Study of Alloy Steel Pressure Vessel with Aramid Fiber Stiffeners

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Abstract— Pressure vessels are containers which hold gases or liquids at a higher pressure than the ambient pressure. A vessel that is improperly designed to handle a high pressure leads to very significant safety hazard. Because of safety features, the design and certification of pressure vessels is governed by design codes. In present work FEA method has been used for analyzing the design of pressure vessel. FEA has been used to analyze the virtual model and perform calculations with given boundary conditions. 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 Technora material. After analysis it was found that the Technora material is better than the alloy steel for design of pressure vessel when providing outer stiffeners.

Keywords: Inner Pressure Vessel, Solid Works, Alloy Steel, Stress, Strain, Displacement, Mass Reduction

I. INTRODUCTION

Container designed to hold gases or liquids at higher or lower pressure dissimilar from the ambient pressure is called a pressure vessel. The material of pressure vessels plays a very important role in the strength of the pressure vessel. It 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 very common and are used in industries to hold liquids as well as gases under pressure.

II. LITERATURE REVIEW

Yarrapragada et al., [1] did a 3-D finite element analysis using ANSYS-12.0 for static and buckling analysis on the pressure vessel. Hossam, I., et al. [2] presented the challenges in designing of rocket motor case structures (RMCS) and concluded the optimum design of RMCS.

Kleber, Richard M., et al.[3] has discussed about the layers in a composite pressure vessel assembly. Briggs, Kerry D [4], discussed about a composite pipe for transportation of fluids. Mhetre, Tejas Vasant [5] designed a reactor pressure vessel to hold gases or liquids above atmospheric pressure using FEM. Praneeth et al. [6] did FEM analysis of pressure vessel.

Pressure vessels are used for storing gases and liquids at high pressures. Materials other than the metals can have better properties than the pure metal. Using FEM, performance analysis of pressure vessels can be easily done.

III. GEOMETRY, DESCRITISATION AND BOUNDARY CONDITIONS

Geometry of pressure vessel has been modeled in Solid works.

Fig. 1: Geometry of pressure vessel

After creation of geometry the mesh of the pressure vessel has been generated using the default values.

A. *Boundary Conditions*

The cylindrical pressure vessel is not allowed to have any deformation or movement in axial direction, so as to allow it to have only radial deformation. The vessel is subjected to radial outward pressure of 500 Mpa from the inside cylindrical surface.

Components	X	Y	Z	Resultant
Reaction force (N)	12.1729	-28.002	235.685	237.654
Reaction Moment (N-m)	0	0	0	0

Table 1: Fixture details and load condition

IV. RESULTS AND DISCUSSIONS

With the help of function calculators all the parameters at desired locations have been found out. The obtained values have been shown in figures.

