Outline and Analysis of the Pressure Vessel by utilizing FEM

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Abstract: - *A weight vessel is intended to work under high weight condition so the determination of material and the outline of the weight vessel are generally imperative. In this paper, the warm investigation of weight vessel made of a composite material and subjected to give the aggregate warmth transition. The diagnostic outline of the weight vessel is by utilizing according to ASME code. The warmth transition for a weight vessel is figured with composite material. The demonstrating of weight vessel is completed in CATIA V5 and this model is foreign in ANSYS Workbench where warm examination is done. The therapist fit is connected amid the CAD demonstrating of weight vessel. Additionally weight and warmth motion are done for the weight vessel. The weight vessel is planned by methodology and details given in machine outline and outline information book. Measurements are figured and these are utilized for demonstrating the weight vessel in CATIA V5R20 The primary target of the work is to think about aggregate temperature and warmth transition of an auxiliary steel and aluminum amalgam materials in weight vessel at the best surface.*

Keywords: *Temperature, Heat flux, Pressure vessel materials etc.*

I. INTRODUCTION

The weight vessels (i.e. barrel or tanks) are utilized to store liquids under weight. The liquid being put away may experience a difference in state inside the weight vessel as if there should a rise an occurrence of steam boilers or it might consolidate with different reagents as in a compound plant. The weight vessels are composed with incredible care since crack of weight vessels implies a blast which may cause death toll and property. The material of weight vessels might be weak with the end goal that cast iron or pliable, for example, mellow steel.

Round and hollow or circular weight vessels (e.g., water powered chambers, weapon barrels, funnels, boilers and tanks) are normally utilized as a part of industry to convey the two fluids and gasses under weight. At the point when the weight vessel is presented to this weight, the material including the vessel is subjected to weight stacking, and subsequently worries, from all bearings. The ordinary burdens coming about because of this weight are elements of the sweep of the component under thought, the state of the weight vessel (i.e., open finished chamber, shut end barrel, or circle) and also the connected weight.

1.1Structural Steel

Auxiliary steel is a classification of steel utilized as a development material for making basic steel shapes. An auxiliary steel shape is a profile, framed with a particular cross segment and following certain gauges for synthetic synthesis and mechanical properties.

1.2 Aluminum compound

Aluminum compounds are composites in which aluminum (Al) is the dominating metal. The commonplace alloying components are copper, magnesium, manganese, silicon, tin and zinc. ... Around 85% of aluminum is utilized for fashioned items, for instance moved plate, foils and expulsions.

II. LITERATURE SURVEY

BHPV manual on Multilayer Pressure Vessel[1] et al has investigated There is a percentage saving in material of 26.02% by using multilayered vessels in the place of solid walled vessel. This decreases not only the overall weight of the component but also the cost of the material required to manufacture the pressure vessel. This is one of the main aspects of designer to keep the weight and cost as low as possible. The Stress variation from inner side to outer side of the multilayered pressure vessel is around 12.5%, where as to that of solid wall vessel is 17.35%. This means that the stress distribution is uniform when compared to that of solid wall vessel. Minimization of stress concentration is another most important aspect of the designer. It also shows that the material is utilized most effectively in the fabrication of shell. Theoretical calculated values by using different formulas are very close to that of the values obtained from ANSYS analysis. This indicates that ANSYS analysis is suitable for multilayer pressure vessels. Owing to the advantages of the multi layered pressure vessels over the conventional mono block pressure vessels, it is concluded that multi layered pressure vessels are superior for high pressures and high temperature operating conditions.

Henry H. Bednar [5] et al has investigated Theoretical calculated values by using Different formulas are very close to that of the values obtained from ANSYS analysis is suitable for multilayer pressure vessels. Owing to the advantages of the multi layered pressure vessels over the conventional mono block pressure vessels, it is concluded that multi layered pressure vessels are superior for high pressures and high temperature operating conditions.

Noel,M.R [15] et al has investigated Due to shrink fitting, compressive stresses developed in the layers counter tensile stresses induced due to internal pressure which results in decreased Hoop's stress. It is found that thickness required for shell of Mono Wall. Pressure vessel is higher than that of multi wall pressure vessel. Hence preference to multi wall vessel is justified both economically (material cost) and physically (material weight). Multi Wall Pressure Vessels are more useful in the high. Pressure applications than Mono Wall Pressure vessels. Thickness calculation of shell by ASME codes conforms. to Lami's theorem with very small error. Calculation on ANSYS gives the very small amount of. errors with the manually calculated quantities, which confirms the validity of design methodology.

