Analysis On Pressure Vessel Design Parameter's With Solidworks

Bhupinder Singh [1] Sandeep Kumar [2] Mahakdeep Singh [3]

[1] *Asst. Prof., Mech.Engg.Dept., Chandigarh University, Gharuan, Mohali, India*
[2] *Research Scholar, Mech.Engg.Dept., Chandigarh University, Gharuan, Mohali, India*
[3] *Asst. Prof , Mech.Engg.Dept., Chandigarh University, Gharuan, Mohali, India*

[1] *bhupinder.singh003@gmail.com*
[2] *er.sandip@rediffmail.com*
[3] *mahakdeep.cu@gmail.com*

Abstract – In this paper scope of improvement lying in the design of the shell of the pressure vessel as the shell is the main component in a vessel which with stands maximum value and type of pressures so that is why the focus was shifted to wall thickness. With help of solidworks FEA module the various iterations are compared and by reviewing the values of the stresses and by analysis of the distribution tables and figures. The results shows the carried out work in form of analysis in solidworks the effective wall thick is found out to be median which is applicable to vertical pressure vessels. one of the main reason why the standard pate thickness have been chosen to be between 8mm to 17 mm as these are the three standard plate thicknesses available. with material C276 which is a grade of stainless steel. This particular grade with thickness 11mm proves to be best suited for many reasons, mainly that all the stresses are found to be comparatively less at around 18% and at the same time the property of material being less corrosive (as it is used to store corrosive chemicals) and weld ability, gives the encouragement to suggest that the alloy C276 will best meet the purpose. Two other grades are also analyses in comparison. and the analysis has been done on solidworks analyses module.

***Keywords* – Solidworks FEA Module, Pressure vessels, Stress, Strain, C276**

I. INTRODUCTION

The [1-4] -discussion in paper is about the standard plate wall thickness with different iterations of material grade and wall thicknesses, because of this the most effective thickness the strength of the vessel is increased as the stresses formed by the pressure from inside is contained under the maximum allowable limits.

Three standard sizes of plate of thickness of 8mm, 11mm and 17 mm are considered, Firstly an glance of distributions of stresses, strains and von misses are elaborated and then further the table of resulting values is given with respect to the grades and thicknesses [15, 16, 17]. By the observation of the values it can be categorically finalized that the hastelloy C276 at the thickness of 11 mm can prove to be the best material to with stand the thermal and structural pressure [22, 24, 26, 28] .

Currently the work which is being carried on focuses mainly on optimal wall thickness of the most cost effective material, ideas is to reduce the cost of manufacturing by selecting latest alloy material which can satisfy the all around requirements of a pressure vessel, In the scope of work the factors affecting the stress consecrations and heat conservation will be also monitor and overall enhancement the design of the vessel will be drafted and the code of selection will be maintained as per the international standards maintained by the societies regulating the designs the scope will also touch in the improvement of design of the rest of mounting which can affect the total performance of a vessel [29, 30].

II. RESEARCH OBJECTIVE

1. To improve the design by finding out the most effective wall thickness
2. To reduce the cost of manufacturing y reducing the use of excess material used in form of excessively thick sheets of material.
3. To used a material which has more availability in the industry so that again the manufacturing is comparatively easy
4. To reduce heat and stress concentration caused because of increased thickness.

