DESIGN AND ANALYSIS OF AIR FILTER USE IN PROCESS INDUSTRIES AS PER ASME CODE SECTION VIII DIVISION 1

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Abstract

Design and analysis of air filter use in process industries. It is one of the type of vertical pressure vessel. Here the paper shows the theoretical calculations from American Standard of Mechanical Engineering code Section VIII Division 1 and analysis is done on ANSYS for the static stress on flange of the nozzle. Stainless steel material is use in the manufacturing of the pressure vessel here. The Boiler Pressure Vessel code is also use in the designing of the boiler. Both the calculations are compared for the optimum working of air filter.

Keywords :– *Air filter, Pressure Vessel, Nozzle, Flange*

1. INTRODUCTION

The vessel which can sustain high pressure for the process is called Pressure Vessel. Pressure vessel are use for many purpose in process industries such as air filter, nuclear reactor, boiler etc. The ASME (American Society of Mechanical Engineer) codes are introduced for the safe manufacturing of the pressure vessel. According to BPVC (Boiler Pressure Vessel Codes) in the ASME code Section VIII Division 1 the standards are given for the pressure vessel manufacturing. Here in the paper designing is done through Solid Works and analysis is done through ANSYS software. Theoretical calculations are ASME code book and Analytical calculations are from analysis result performed on ANSYS.

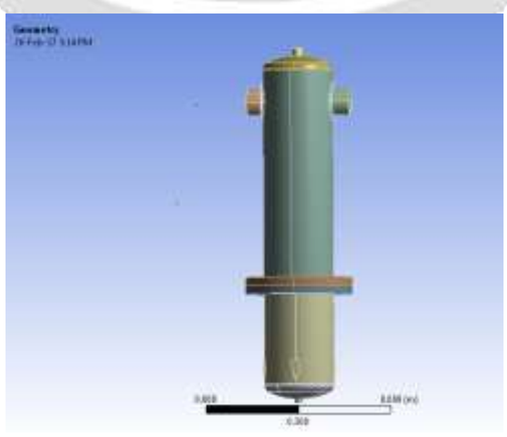

Fig -1:- Vertical Pressure Vessel

2. MODELING DETAILS :-

Table shows the modeling parameters of the vertical pressure vessel used for air filtration in the process industries.

Table -1:- Design Parameters

Object Name	*BODY FLANGE*	*BOTTOM SHELL*	*BOTTOM ELLIPTICAL HEAD*
Length X	345. mm	224.76 mm	
Length Y	27. mm	670. mm	49.545 mm
Length Z	345. mm	224.76 mm	
Properties			
Volume	1.3704e+006 mm³	8.6279e+005 mm³	1.9427e+005 mm³
Mass	10.62 kg	6.6867 kg	1.5056 kg

3. MATERIAL CHARACTERISTICS :-

Following table shows the compressive and tensile yield stress as well as ultimate tensile strenght. Moreover it also shows the different value of matrial properties which is utilize for ANSYS analysis.

Table -2:- Material Specification

Stainless Steel > Constants	
Density	7.75e-006 kg mm^-3
Coefficient of Thermal Expansion	1.7e-005 C^-1
Specific Heat	4.8e+005 mJ kg^-1 C^-1
Thermal Conductivity	1.51e-002 W mm^-1 C^-1
Resistivity	7.7e-004 ohm mm

Stainless Steel > Compressive Yield Strength
Compressive Yield Strength MPa
207

Stainless Steel > Tensile Yield Strength
Tensile Yield Strength MPa
207

Stainless Steel > Tensile Ultimate Strength
Tensile Ultimate Strength MPa
586

Stainless Steel > Isotropic Secant Coefficient of Thermal Expansion
Reference Temperature C
22

4. ANALYTICAL WORK

Here the analysis shows the static structural deformation of the pressure vessel. The maximum stress is held on the flange and the minimum stress is on the fix supports of the pressure vessel. The flange is use to connect the pipe through which the air enter and exits so it has more stress on it and the fix support is fixed with the legs or the machine so it has less stress acting. Meshing details are nodes 32318 and elements 13118.