Harold H.Wait[11] has investigated Fatigue analysis will be carried out for entire equipment for specified regeneration cycles and we will found fatigue life more than required cycles. Accordingly we conclude that all evaluation points for fatigue are within allowable limits specified by code. The maximum fatigue damage fraction observed which less than unity as required by code.

Fratcher [8]et al has investigated At present solid wall pressure vessels are used extensively. But by using multilayered vessels, there is a huge difference in weight. The weight is almost decreased by 18495Kg when multilayered vessels are used in place of solid vessels. This decreases not only the overall weight of the component but also the cost of the material required to manufacture the pressure vessel. This is one of the main aspects of designer to keep the weight and cost as low as possible. The stresses developed in the multilayered vessels are more when compared with solid vessels. Minimization of stress concentration is another most important aspect of the designer. It also shows that the material is utilized most effectively in the fabrication of shell. Owing to the advantages of the multi layered pressure vessels over the conventional single walls pressure vessels, it is concluded that multi layered pressure vessels are superior for high pressures and high temperature operating conditions.

The pressure vessel is designed according to procedures and specifications given in machine design and design data book. Dimensions are calculated and these are used for modeling the pressure vessel in CATIA V5R20 as shown in Fig

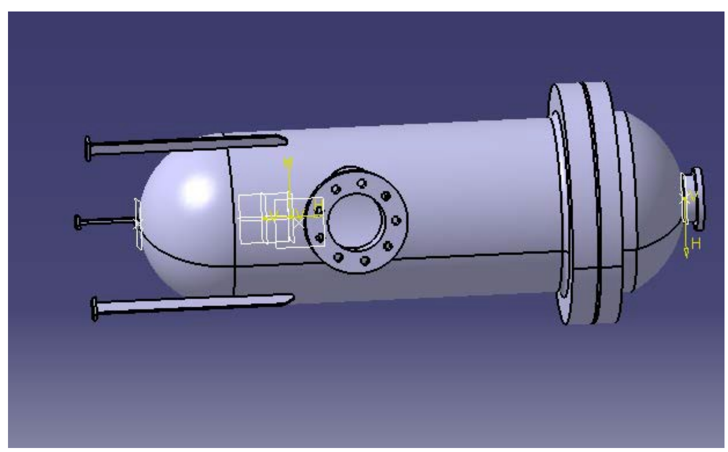

Fig.2.1 Pressure vessel.

Boundary Condition for Thermal Analysis of pressure vessel:

The thermal boundary conditions consist of applying a convection and temperature of the pressure vessel of two different materials of structural steel and aluminum alloy.

III. METHODS FOR DESIGN & ANALYSIS TO DEVELOP THE WORK

3.1 CATIA V5 R18: As the world's one of the provider of programming, particularly planned to help a completely Integrated item improvement process. Dassault Systems (DDS) in perceived as a vital accomplice which can help a maker to the transform a procedure into focused progress, more prominent piece of the overall industry and higher benefits and modern and mechanical plan to utilitarian reproduction assembling and data administration.

Catia Mechanical outline arrangement will enhance our plan efficiency. Catia is a suit of projects that are utilized as a part of outline, examination and assembling of an essentially boundless scope of the item." Feature based" implies that we make parts and gatherings by characterizing highlight like expulsion clears, cuts, gaps, round et cetera as opposed to determining low level geometry like lines, zones circles. This implies the creator can think about the PC demonstrate at an abnormal state and leave all low geometry detail for Catia to make sense of.