III. EXPERIMENT ANALYSIS

2.1 COMPARISON GRAPHICALLY :-

2.1.1 Stress distribution Comparison

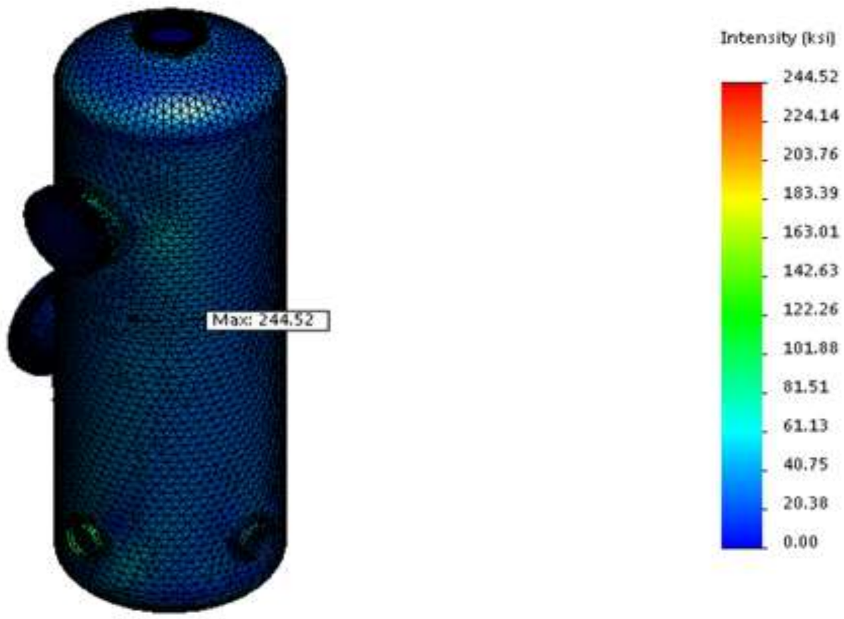

Figure - 1 Stress distribution Comparison

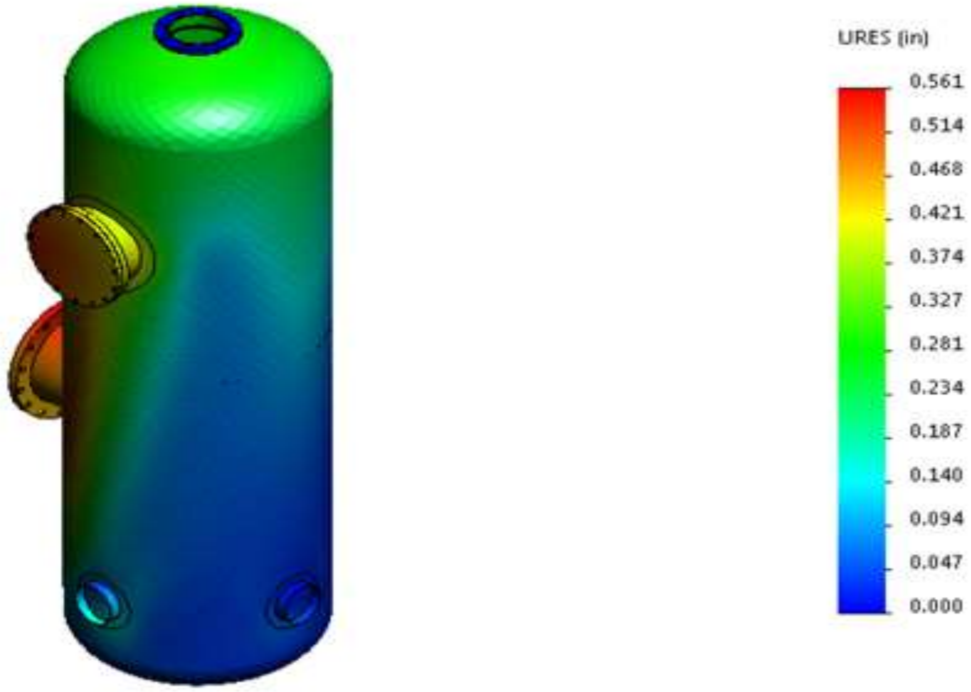

Figure - 2 Stress distribution Comparison

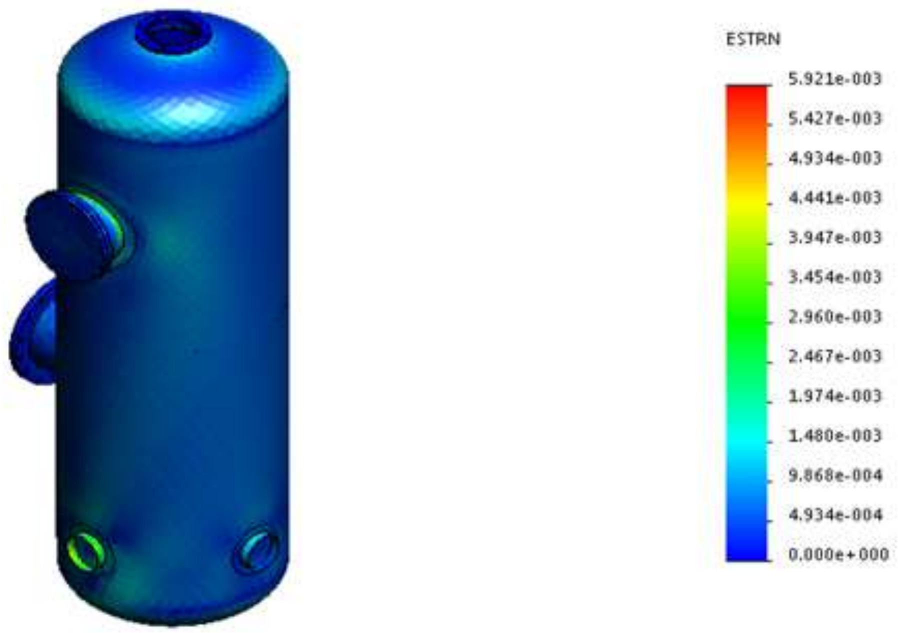

Figure - 3 Stress distribution Comparison

3.0 - Strain Comparison :-

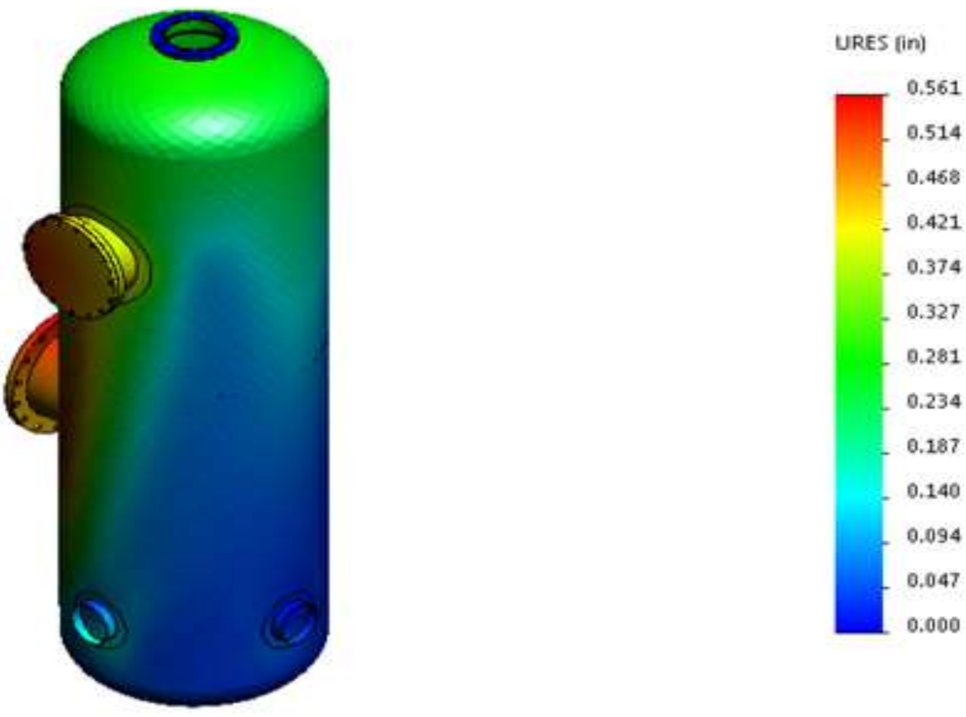

