International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 4 Issue 6, September-October 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

A Basic Review on Pressure Vessels

Shubham Choudhary[1], N. V. Saxena[2]

[1]Research Scholar, [2]Assistant Professor,
[1,2]Department of Mechanical Engineering, Millennium Institute of Technology, Bhopal, Madhya Pradesh, India

ABSTRACT
A pressure vessel is a container which holds gases or liquids at a pressure higher than the ambient pressure. They are used to store fluids under 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. Example ASME Boiler and Pressure Vessel Code, the Pressure Equipment Directive of the EU (PED), Japanese Industrial Standard (JIS), CSA B51 in Canada, Stoomwezen etc. In the present paper, work done by various researchers across the globe has been summarized. It can be concluded that with the help of CFD designing of pressure vessels can be very easily done.

KEYWORDS: *Inner pressure vessel, solid works, alloy steel, stress, strain, displacement, mass reduction*

How to cite this paper: Shubham Choudhary | N. V. Saxena "A Basic Review on Pressure Vessels" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-6, October 2020, pp.282-283, URL: www.ijtsrd.com/papers/ijtsrd33366.pdf

IJTSRD33366

INTRODUCTION

A pressure vessel is a container designed to hold gases or liquids at a pressure dissimilar from the ambient pressure. The end caps fitted to the cylindrical body are called heads. 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 hold both liquids and gases under pressure.

LITERATURE REVIEW

Yarrapragada et al., [1] expressed that outer shells of the pressure vessels are made up of conventional metals which are used for various applications. The performance/ speed/operating range of the pressure vessels depend upon its weight. Lower weight leads to better performance. The use of composite materials improves the performance of vessel and reduces the weight. The author has done graphical analysis to find optimum fiber orientation for given layer thicknesses for a pressure vessel. The author has done 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). The authors have described the construction and different operational loads that govern its design. Different materials that are suitable for use have been worked upon. The authors have discussed complexities of the design process using conventional and composite materials in details. The optimum design of RMCS has been studied and concluded.

Kleber, Richard M., et al.[3] has discussed about the layers in a composite pressure vessel assembly. The first material layer comprising of composite material is formed on the exterior surface of the tubular member. The second material layer comprising of second composite material is formed on the first material layer with a portion of the second material layer being disposed into the annular groove. The third material layer comprising of third composite material including fibers is formed adjoining the second material layer.

Grandt, Axel, et al., [4] invented a catheter having an elongate main body having a proximal section and a distal section. The elongate main body includes a first and a second guidewire lumen each including a proximal port and a distal port in communication with an external environment.

Briggs, Kerry D [5], has discussed about a composite pipe which could be wound on a reel and which can be quickly deployed at cheap price for carrying water from one location to another. The minimum burst strength of pipe is about 3,000 psi with a minimum tensile strength of about 130,000 lbs., the specific gravity of pipe material is less than that of water when expty and greater than that of water when in use.

Mhetre, Tejas Vasant [6] designed a reactor pressure vessel to hold gases or liquids above atmospheric pressure. Finite Element Model has been developed to predict the performance of the pressure vessel which is designed to be subjected to extreme pressure and temperature and the performance has been compared with pressure vessel manufactured of conventional materials. A carbon steel material pressure vessel system has been analysed under design pressure and temperature for stresses, deformation and Safety Factor. Various loading cases have been considered. Finite element analysis of internally pressurized cylindrical vessel with closed ends metallic liner has been done. The structure was examined for various composite materials such as E-glass, S-glass and Carbon Fibre or their combination with different ply angles under similar boundary conditions. It was found out that pressure vessel with metallic liner and composite wrapping was safer and lighter than carbon steel pressure vessel under considered conditions.

Von Oepen et al., [7], invented a catheter having an elongate main body with a proximal section and a distal section.

Teng, J. G. et al. [8] stressed on fiber-reinforced polymer (FRP) composites because of advantages such as their high strength-to-weight ratio and excellent corrosion resistant property. The authors have discussed the use of FRP in the strengthening of steel structures with the help of review of various other researchers. Steel surface preparation for adhesive bonding, selection of a suitable adhesive, bond behavior between FRP and steel and its appropriate modeling, flexural strengthening of steel beams, fatigue strengthening of steel structures, strengthening of thin-walled steel structures against local buckling, and strengthening of hollow or concrete-filled steel tubes through external FRP confinement have been covered.