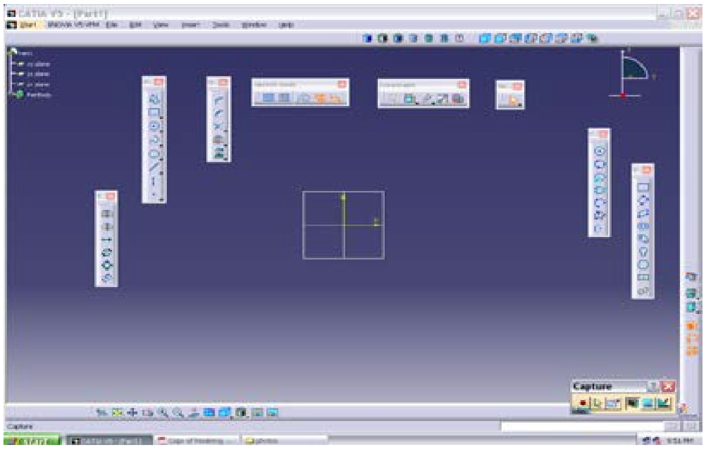

Fig.3.1 **Sketch 1 for Catia Manu bar**

The figure shows the sketcher Manu bar in catia.For this sketch Catia V5R18 software is using. It provides a greater flexibility for change, for example, if we like to change the dimensions in design assembly, manufacturing etc. will automatically change. It provides clear 3-D Model which are easy to visualize or model created and & it Also decrease the time required for the assembly to a large extent.

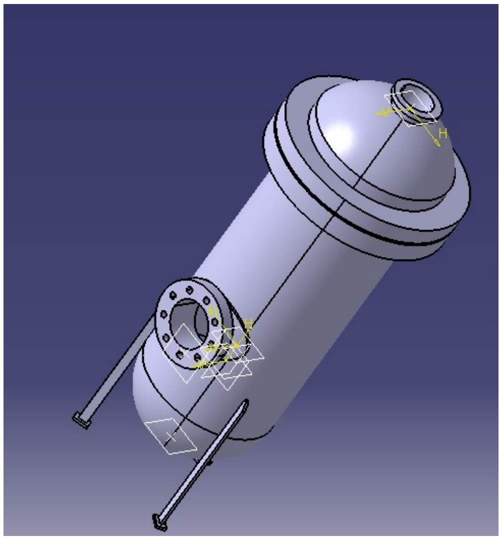

Fig.3. 2 Sketch 2 Pressure Vessel Design

This figure also shows the complete drawing of the pressure vessel in Y-direction.

3.2 ANSYS:

Dr. John Swanson founded ANSYS. Inc in 1970 with a vision to commercialize the concept of computer simulated engineering, establishing himself as one of the pioneers of Finite Element Analysis (FEA). ANSYS inc. supports the ongoing development of innovative technology and delivers flexible, enterprise wide engineering systems that enable companies to solve the full range of analysis problem, maximizing their existing investments in software and hardware. ANSYS Inc. continues its role as a technical innovator. It also supports a process-centric approach to design and manufacturing, allowing the users to avoid expensive and time-consuming “built and break” cycles. ANSYS analysis and simulation tools give customers ease-of-use, data compatibility, multi platform support and coupled field multi-physics capabilities.

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IV. ANALYSIS

The goal of this project is to determine both temperature and heat flux distributions of pressure vessel. Effects of the different materials of structural steel and aluminium alloy on temperature and heat flux distributions are investigated, including comparisons with results from an pressure vessel of Thermal analysis Using CATIA and ANSYS.

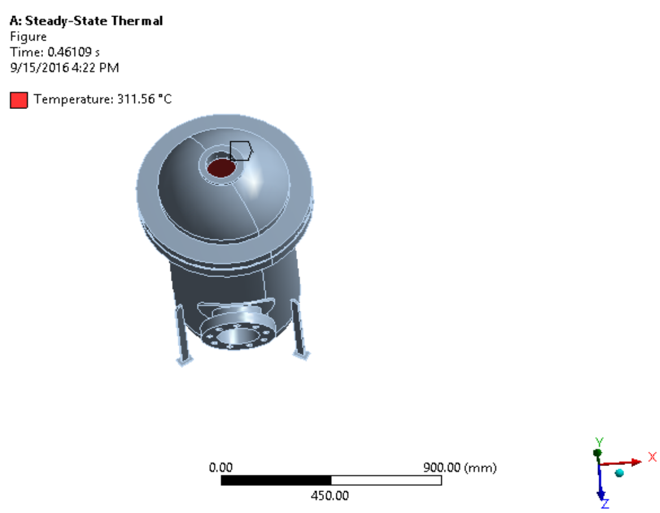

Fig 4.1 Steady-State Thermal when temperature is given

The figure shows the steady state thermal condition of the pressure vessel when the initial temperature is 311.56°c is given.

