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Analysis of Design of Multilayer High Pressure Vessel

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Abstract – Multilayer Pressure Vessels have expanded the craft of weight vessel development and gave the procedure fashioner a dependable bit of hardware valuable in a wide scope of working conditions for the issues created by the capacity of hydrogen and hydrogenation forms.

In this paper, "Structure and examination of multilayer high weight vessels" highlights of multilayered high weight vessels, their preferences over mono square vessel are talked about.

Keywords: Multilayer Vessels, Structure, Material

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INTRODUCTION

The term weight vessel alluded to those repositories or holders, which are exposed to inner or outside weights.

The weight vessels are utilized to store liquids under strain. The liquid being put away may experience a difference in state inside the weight vessels as in the event of steam boilers or it might consolidate with different reagents as in concoction plants. Weight vessels find wide applications in warm and atomic power plants, procedure and synthetic businesses, in space and sea profundities, and in water, steam, gas and air supply framework in enterprises.

The material of a weight vessel might be fragile, for example, cast iron, or malleable, for example, mellow steel.

HIGH WEIGHT VESSELS:

High Pressure vessels are utilized as reactors, separators and warmth exchangers. They are vessel with an essential base and a removable top head, and are by and large furnished with a gulf, warming and cooling framework and furthermore an instigator framework. High Pressure vessels are utilized for a weight scope of 15 N/mm2 to a limit of 300 N/mm2. These are basically thick walled round and hollow vessels, going in size from little cylinders to a few meters distance across. Both the size of the vessel and the weight included will direct the sort of development utilized.

Coming up next are not many strategies for development of high-weight vessels.

1. A strong divider vessel delivered by fashioning or exhausting a strong bar of metal.

2. A chamber shaped by bowing a sheet of metal with longitudinal weld.

3. Shrink fit development in which, the vessel is developed of at least two concentric shells, each shell continuously contracted on from within outward. From monetary and creation contemplations, the quantity of shells ought to be constrained to two.

4. A vessel developed by wire twisting around a focal chamber. The wire is twisted under pressure around a chamber of around 6 to 10 mm thick.

5. A vessel developed by wrapping a progression of sheets of generally flimsy metal firmly cycle each other over a center cylinder, and holding each sheet with a longitudinal weld. Rings are embedded in

the finishes to hold the internal shell round while consequent layers are included. The liner chamber for the most part up to12 mm thick, while the resulting layers are up to 6 mm thick

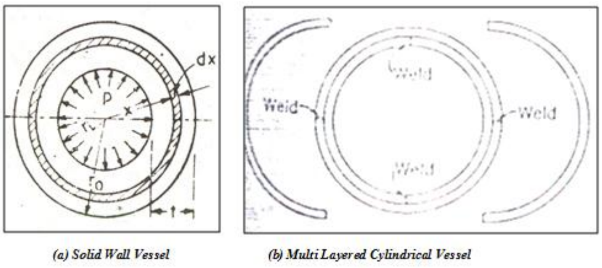

Fig.1 Types of High Pressure Vessels

LITERATURE REVIEW

David Heckman1 et.al (1998) Finite component examination is an amazingly incredible asset for weight vessel investigation when utilized accurately. Tried models were kept running with mistakes going from seven to about zero percent blunder and could be kept running in a generally brief time. Be that as it may, even with such outcomes the administrator still is required to be learned of not exactly how to run the limited component examination, yet additionally how to peruse the outcomes.

Information must be checked with hand counts to affirm that arrangements are moderately exact. Where results are faulty, for example, in the last contact component model, one must see exactly what the limited component model is demonstrating and how well this approximates the genuine subject. For this weight vessel, the model had a sharp corner, where in the genuine weight vessel there is a little sweep which diminishes the pressure. For weight vessels limited component investigation gives an extra device to use in examination.

Be that as it may, it must be contrasted with other accessible information, not taken as being right since it looks right. Utilized with this understanding, limited component examination offers extraordinary knowledge into the intricate collaborations found in weight vessel plan.

Farhad Nabhani2 et.al Three fundamental components are believed to contribute broadly to the advancement of worries in weight vessels. These are thickness, spout positions and the joints of the walled in area heads. From the model plan cases utilized in this exploration, it could be considered that to be the thickness of weight vessel builds, the burdens diminishes, anyway this is certifiably not a feasible arrangement because of expense. Spouts however are wellbeing alleviation gadgets and significant segment of weight vessels accompanies its own weaknesses of expanding feeble territories and stress focus.

