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The Design and Analysis of Pressure Vessel and Its Supports

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Abstract - The Designing play the significant role now-a-days in industry for increasing their productivity. Designing has many benefits such as time reduction, more productivity, improved utilization of materials, reduction in scraps and waste etc. This paper highlights design and analysis of pressure vessel through 'PV Elite' software. It also demonstrates the optimization of vessel based on the software. The aim of our project is to design the pressure vessel and to primarily work on its supports to optimize the cost by altering the thickness of material as well as by optimizing the geometrical parameters of the supports and to find whether supports can sustain the pressure under loading conditions.

Keywords- Optimization, Altering, Designing, Weight Reduction, Productivity, Significant, Utilization, Demonstrate.

1. INTRODUCTION

A pressure vessel is a closed container designed to hold gases or liquids at a pressure different from the ambient pressure as well as to generate steam at low pressure for a boiler drum. The vessel is made up of a cylindrical portion with the two ends closed by means of hemispherical structure. The end lids fitted to the cylindrical body are called heads. A nozzle is welded on at the midpoint of the length of the vessel which is supported on two supports. The design comprises parameters such as maximum safe operating pressure and temperature, safety factor, corrosion allowance and minimum design temperature (for brittle fracture). The vessel is constructed using material low alloy steel of type ASME SA-516 Gr70.

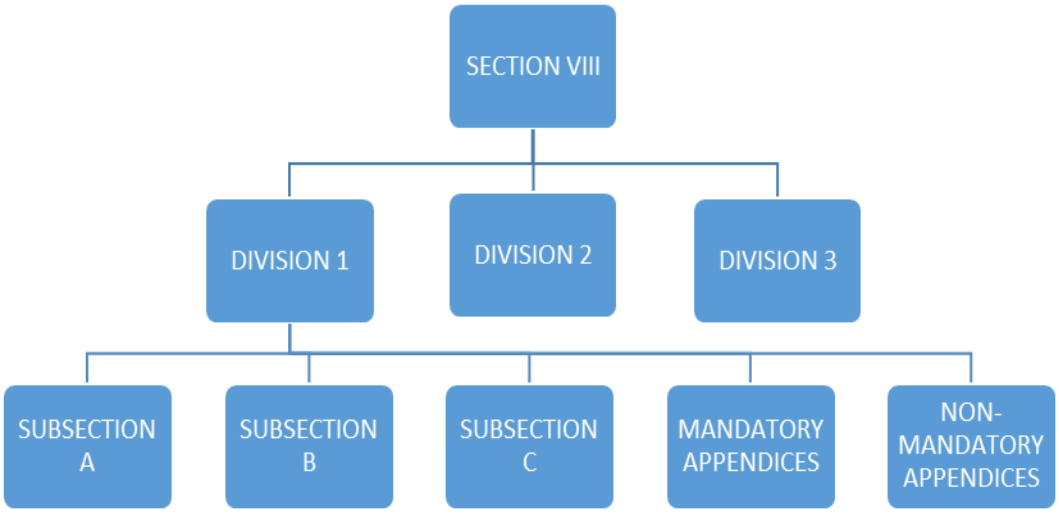

Figure 1. Section VIII

Division 1 is essentially for SMALL pressure vessel which are not able to sustain high pressure capacity.

Division 2 is essentially for HIGH pressure vessel which are there to sustain high pressure capacity. High pressure begins around 3000 PSI. Perhaps a better way to decide whether a pressure vessel is high pressure or not is based on R/t ratio. Ratio of R/t less than 10 should be considered as high pressure. The capacity of a pressure vessel depends on the fuel type used and it is the factor that decides whether a pressure vessel should be of DIV 1 or DIV 2. The optimization done within the vessel is finished by reducing the thickness wherever if possible so that it could work identical to the actual conditions of systematic data. The thickness is calculated by the trial and error method and then the finest suitable and optimal thickness is taken into the service. The material is also change according to the service condition, which would further benefit us in the reduction of cost. The input data specified for design is selected from the standard ASME Codes and then further method of optimization is applied. The designing of each part of vessel is carried out with different designing standard and aspect and each part has to be passed for the services.

1.1. Components used in pressure vessel:

A. Shell

The Shell is made up of a cylindrical portion used to hold gases or liquid at a high Pressure.