4.1 Material-Structural Steel

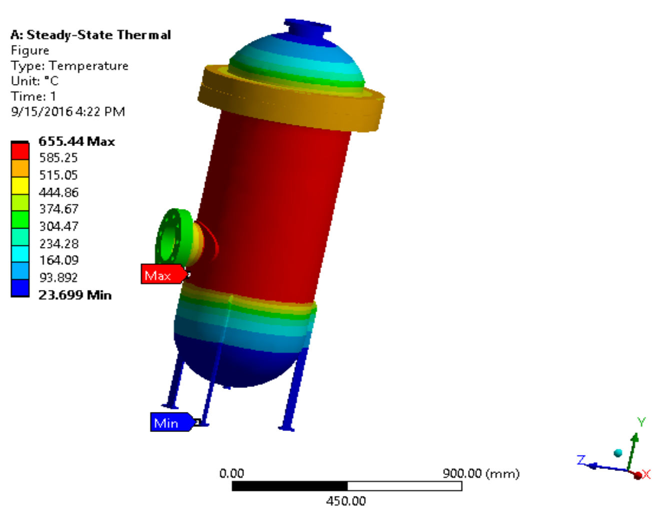

Fig 4.2 Temperature of pressure vessel in structural steel material

The above fig. Shows total temperature distribution throughout the pressure vessel.

In this condition the temperature distribution is varies from one element to other element. The minimum temperature of the component is 23.699°c and the maximum temperature of the components is 655.44°c.

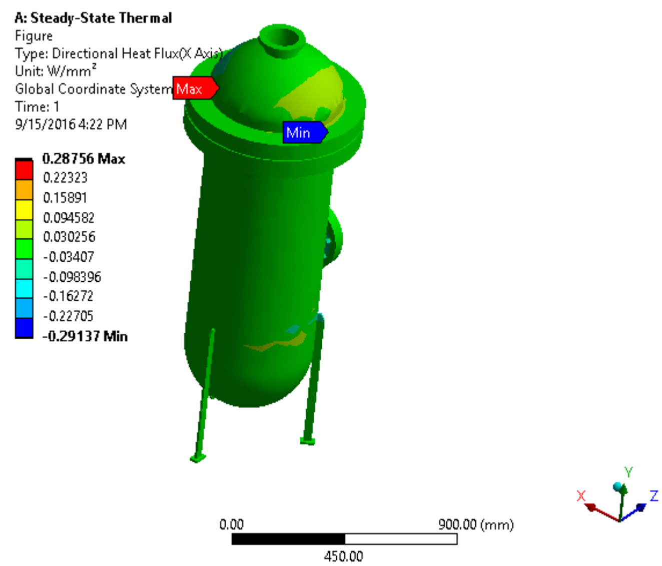

Fig 4.3 Heat flux of pressure vessel in structural steel

The above fig. Shows total Heat flux distribution throughout the pressure vessel. In this condition the heat flux distribution is varies from one element to other element. The minimum heat flux of the component is -0.29137 W/mm^2 and the maximum heat flux of the component is 0.28756 W/mm^2.

4.2 Material-Aluminum Alloy

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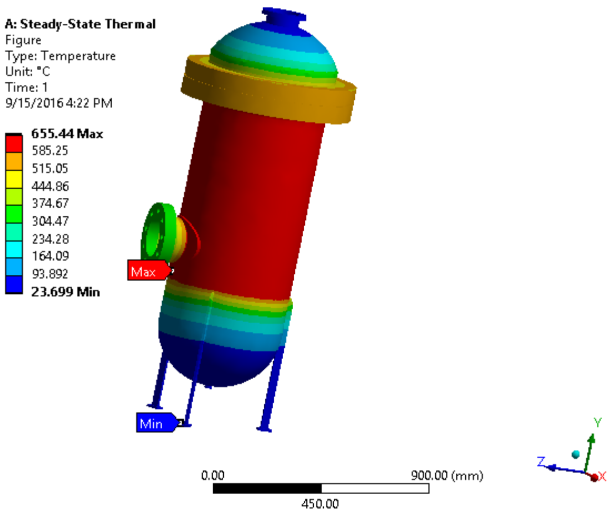

Fig 4.4 Temperature of pressure vessel in aluminum alloy

The above fig. Shows total temperature distribution throughout the pressure vessel.

In this condition the temperature distribution is varies from one element to other element. The minimum temperature of the component is 23.699°c and the maximum temperature of the components is 655.44°c.