In any case, this was relieved by utilization of high combination fortification cushions as connected in the structure case two and three of this work. The high quality fortification cushion utilized has a concoction organization of titanium 0.4 to 1.20%; empty circle formed with rectangular area can likewise decrease the anxieties fixation around the spout. At long last, the joints of fenced in area heads either welded or blasted were distinguished as territories with the most elevated grouping of stresses for example with pinnacle pressure. Expansion of 254 mm skirt length toward the finish of fenced in area heads give more space to the worries to grow gradually in the mass of the head areas, in this way making the weight vessels increasingly impervious to the loadings.

Siva Krishna Raparla13 et.al The hypothetical qualities and ANSYS qualities are thought about for both strong divider and multilayer weight vessels. There is a rate sparing in material of 26.02% by utilizing multilayered vessels in the spot of strong walled vessel. These reductions the general load of the segment as well as the expense of the material required to fabricate the weight vessel. This is one of the fundamental parts of creator to keep the weight and cost as low as could be allowed. The Stress variety from inward side to external side of the multilayered weight vessel is around 12.5%, where concerning that of strong divider vessel is 17.35%. This implies the pressure dissemination is uniform when contrasted with that of strong divider vessel. Minimization of stress focus is another most significant part of the planner. It likewise demonstrates that the material is used most viably in the creation of shell. Hypothetical determined qualities by utilizing various equations are near that of the qualities got from ANSYS examination. This demonstrates ANSYS investigation is appropriate for multilayer weight vessels.Owing to the upsides of the multi layered weight vessels over the customary mono square weight vessels, it is inferred that multi layered weight vessels are prevalent for high weights and high temperature working conditions.

Shaik Abdul Lathuef4 et.al In the previous quite a long while there have been critical changes to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code and the utilization of universal weight vessel codes, for example, EN13445.

This paper examines a portion of the potential unintended outcomes identified with Governing Thickness of shell according to ASME. Here have an extension to change the code esteems by take the base administering thickness of weight vessel shell to the ideal necessities and furthermore move of spout area to limit the worries in the shell. A low estimation of the factor of security brings about economy of material this will prompt more slender and increasingly adaptable and prudent vessels.

Here we assessed the worry in the vessel by Zick examination approach.

A numerical plan study was performed to assessment basic disappointment of weight vessels presented to inward weight by changing the shell thickness and spout area. By investigating these plots it evident that the base thickness 8mm will taken safe for configuration conditions.

Bandarupalli Praneeth5 et.al the principle goal of this paper is limited component examination of weight vessel and funneling structure. Highlights of multilayered high weight vessels, their points of interest over mono square vessel are talked about. Different parameters of Solid Pressure Vessel are structured and checked by the standards.

STRUCTURE OF MULTILAYER HIGH PRESSURE VESSEL

Multi layer vessels are developed by folding a progression of sheets around a center cylinder. The development includes the utilization of a few layers of material, more often than not with the end goal of value control and ideal properties. Multi layer development is utilized for higher weights. It gives inbuilt wellbeing, uses material financially, no pressure help is required. For destructive applications the inward liner is made of exceptional material and isn't considered for quality criteria. The external burden bearing shells can be made of high malleable low carbon amalgams.

Description of the problem:

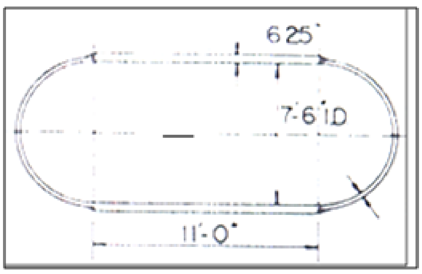

Fig: A typical Multilayer Pressure Vessel to be designed

DESIGN OBJECTIVES:

Design considerations:

1. A multilayer Vesesl is designed to ASME Code Section VIII division I.
2. A Safety Factor of "3" on Ultimate Tensile Strength is considered in the design of the multi-layer shell only. For other parts the Factor of safety is taken as "4" at room temperature.
3. A joint efficiency of 100% for longitudinal seam on liner shell is taken.
4. 100% radiography for longitudinal seam of liner shell.
5. Fully ultrasonic test for dished end plates is considered
6. Dished ends to be stress relieved after attachment of boss, nozzle etc.
7. The longitudinal welds in a multi-layered shell were staggered.
8. The number segments (longitudinal welds in a layer are taken as "3".
9. The coefficient of weld shrinkage is taken as 10% (From Davis R.L. "Circumferential welds in Multiplayer Pressure Vessel" Paper. 70-WA/PVP-6.)
10. The thickness of the liner shell is taken as 12mm.
11. The thickness of subsequent layers is 6mm.