Figure - 4 Strain distribution comparison

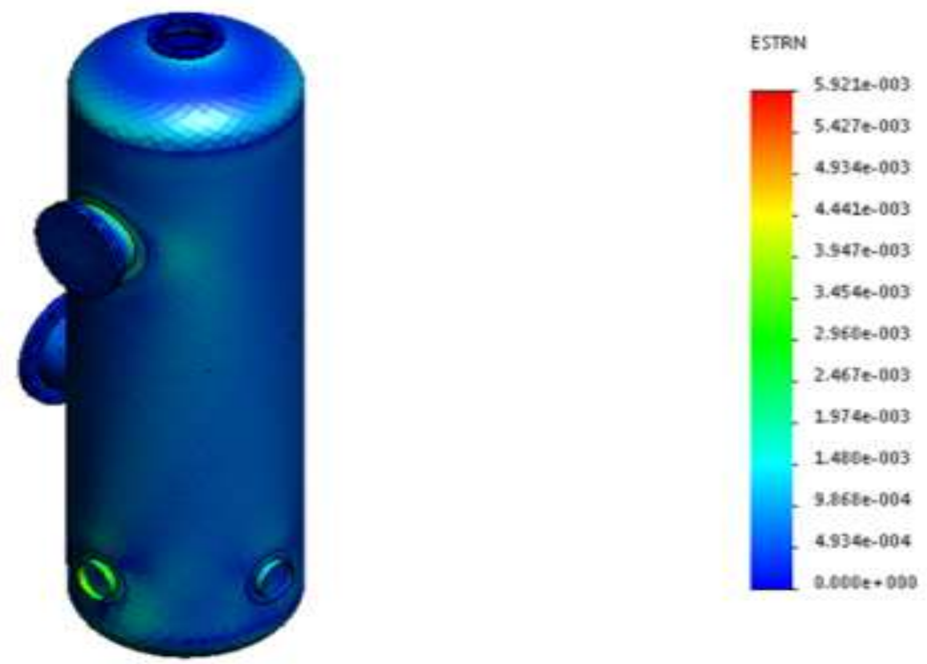

Figure - 5 Strain distribution comparison

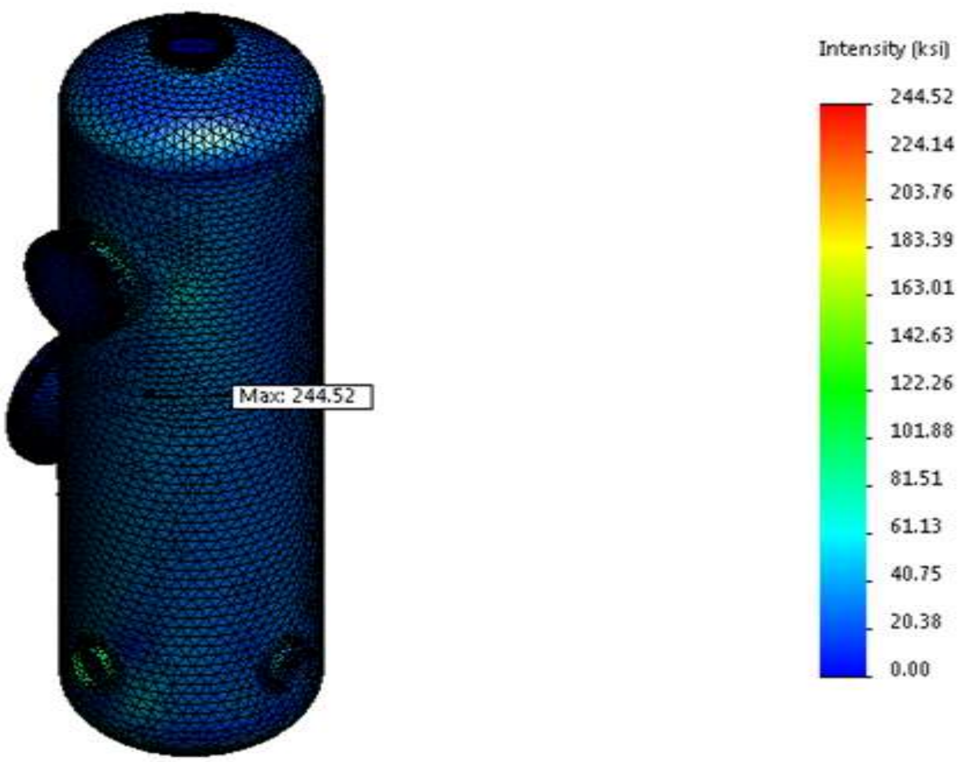

Figure - 6 Strain distribution comparison

3.1 - Von Mises Stress Comparison :-

Figure - 7 Von Misses distribution comparison

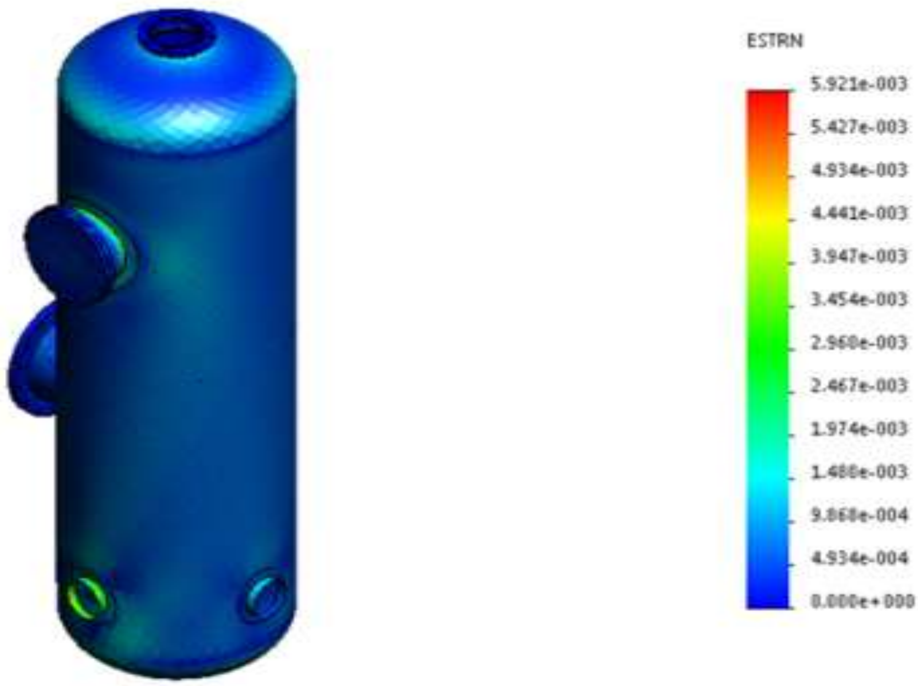

Figure - 8   Von Misses distribution comparison

Figure - 9 Von Misses distribution comparison

3.2 - COMPARISION OF THE STRESS VALUES

3.2.1 - Hoop Stress Comparison

Material	Stress Values 1	Nominal Thickness 1	Stress Values 2	Nominal Thickness 2	Stress Values 3	Nominal Thickness 3
Alloy B-2/B-3	725 N/mm2	8mm	695 N/mm2	11mm	710 N/mm2	17mm
Alloy C-276	525 N/mm2	8mm	500 N/mm2	11mm	515 N/mm2	17mm
Type 316/316L Stainless Steel	801 N/mm	8mm	765 N/mm2	11mm	898 N/mm2	17mm

Table 5.1 - Hoop Stress Comparison

3.2.2 - Longitudinal Stress Comparison

Material	Stress Values 1	Nominal Thickness 1	Stress Values 2	Nominal Thickness 2	Stress Values 3	Nominal Thickness 3
Alloy B-2/B-3	252 N/mm2	8mm	210 N/mm2	11mm	220 N/mm2	17mm
Alloy C-276	175 N/mm2	8mm	170 N/mm2	11mm	180 N/mm2	17mm
Type 316/316L Stainless Steel	325 N/mm	8mm	315 N/mm2	11mm	320 N/mm2	17mm