B. Vessel Head

Head is an end portion of pressure vessel designed in different shapes to withstand pressure in vessel. Shapes like Elliptical, Hemispherical, Tori spherical, etc. are used as per requirements.

C. Nozzle

The Nozzle are circular opening used for feeding. The large diameter nozzle is called as manhole, it is provided so that person could pass in for maintenance purpose.

D. Stiffener Ring

The stiffener ring is used to decrease the thickness of the shell and to eliminate the buckling of vessel.

E. Supports

There are three types of Pressure Vessel Supports

a) Saddle support (Horizontal Vessel Type)
b) Leg support (Vertical Vessel Type)
c) Skirt support (Vertical Vessel Type)
d) Bracket Support (Vertical Vessel Type)

F. Platform

It is used for maintenance purpose by which it makes easy for the man to reach each component of the vessel with minimum efforts.

G. Ladder

It is a component that is attached to the platform and helps the person to not only get to the platform but also reach to the surface of the vessel which are out of reach under platform.

H. Lifting

Lifting attachment is used for the erection of large diameter and heavy wall pressure vessels which requires distinct consideration to ensure that their attachment to their vessel shells or heads do not overstress the vessel throughout the erection process when lifting this from grade on to their respective foundation.

I. Tail Lugs

This are normally used to tail a vertical vessel. They are welded to the skirt and base ring. The lug plate is usually a single plate with or without pads at the lug hole.

J. Reinforcement pad

It is a donut shaped pad that goes around the branch of a branch joint to enhance strength to the joint.

1.2. Aim of paper

The aim and objective of this paper is to design a pressure vessel with assistance of designing software popularly known as 'PV Elite'. The main objective of optimizing the cost is achieved by reducing the material thickness by means of different trial and error methods for which the pressure vessel passes the designing criteria and conditions.

A. Service considerations
B. Cyclic service: Fatigue
C. Lethal Service
D. Vibration Service
E. Shock Service; Thermal or Impulse loading
F. Low Temperature service
G. Cryogenic
H. High Temperature Service
I. Creep – Fatigue
J. Corrosion Service
K. Special Services
L. Hydrogen Service Failure

1.3. General size categories of vessels

Type	Small		Medium		Large	
Horizontal/ Vertical	Diameter	<10 Ft	Diameter	10 to 15 Ft	Diameter	>15 Ft
	Weight	<25 Tons	Weight	25 to 50 Tons	Weight	>50 Tons
Trayed columns	Diameter	<10 Ft	Diameter	10 to15 Ft	Diameter	15 to25 Ft
	Weight	<30 Tons	Weight	30 to 100 Tons	Weight	>100 Tons
	Length	<50 Tons	Length	50 to 100 Ft	Length	>100 Ft
Reactors and high-pressure vessels	Diameter	<6 to9 Ft	Diameter	10 to14 Ft	Diameter	>15 Ft
	Weight	<200 Tons	Weight	200 to500 Tons	Weight	>500 Tons
	Thickness	2" to 4"	Thickness	4" to 6"	Thickness	>6"

2. PROCEDURE

This Procedure Table enables the user to input data about the number of stiffener rings he/she wants to allocate on the pressure vessel and stress on different location is automatically calculated on that location of pressure vessel as well as the stiffener rings which helps in reducing the thickness of pressure vessel with minimum effort and full accuracy for both vertical and horizontal pressure vessels.

	A	B
1	INPUT	
2	INNER DIAMETER (ID)	1000
3	TANGENT LINE(TL) TO TANGENT LINE (TL)	4500
4	NO OF RINGS	5
5		
6	VESSEL ID	+B6
7	TL TO TL	+B3
8	ID/12	+B6/12
9	2(ID/12)	2*B8
10	TL TO TL + 2(ID/12)	B7+B9
11	NUMBER OF STIFFNER RING	+B4
12		1+B11
13	SPAN	+B10/B12
14	OUTPUT	
15	1ST RING ELEVATION	+B13-B8
16	2ST RING ELEVATION	+B13+B15
17	3ST RING ELEVATION	+B13+B16
18	4ST RING ELEVATION	+B13+B17
19	5ST RING ELEVATION	+B13+B18
20	6ST RING ELEVATION	+B13+B19
21	7ST RING ELEVATION	+B13+B20
22	8ST RING ELEVATION	+B13+B21
23	9ST RING ELEVATION	+B13+B22
24	10ST RING ELEVATION	+B13+B23

3. RESULT

After designing the pressure vessels for both vertical and horizontal supports results were concluded that with the help of developer formulation one could achieve less thickness for same stress on any type of vessel.

