Analysis of Pressure Vessel by using Stiffeners: A Review

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Abstract— A pressure vessel is a closed container designed to hold gases or liquids at a pressure different from the ambient pressure. The end caps fitted to the cylindrical body are called heads. Pressure vessels are used to store fluids under pressure. A vessel that is inadequately designed to handle a high pressure constitutes a very significant safety hazard. Because of that, the design and certification of pressure vessels is governed by design codes such as the ASME Boiler and Pressure Vessel Code in North America, the Pressure Equipment Directive of the EU (PED), Japanese Industrial Standard (JIS), CSA B51 in Canada, Stoomwezen etc. In the present work simple pressure vessel, inner stiffeners pressure vessel and outer stiffeners pressure vessel have been used for comparative analysis based on various parameter (Stress, Displacement, Strain, mass) for alloy steel and Kevlar material.

Key words: Inner And Outer Pressure Vessel, Solid Works, Alloy Steel, Kevlar

I. INTRODUCTION

A pressure vessel is a closed container designed to hold gases or liquids at a pressure different from the ambient pressure. The end caps fitted to the cylindrical body are called heads. Pressure vessels are used to store fluids under pressure. The fluid being stored may undergo a change of state inside the pressure vessel as in case of steam boilers or it may combine with other reagents as in a chemical plant.

The material of pressure vessels may be brittle such that cast iron or ductile such as mild steel. Pressure vessel often has a combination of high pressure together with high temperature and in some cases flammable fluids or highly radioactive material. Cylindrical or spherical pressure vessels are commonly used in industry to carry both liquids and gases under pressure.

A. Types of pressure vessel

1) Spherical Pressure Vessel (Sphere)

This type of vessel is preferred for storage of high pressure fluids. A sphere is a very strong structure. The even distribution of stresses on the sphere's surfaces, both internally and externally, generally means that there are no weak points. Spheres however, are much more costly to manufacture than cylindrical vessels.

Storage Spheres need ancillary equipment similar to tank storage - e.g. Access manholes, Pressure, Vacuum vent that is set to prevent venting loss from boiling and breathing loss from daily temperature or barometric pressure changes.

2) Cylindrical Pressure Vessel

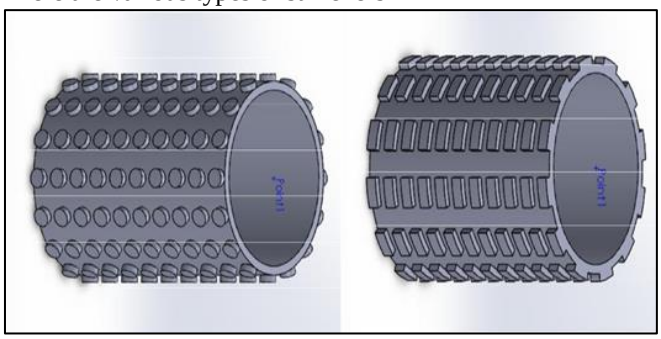
Cylinders are widely used for storage due to their being less expensive to produce than spheres. If the whole cylinder is manufactured from thicker material than a comparable spherical vessel of similar capacity, storage pressure can be similar to that of a sphere.

3) Stiffeners

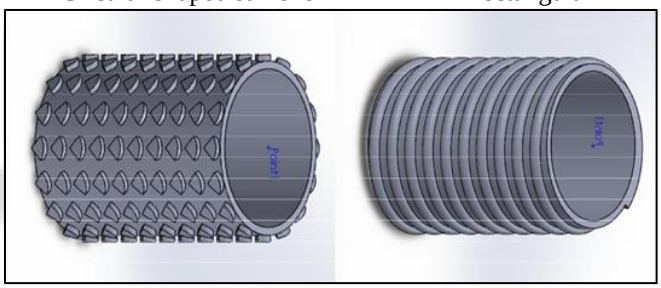
Stiffeners are secondary plates or sections which are attached to beam webs or flanges to stiffen them against out of plane deformations. Stiffeners provide stiffness to vessel. In pressure vessel it used for better stiffness and weight reduction.

B. Types of stiffeners

There are various types of stiffeners



Circular shaped stiffener Rectangular



Sector Shaped Helical shaped

II. LITERATURE REVIEW

Ehud kroll et.al(2018) [1] "Weight reduction of 3D-printed cylindrical and toroidal pressure vessels through shape modification" this study investigate that the significance of minor geometrical modifications of the torus cross section on its weight—about 63% weight reduction in this case.

Eswara Kumar.A et.al (2018)[2] "Static and Dynamic Analysis of Pressure Vessels With Various Stiffeners" in this wok helical type stiffners design carrid out With comparing to the basic cylinder, the helical stiffener design having a weight reduction of 28% and 0.5% more specific structural stiffness. In strength point of view,helical stiffener design having 23% less von mises stress than basic cylinder.

Rashmi Khobragade el.al(2017)[3] "Design, And Analysis of Pressure Vessel with Hemispherical and Flat Circular End" in this work Horizontal pressure vessels are analysis for three different curved saddle supports and vertical pressure vessels for three different lengths of legs and modifications are done for better functioning of pressure vessels.

Anandhu P D et.al(2017)[4] "Design and Analysis of Horizontal Pressure Vessel and Thickness optimization" This project deals with design and analysis of horizontal pressure vessel and also thickness optimization of vessel. Pressure vessel is a container for confining fluid at elevated temperature and pressure. The result obtained in this work that the thickness of vessel can be reduced from 18mm to 16mm ,by increasing the diameter of manhole pad from 996mm to 1500mm.We also observed that mass of the vessel can be reduced from 10138 kg (pressure vessel with 18 mm thickness and manhole reinforcement pad of diameter 996 mm) to9319 kg (pressure vessel with 16 mm thickness and manhole reinforcement pad of diameter 1500 mm).So wehave been able to reduce the mass of vessel upto 819

Prof. Chaudhari P. Sandip(2016)[5] "Pressure Vessel Analysis by Using FEM" this work concluded that addition of stiffener rings helps to reduce the thickness of the shell by 25% compare to pressure vessel without stiffeners, which in turn helps in saving of material and cost associated with it. The overall cost reduction is achieved up to 14 %

A. DEVARAJU et.al(2015)[6] "A Study On Stress Analysis For Design Of Pressure Vessel" in this work It was found that the values are found to be within the limits. The ANSYS results are compared with allowable stresses and found that the values are also within the limits.

Vishal V. Saidpatil (2014)[7] "Design & weight Optimization of Pressure Vessel Due to Thickness Using Finite Element Analysis." In this work FEA analysis has been done and and optimize that the Comparison of the results and design parameters calculated by ASME boiler and pressure vessel code and finite element analysis are in thickness and reduces in weight of pressure vessel.

Viraj H .Barge(2013)[8]"Thermal structural analysis &optimization of pressure vessel using finite element analysis" this study carried out with the design problem in the pressure vessel is that the holes at the bottom of pressure vessel which controls the mass flow rate are the weak regions structurally & thermally.

III. SUMMARY

It has been studied that from all literature review that The Strength to weight ratio is very low for steel and if we can increase this strength to weight ratio, then we could either reduce the weight of the vessel for same strength or we could increase the pressure inside the vessel by increasing the mass.

IV. CONCLUSION

Pressure vessels are very important in human life for industrial purpose and transportation.

So in our study on pressure vessel in future problems from literature review can be overcome by using stiffeners and by changing material with the help of different parameter can reduce the weight and easily use in transportation and industrial purpose.