Table 5.2 - Longitudinal Stress Comparison

3.2.3 - Von Mises Stress Strain Comparison

Material	Stress Values 1	Nominal Thickness 1	Stress Values 2	Nominal Thickness 2	Stress Values 3	Nominal Thickness 3
Alloy B-2/B-3	85.2 N/mm2	8mm	75.8 N/mm2	11mm	87.5 N/mm2	17mm
Alloy C-276	75.8 N/mm2	8mm	70.1 N/mm2	11mm	80.9 N/mm2	17mm
Type 316/316L Stainless Steel	99.1 N/mm	8mm	89.5 N/mm2	11mm	101.2 N/mm2	17mm

Table 5.3 - Von Mises Stress Strain Comparison

It can be clearly observed by different iterations that Alloy C-276 is preferably the least in stress

3.2.4 - MATERIAL COST AND COMPARISON

Material	USD PER kg	Rs PER Kg	Availability	Availability in sheets	Corrosion resistibility	Weld Ability
Alloy B-2/B-3	$ 55-50/Kg	3668.36 /Kg	Moderate	Yes	Low	High
Alloy C-276	$ 35-40Kg	2334.41 /Kg	High	Yes	Moderate	High
Type 316/316L Stainless Steel	$ 57-60/Kg	4001.85 /Kg	Low	Yes	High	Low

Table 5.4 – Material cost and comparison

Above is the comparison of the different type of materials at various parameters as weldabilty . ,Material availalabilty Cost comparison and Availability in sheets. Hastelloy C276 is a nickel-molybdenum-chromium superalloy with an addition of tungsten designed to have excellent corrosion resistance in a wide range of severe environments. The high nickel and molybdenum contents make the nickel steel alloy especially resistant to pitting and crevice corrosion in reducing environments while chromium conveys resistance to oxidizing media. The low carbon content minimizes carbide precipitation during welding to maintain corrosion resistance in as-welded structures. This nickel alloy is resistant to the formation of grain boundary precipitates in the weld heat-affected zone, thus making it suitable for most chemical process application in an as welded condition.

IV. CONCLUSIONS

1. Since the excess wall thickness is discouraged in the result the wall thickness recommended is less especially at the head level and all portions of the pressure vessel are totally safe and under maximum allowable limit as prescribed by ASME. It should also be noticed that the cost of grade Alloy B-2/B-3 is 25.7 % high as compared to Alloy C-276
2. Alloy C-276 compared to Alloy B-2/B-3 has more availability in the industrial market and is more malleable and machinable so as to form a vessel there for the objective of making it much easy to manufacture
3. The strength comparison are earlier mentioned and they provide a very elaborated schematic in order to explain the best combination
4. One of the Important finding is that the material c276 will best perform under the stressed conditions
5. Also the longitudinal stress and von misses stress distribution will be as low as 350 psi approx. at the thickness of 11 mm

V. FUTURE SCOPE

1. The wall thickness recommended is less especially at the head level and all portions of the pressure vessel are totally safe and under maximum allowable limit as prescribed by ASME. It should also be noticed that the cost of grade Alloy B-2/B-3 is 25.7 % high as compared to Alloy C-276 therefore this will act as a direct factor to contribute in reducing the cost effectiveness.
2. Alloy C-276 compared to Alloy B-2/B-3 has more availability in the industrial market and is more malleable and machinable so as to form a vessel there for the objective of making it much easy to manufacture and that to without using special tools and welding process.
3. The cost and strength comparison are earlier mentioned and they provide a very elaborated schematic in order to explain the best combination and iteration which can be set in order to evolve the technology of pressure vessel design.
4. One of the Important finding is that the material c276 will best perform under the stressed conditions.
5. The hoop stress which stands for the radial stress on the circumference will also be down by 15 % approx. at thickness of 11mm.
6. longitudinal stress and von misses stress distribution will be as low as 350 psi approx. at the thickness of 11 mm.
7. However the even important result is that the cost will reduce by 25% if C 276 is used .

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