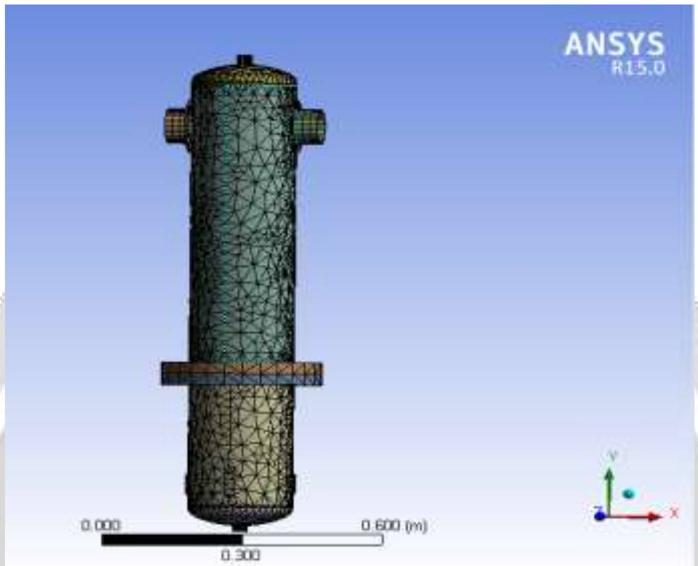

Fig -2:- Meshing

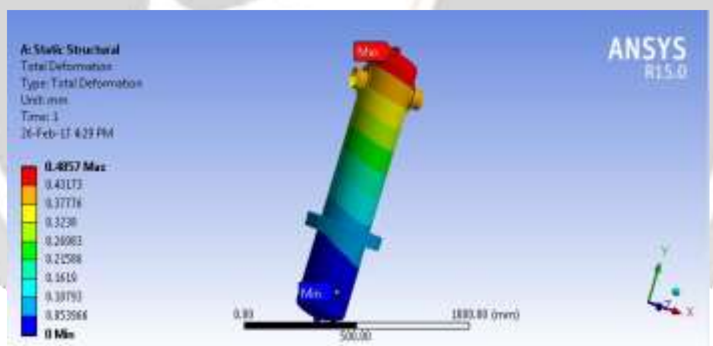

Fig -3:- Static Deformation

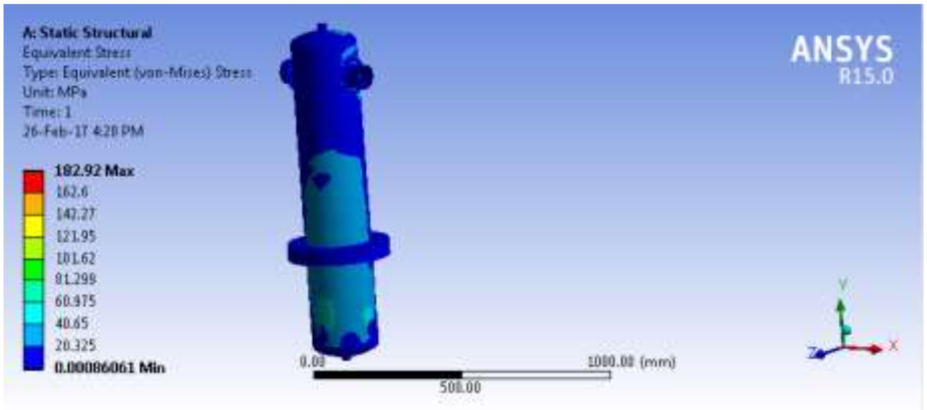

Fig -4:- Von-Mises Stresses Distribution

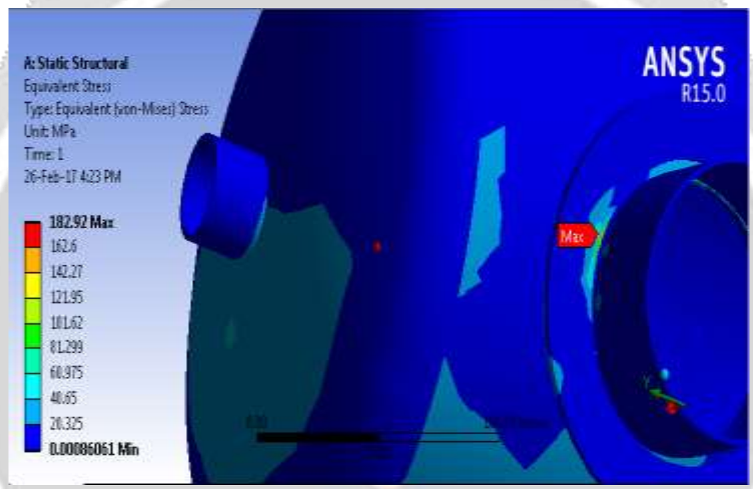

Fig -5:- Maximum Stress

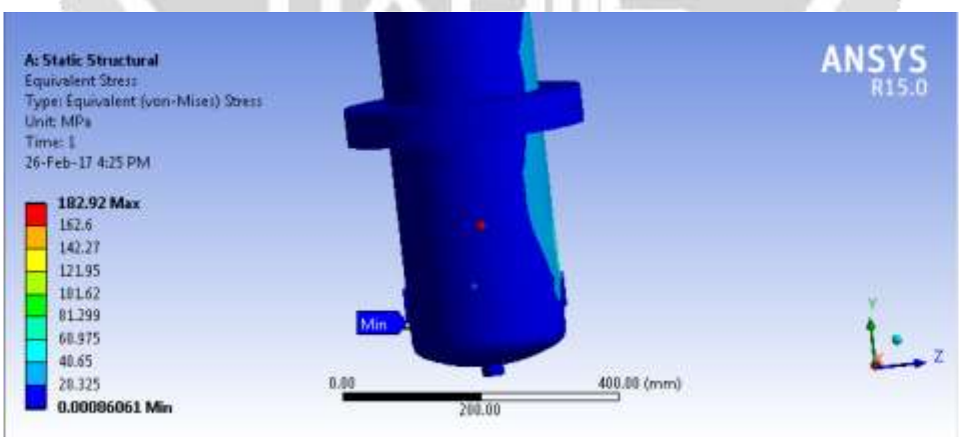

Fig -6:- Minimum Stress

5. THEORITICAL CALCULATIONS :-

The calculations are standards for BPVC which are included in the ASME code book

Table -3:- Stress Results

Stress Result	Operating		Gasket Setting	
	Actual	Allowable	Actual	Allowable
Tangential flange	502	**1313**	654	**1406**
Bolting	331	**1758**	0	**1758**

5.1 Flange Rigidity Based on Required Thickness [ASME]:

5.1.1 Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

= 109.4 * Ma * Cnv_fac / (Eamb * t^3 * ln(K) * Kl)

= 109.4 * 231 * 100000.023 / (1989688 * 24.333^3 * 1.558 * 0.20)

= 0.999 (should be <= 1)

5.1.2 Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

= 109.4 * Mo * Cnv_fac / (Eop * tc^3 * ln(K) * Kl)

= 109.4 * 177 * 100000.023 / (1959406 * 24.333^3 * 1.558 * 0.20)

= 0.778 (should be <= 1)

5.2 Flange Rigidity Based on Given Thickness [ASME]:

5.2.1 Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

= 109.4 * Ma * Cnv_fac / (Eamb * t^3 * ln(K) * Kl)

= 109.4 * 231 * 100000.023 / (1989688 * 27.000^3 * 1.558 * 0.20)

= 0.731 (should be <= 1)

5.2.2 Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

- 109.4 * Mo * Cnv_fac / (Eop * tc^3 * ln(K) * Kl)
- 109.4 * 177 * 100000.023 / (1959406 * 27.000^3 * 1.558 * 0.20)
- 0.570 (should be <= 1)

6. Conclusion

Hence from the above calculation we concluded that in theoretical calculation the allowable stress for the flange is 1313 kgf/cm^2 in operation and 1406 kgf/cm^2 in gasket setting whereas ANSYS analysis shows that allowable stress ranges between 162 Mpa – 183 Mpa which states vertical pressure vessel can withstand up to 1850 kgf/cm^2.

7. REFRENCES :-

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