Analysis done by the team are quite convincing as the result table and chart clears one's idea about what work is done and the final aim of the Project is achieved with the help of The Procedure Table or Developer Formulation in actual.

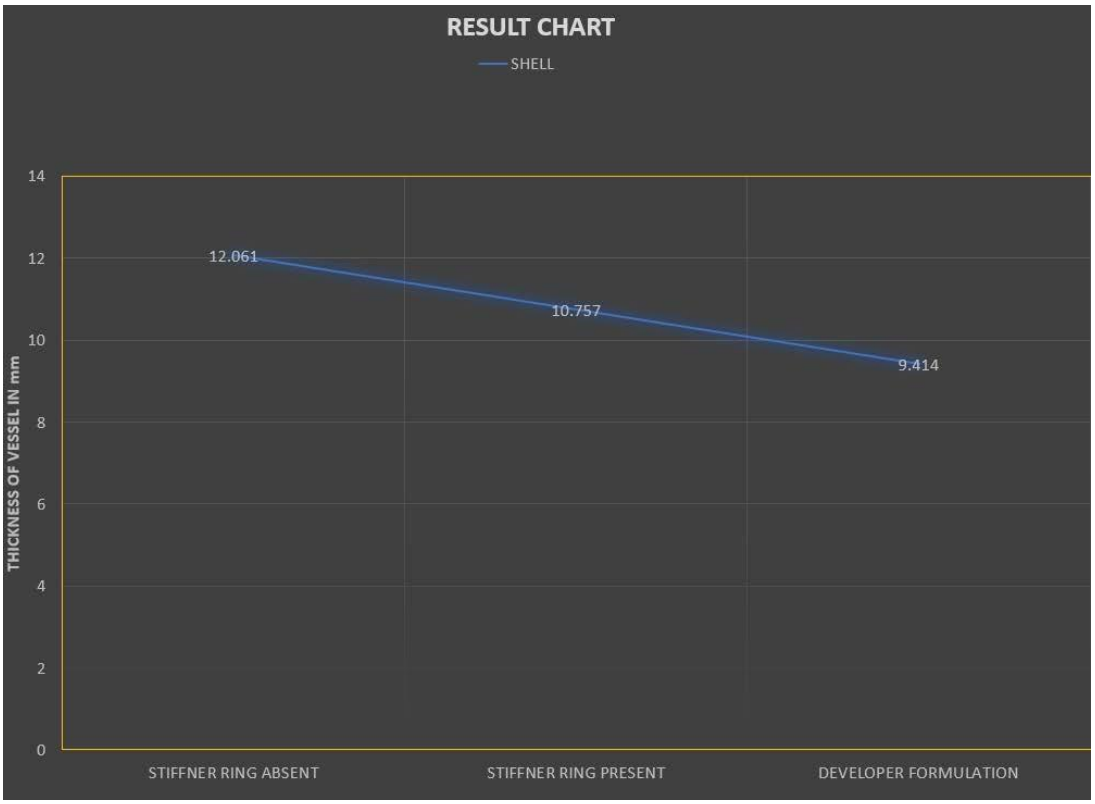

Fig.2 Result Chart

PARAMETERS	BEFORE	AFTER
THICKNESS	14	12
WEIGHT	3,28, 236 KG	3, 01, 648 KG
COST	91,196,840	81,891,040

Fig.3 Before / After Difference

IV. TEST RESULT

Design approach of pressure vessel are by ASME codes and PV Elite software out of which analysis of Pressure vessel by PV Elite software is easy and get optimum parameters. Design calculation of PV Elite software is compare with ASME boiler and pressure vessel regulations. In Comparison of the results and design parameters calculated by ASME boiler and pressure vessel code are in thickness and reduces in weight of pressure vessel. Design by PV Elite software is in weight reduction of pressure vessel.

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