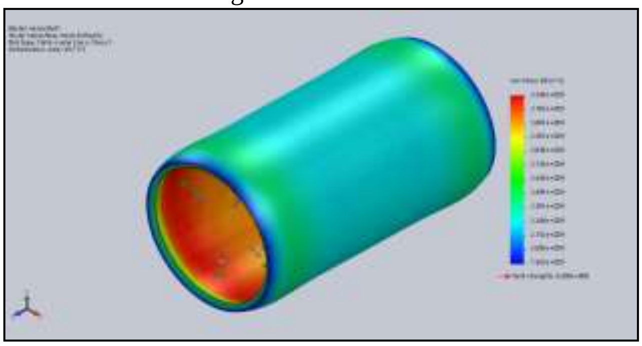

Fig. 2: stress variation of simple cylinder alloy steel

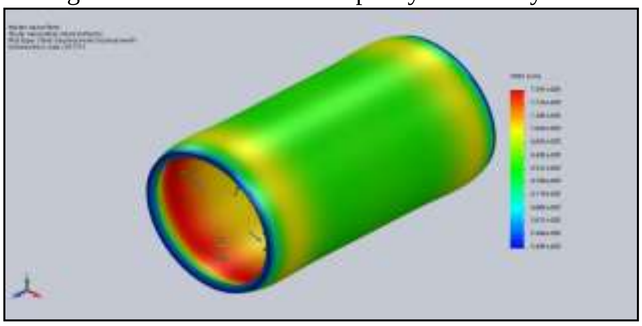

Fig. 3: displacement variation of simple cylinder alloy steel

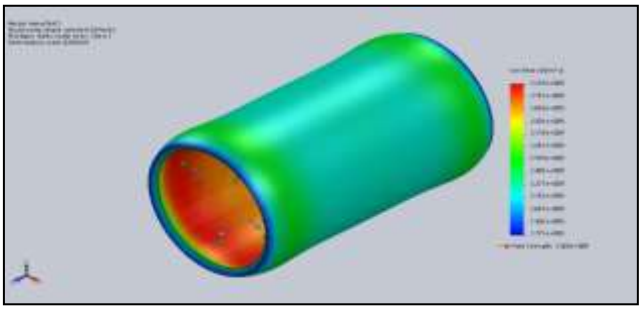

Fig. 4: stress variation of simple cylinder Technora

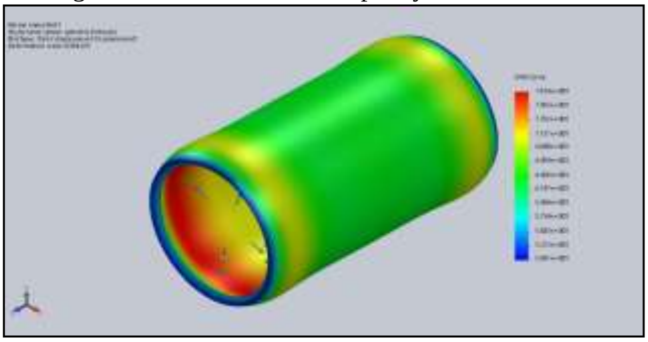

Fig. 5: displacement variation of simple cylinder Technora

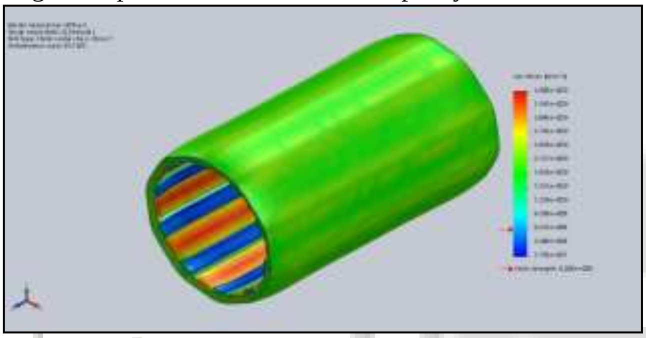

Fig. 6: stress variation of inner stiffeners cylinder alloy steel

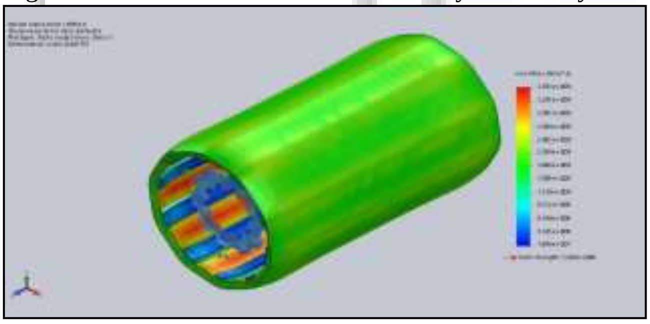

Fig. 7: stress variation of inner stiffeners cylinder Technora

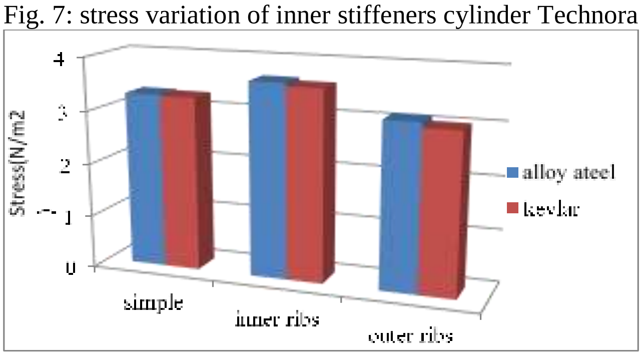

Fig. 8: Stress variation with and without stiffeners

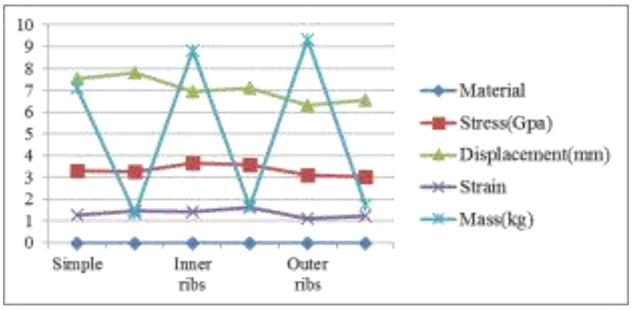

Fig. 9: Comparison of all the parameters

V. CONCLUSIONS

It has been observed that a huge amount of reduction in weight is obtained while keeping the stress levels same in case of Technora material which is 81.30% less than steel. It has also been observed that creating ribs on the outer surface of the cylinder tends to reduce the stress that the vessel is undergoing. Whereas the value of stress increases after providing inner ribs

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