DESIGN DATA OF THE VESSEL:

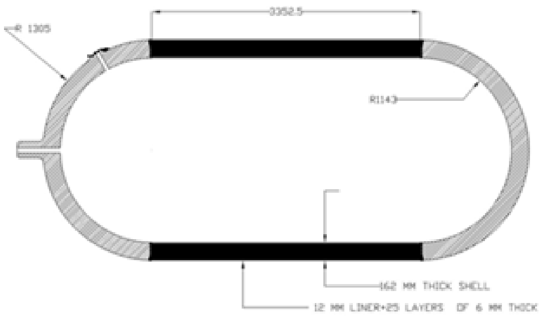

Fig: Drawing of Multilayer Pressure Vessel

Design Pressure	P	-	21 N/mm^2, Hydrogen.
Design Temperature, T		-	20^0C
Hydrostatic Pressure	P_H	-	27.3 N/mm^2

CASE 1: MATERIALS OF CONSTRUCTION

Description	Material	Type of Steel	UTS (Min) N/mm^2	YP (Min) N/mm^2
Shell Liner	SA 515 GR 70	Austenitic	492.9	267.6
Shell Layers	SA 515 GR 70	Austenitic	492.9	267.6
Dished Ends	SA 515 GR 70	Austenitic	492.9	267.6

Allowable Stress values:

Shell Liner & Layers	;	164 N/mm^2
Dished Ends	:	123 N/mm^2

DESIGN PARAMETERS:

The design of Multilayer pressure vassel includes,

(a) Design of Shell thickness

(b) Design of Dished end thickness

Design of Shell Thickness (t):

The Shell hold the solution under pressure and the peripheral stress is taken as plan stress. A joint in the longitudinal direction, which is considered in terms of joint efficiency, forms the shell.

Input Data:

Design pressure, P	: 21 N/mm^2
Inside radius of shell, R_i	: 1143 mm
Inside Diameter of the shell, D_i	: 2286 mm
Corrosion allowance, C.A	: 3.0mm
Joint efficiency, J	: 1.0
Permissible Stress for shell material, S	: 164 N/mm^2
Thickness of shell, t	:?

The thickness of the shell is calculated from the ASME modified membrane theory equation as:

$$t = \frac{P\ R_i}{S\,J - 0.6P} + C.A$$

$$= \frac{21 \times 1143}{164 \times 1 - 0.6 \times 21} + 3.0$$

$$= 161.64 \text{ mm}$$

Provided thickness, t=162mm (12mm liner) + 25 layers of 6 mm thick

The Thickness of Liner (Core Tube) = 12mm

The Tickness of Each Layer = 6mm

Numbe of Layers = 25

(i) Check for least Shell Thickness:

The base shell thickness required is checked by the condition according to API-ASME code for welded weight vessels is as

$$, t = \frac{P\ D_i}{2\ S\eta - P} + C.A$$

Where S = Design stress value for total thickness and is given by

$$S = \frac{S_c\ t_c + n\,S_l\ t_l}{t_c + n\,t_l}$$

S_c = Allowable stress at design temperature of liner = 164 MPa

S_l = Allowable stress at design temperature of layers = 164 MPa

n = Number of layers.

t_c = Thickness of liner or core tube

t_l = Thickness of layer

$$S = \frac{164 \times 12 + 25 \times 164 \times 6}{12 + 25 \times 6}$$

$$= 164\ N/mm^2$$

η = Weld Efficiency is given by the equation,

$$\eta = \frac{\eta_c\ t_c + (n - 1 + \eta_l)\ t_l}{t_c + n\,t_l}$$

$$\eta = \frac{1.0 \times 12 + (25 - 1 + 0.8)\,6}{12 + 25 \times 6} = 0.9925$$

The minimum required shell thickness:

$$t = \frac{21 \times 2286}{2 \times 164 \times 0.9925 - 21} + 3.0 = 160.2 \text{ mm}$$

Provided thickness (162 mm) is more than the required,

Hence the design is safe.

CONCLUSION

At present strong divider weight vessels are utilized widely. Be that as it may, by utilizing multilayered vessels, there is a gigantic distinction in weight. The weight is nearly diminished by 18495Kg when multilayered vessels are utilized instead of strong vessels.

These abatements the general load of the part as well as the expense of the material required to make the weight vessel. This is one of the fundamental parts of originator to keep the weight and cost as low as could be expected under the circumstances.

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