Alderliesten, Rene [9] has focused on hybrid technology of combining metallic constituents with fibre reinforced polymers. The author has discussed an overview of the patents that have been filed worldwide on hybrid material concepts and related manufacturing aspects.

Behera, Ajit, et al. [10] has discussed about fiber-reinforced metal matrix nano-composite and its application because of better physical and mechanical properties. The effect of different reinforcement on MMCs on the mechanical properties such as tensile strength, strain, hardness, wear, and fatigue has also been covered. The authors has discussed about the fiber reinforced matrix in detail.

Praneeth et al. [11] did finite element analysis of pressure vessel and piping design. The authors have also discussed features of multilayered high pressure vessels, their advantages over mono block vessels. The parameters of Solid Pressure Vessel are designed according to the principles specified in American Society of Mechanical Engineers (A.S.M.E). The stresses developed in Solid wall pressure vessel and Multilayer pressure vessel has been analyzed by using ANSYS. The numerical results have been compared with the theoretical values.

Mohammad Z.Kabir [12] did numerical analysis of filament-reinforced internally pressurized cylindrical vessels with over-wrapped metallic liner. The structure has been modeled as an elastic, ideally plastic liner-reinforced with a quasi-isotropic elastic composite. A 3-D, 2-node interface element has been used to model contact at discrete points between the metallic liner and its surrounded composite shell. Numerical results have been obtianed for the effects of different head shapes and the superiority of optimum geodesic head shapes in reducing the maximum stresses.

Conclusions

Pressure vessels are used for various purposes. They are used for storing gases and liquids at high pressures. Fluid under high pressure is also passed through pressure tubes which has nearly same concept at pressure vessels. Nower days fibers are being used for manufacturing of pressure vessels and they have high strength as compared to the traditional material. Also, Computational Fluid Dynamics has made analysis of pressure vessels very easy.

References

[1] KSS, RAO YARRAPRAGADA, R. KRISHNA MOHAN, and B. VIJAY KIRAN. "Composite pressure vessels." International Journal of Research in Engineering and Technology 1.4 (2002).

[2] Hossam, I., Sh Saleh, and H. Kamel. "Review of challenges of the design of rocket motor case structures." *IOP Conference Series: Materials Science and Engineering*. Vol. 610. No. 1. IOP Publishing, 2019.

[3] Kleber, Richard M., et al. "Composite pressure vessel and method of assembling the same." U.S. Patent No. 8,757,423. 24 Jun. 2014.

[4] Grandt, Axel, Randolf Von Oepen, and Thomas Rieth. "Catheter having first and second guidewire tubes and overlapping stiffening members." U.S. Patent No. 7,625,353. 1 Dec. 2009.

[5] Briggs, Kerry D. "High pressure flexible pipe." U.S. Patent No. 4,850,395. 25 Jul. 1989.

[6] Mhetre, Tejas Vasant. *Finite Element Analysis of Composite Reactor Pressure Vessel*. Diss. 2018.

[7] Von Oepen, Randolf, Axel Grandt, and Thomas Rieth. "Catheter having plurality of stiffening members." U.S. Patent No. 7,785,318. 31 Aug. 2010.

[8] Teng, J. G., T. Yu, and D. Fernando. "Strengthening of steel structures with fiber-reinforced polymer composites." *Journal of Constructional Steel Research* 78 (2012): 131-143.

[9] Alderliesten, Rene. "On the development of hybrid material concepts for aircraft structures." *Recent Patents on Engineering* 3.1 (2009): 25-38.

[10] Behera, Ajit, Swadhin Patel, and Manisha Priyadarshini. "Fiber-reinforced metal matrix nanocomposites." *Fiber-Reinforced Nanocomposites: Fundamentals and Applications*. Elsevier, 2020. 147-156.

[11] Praneeth[1], Bandarupalli, and T. B. S. Rao. "Finite element analysis of pressure vessel and piping design." International Journal of Engineering Trends and Technology-Volume3Issue5-2012 (2012).

[12] Kabir, Mohammad Z. "Finite element analysis of composite pressure vessels with a load sharing metallic liner." Composite structures 49.3 (2000): 247-255.