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A Review of Pressure Vessel Head using ANSYS

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Abstract- Pressure vessels are highly used in industries and in commercial purposes such as filtration, boiling, softening and hot water storage tanks. Pressure vessels are subjected to thermal loads and structural loads such as internal and external pressures which leads to its deformation. Present work focusses on the modeling of the pressure vessel according to standard dimensions using ANSYS software and analyzing it for three different shapes of pressure values Flat pressure Head, Hemispherical pressure Head, Conical pressure Head using finite element approach. The finite element analysis results have been presented in graphical form.

Key Terms— Conical, ANSYS, Hemispherical.

I. INTRODUCTION

Pressure vessel is closed container which is used for the storage of highly pressurized fluid; fluid may be gaseous or liquid. The pressure inside of the Container is always much greater than the outside pressure called ambient pressure. This also termed as Storage tank as it is used to keep the fluids under pressure. Fig 1.1 shows model of Pressure vessel which will be used for LPG storage.

Figure 1.1: Horizontal Pressure vessel used of LPG gas

Applications

- Petroleum's for the storage of Diesel, Petrol
- Gaseous fuel storage- LPG,CNG
- Milk storage
- Water storage and transportations.
- Chemicals
- Oxygen and nitrogen storage for medical purposes.

Classifications of Pressure vessel

Pressure vessel may classify in the following category:
These are the Pressure vessel based on the applications-

A. Operational Pressure vessel.
B. Storage Pressure vessel.
C. Transportation Pressure vessel.

It also can be categorized based on these two criteria; one is on the basis of Position –

A. Horizontal Pressure vessel.
B. Vertical Pressure vessel.

And another one is on the basic of shell thickness and pressure.

A. Thick Shell.
B. Thin Shell.

II. LITERATUERE SURVEY

Jilin Xue et al. In 2022, the researchers have worked for the stainless steel cladded liner over the Pressure vessel wall for the corrosion resistance. This research was motivated to calculate the anisotropic elastic constants; the impact of the welding residual stress was calculated in the work. Experimental counter method was used to execute this work.

Shaik Abdul lathuef and Mr. K. Chandrashekhar et. al, In the year 2021 a design and structural analysis was proposed for the Pressure vessel with a modification in position of opening of Pressure vessel. In this research work the researchers has experimented with the nozzle location to figure the effects in the structure. Standard set by ASME and EN 13445 was followed to minimize the stress by altering the position the nozzle and along with that an attempt was made for the bringing of a thickness thinner what can sustain the applied pressure. Different nozzle orientation was employed for 8mm thickness of the shell by using Finite Element Method.

Sadanandam et al., The researchers have proposed in the year 2019. An approach was used by designing and analyzing the Pressure vessel using Finite Element Method. In these methods the research has tried to compose a material which is best suited as per the constraint and for this a manual calculation was also done to validate the result of analytical method. Maximum principle stress theory and Distortion theory was used to follow the standards. Stainless steel 18Cr/8Ni(304) of minimum thickness of 3 mm was used for the analysis . A comparison was made between the conventional and analytical design and was found that the result of analytical approach is more accurate.

Onur Gungor et. al, In the year 2018 an approach was proposed by the researcher for the thick cylinder Pressure vessel. In this work an optimized techniques was used for the wall thickness to reduce the weight of the cylinder shell, specifically weight/load carrying capacity. Distribution of residual stress by the auto fret age method was used in which material from the inside and outside wall of cylinder was removed to make it light weighted. A numerical calculation was done for residual stress and compared with the analytical result of the effect of residual stress after auto fret age. 22.9 % weight reduction was done by using numerical and in addition with this an extra 4.2 % weight reduction was an outcome of this work.

Mutahir Ahmed et al. In the year 2014 an investigation was done by the researchers for the combined thermal and mechanical loading what causes expansion load as temperature increases. Design and Analysis was performed and compared the stress between various geometry of Pressure vessel. An optimized approach was used for thermal and structural loading and study was done for hoop stress, von-Mises stress and deformation. FEA analysis was used for the Pressure vessel containing Hydrogen fuel with an internal Pressure of 5MPa and Oil temperature of 250°C.

R Pramod et al. In the year 2013 an attempt was made for the design and analysis of Pressure vessel using composite overwrapped Pressure vessel (COPV). In this work AA 6061-T6 material was used with galvanized steel with CMT type welding process for the aluminium alloy liner was tested for the pressure sustainability under pressure and optimized thickness was analyzed using FEM ABAQUS software. A numerical approach was used using FEA tool and found that the result are satisfactory and helps to reduce the thickness for the same amount of pressure.

Prashant Kumar et al. In the year 2012, a research was conducted by the researchers for the design and analysis of Pressure vessel, in which PV Elite software was used to perform the analysis. This design intended to find out require thickness of the shell at the pressure of 3 kg/cm^2 what earlier used to operate at ambient temperature. ASME(BPVC) sec-VIII div-I was followed for the calculation of thickness and using PV Elite the material removed was supposed to be compensate with RF pad and was found the this much of pressure also can be sustained.

III. OUTCOME OF THE LITERATURE SURVEY

After going through the Literature survey following outcomes were identified:

- By modifying the geometry a slight differences in the stress intensity is expected and this can be applied in the design of Pressure vessels.
- Very few structural modification is done in the past research work, this structural modification can helps researcher to find a better output.
- For FEM based design and analysis it is rarely seen that the whole body analysis was performed like design for shell, design for head, design for nozzle, design for flanges and design for saddle, for the more accurate result whole body design and detail analysis should be performed.

- While designing Pressure vessel, both external and internal pressure should be considered for the better result, rarely done so only few loads are considered even both internal and external pressure are taken into account.

IV. RESEARCH GAP ANDCONCLUSIONS

Following research gaps have been made after studying the literature outcomes:

- Not many attempts have been made in the context of the stress minimization in Pressure vessel
- An attempt can be made by reducing the radius of cylinder what can help to minimize magnitude of stress but due to this the volume will go slightly down so this can be compensate by enlarging the cylinder length but this is not seen in the literature .
- No attempts are made for the grooving like structure of the Pressure vessel what actually can help in the stress redistribution.

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