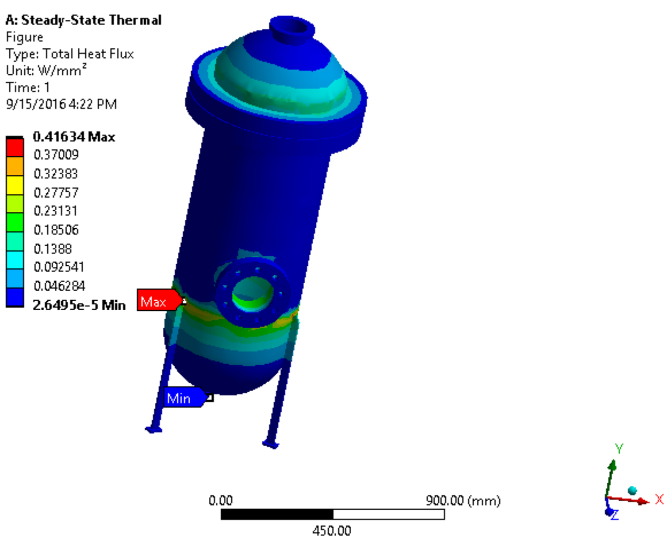

Fig 4.5 Heat flux of pressure vessel in aluminum alloy

The above fig. Shows total Heat flux distribution throughout the pressure vessel. In this condition the heat flux distribution is varies from one element to other element. The minimum heat flux of the component is -0.26495 W/mm^2 and the maximum heat flux of the component is 0.41634 W/mm^2.

V. RESULTS AND DISCUSSION

Structural Steel

Table: 5.1: analysis between Structural Steel Vs Constants

Properties	Values
Compressive Yield Strength MPa	280
Tensile Yield Strength MPa	280
Tensile Ultimate Strength MPa	310
Reference Temperature °C	22

Properties	Structural Steel	aluminium alloy
Temperature (°c) Min	23.699	0.52725
Temperature (°c) Max	655.44	0.27489
Heat flux in max (w/mm^2)	-0.29137	-0.2649
Heat flux in max (w/mm^2)	0.28756	0.4163

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Table: 5.2: Values of the aluminium alloy properties

Properties	Values
Compressive Ultimate Strength MPa	0
Compressive Yield Strength MPa	250
Tensile Yield Strength MPa	250
Tensile Ultimate Strength MPa	460
Reference Temperature° C	22

The table shows the properties of the component of the pressure vessel and their values. Compressive Ultimate Strength is 0 MPa, Compressive Yield Strength is 250 MPa, Tensile Yield Strength is 250 MPa, Tensile Ultimate Strength is 460 MPa and Reference Temperature is 22° C.

VI. CONCLUSION

The paper has prompted various conclusions. Be that as it may, significant conclusions are as underneath:

- The plan of weight vessel is introduced with the detail necessities regarding standard specialized particulars alongside various prerequisites that lay avoided the market.
- The outline of a weight vessel is all the more a determination system, choice of its parts to be more exact rather planning every last segment.
- The weight vessel parts are simply chosen, yet the determination is extremely basic, a slight change in choice will prompt an alternate weight vessel al-together from what is intended to be composed.
- It is watched that all the weight vessel parts are chosen on premise of accessible ASME gauges and the produces additionally take after the ASME models while fabricating the segments. With the goal that leaves the fashioner free from outlining the parts. This part of Design extraordinarily lessens the Development Time for another weight vessel.

Scope of Future Work

In outline of weight vessels FEA device can be successfully utilized. Regularly it causes the fashioner to comprehend thermo mechanical conduct of weight vessel. General conclusions in view of present investigation are as beneath:

- ❖ Pressure vessel is composed and investigated for the given thermo mechanical burdens.
- ❖ Maximum anxiety instigated because of weight alone in the shell is figured utilizing ASME recipe and looked at. With the investigation esteems and the greatest rate blunder is 15%.
- ❖ Safe working conditions for the vessel are checked inside system of FEA propelled strategies.
- ❖ Design approach of weight vessel are by ASME codes and Finite component investigation out of which examination of Pressure vessel by FEA strategy is simple and get ideal parameters.
- ❖ Design count of FEA is contrast and ASME heater and weight vessel controls. In Comparison of the outcomes and outline parameters figured by ASME heater and weight

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- Vessel code and limited component investigation are in thickness and lessens in weight of weight vessel.
- Optimize outline by FEA lessens the aggregate Cost of weight vessel.
- The advancement in plan of weight vessel utilizing FEA is protected and has effectively fulfilled the objective of financial matters.

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