.70 mm

Conclusion: Red Thickness= 3.139 mm < 5.000 mm (Provided) Thickness is OK…

3.1 CFD ANALYSIS

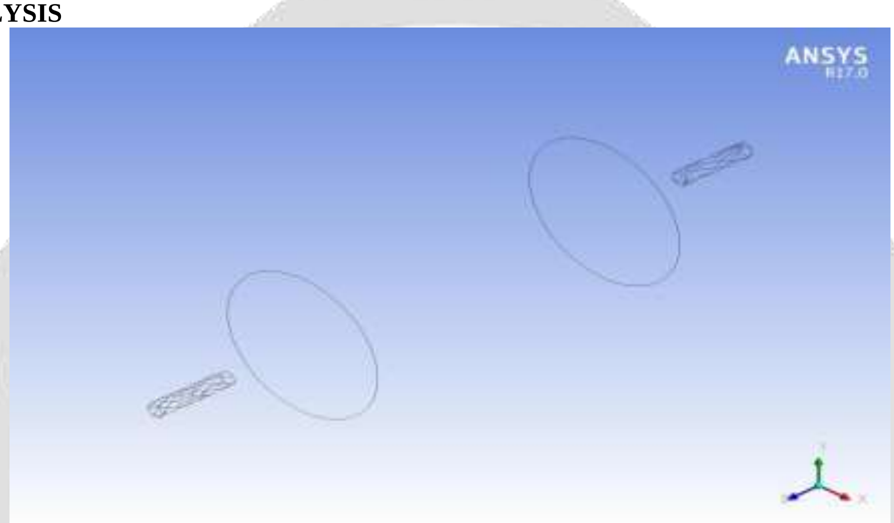


Fig. 1 Iso View of Wireframe

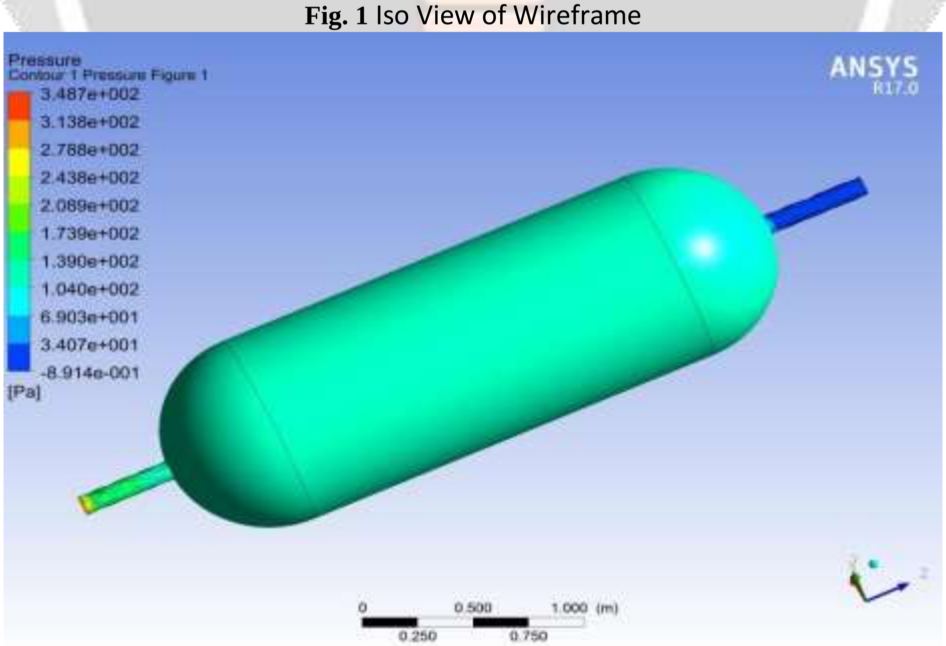


Fig. 2 Pressure Figure

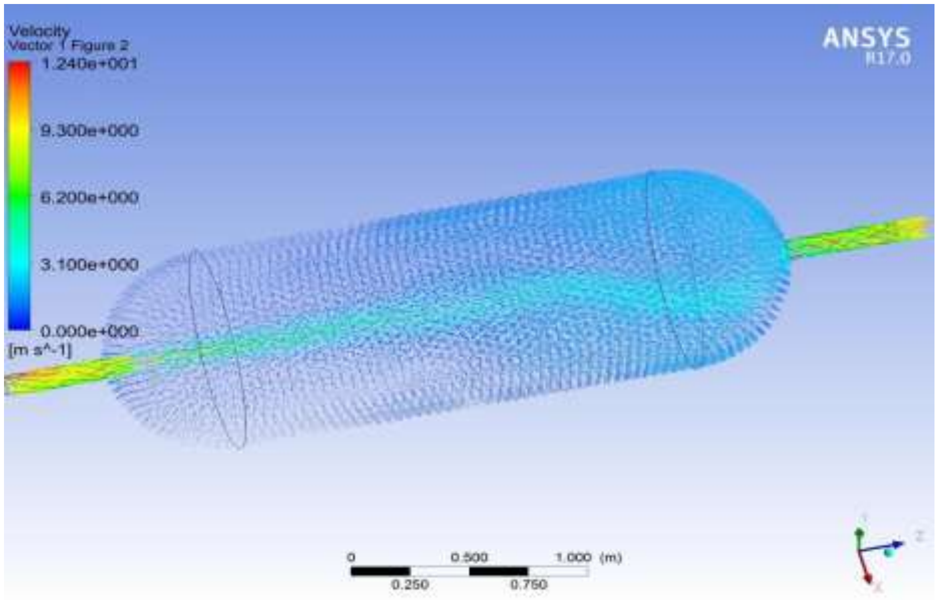


Fig. 3 Velocity Figure

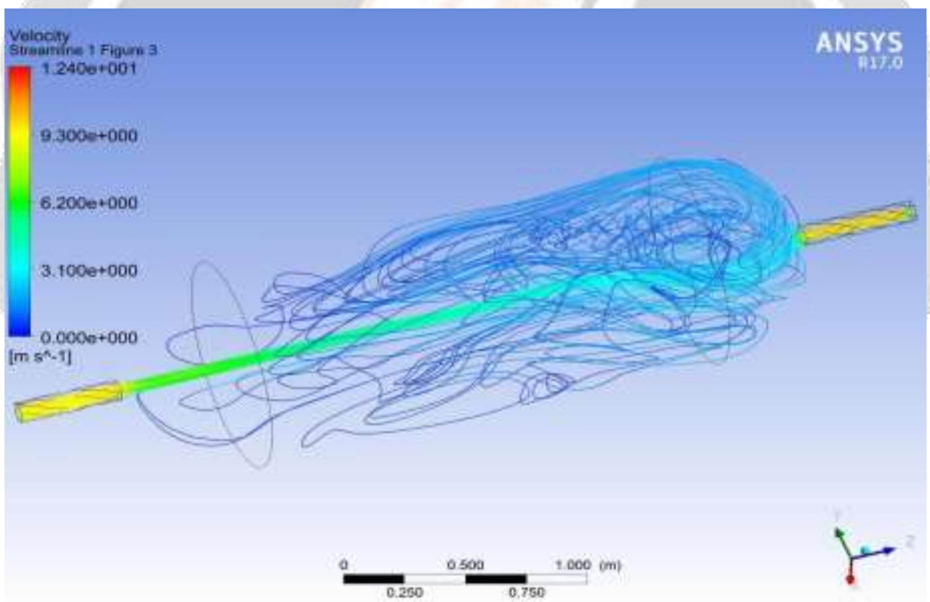


Fig. 4 Stremline Figure

4. CONCLUSIONS

From this Design calculation 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 CFD analysis it is clear that the deformation will be min. as a 0 and maximum as a 2.2141mm. and it is less than selected thickness i.e.5 mm, so the design should safe.

From the CFD analysis it should be clear that all the desin should be on the safe side and

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6. REFERENCES

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