ISSN 2395-1621

Mechanical Design Of Three Phase Separator For Oil Refineries

#1Deshpande Prathamesh Milind., #2M.M.Mirza, #3Ravindra Jamborkar

1prathameshd18@gmail.com
2manzoorahamad@ritindia.edu
3ravindrajambhorkar@adorians.com

#1Student,Department of Mechanical Engineering, Rajarambapu Institute of Technology, Rajaramnagar,Islampur, Maharashtra, India.

#2Associate Professor, Department of Mechanical Engineering, Rajarambapu Institute of Technology, Rajaramnagar, Islampur, Maharashtra, India.

#3Head Of Design, project Engineering Business, Ador Welding Ltd., Pune.

ABSTRACT

The pressure vessel is used for storing the high pressure fluid. The three phase separator is very important for many industries. The purpose of three phase separator is mainly used to separate oil, water and gas from mixture which comes from well heads. This paper present the mechanical design of three phase separator. Mechanical design consist of thickness calculation and stress analysis. The design of dish end , shell etc. some part of design is carried by rules given in ASME code SEC. VIII, Div I. There are many parameters like internal pressure, material properties etc. which are used for thickness calculation. Efforts are made in this paper to design the pressure vessel using ASME codes and Standards.

Keywords: Three Phase Separator, ASME codes;

ARTICLE INFO

Article History

Received: 25th March 2017

Received in revised form : 25th March 2017

Accepted: 25th March 2017

Published online :

4th May 2017

I. INTRODUCTION

The Three Phase separator is a pressure vessel. It is generally used in oil and gas industries. The pressure used in vessel is above atmospheric pressure so it is called as pressure vessel. The internal pressure is higher than external pressure. There are three types of dish end like Ellipsoidal, Torispherical, Spherical used in industries but Ellipsoidal is used widely used The design of pressure vessel is very critical as it may contains many poisonous gas. So high factor of safety is required. the proper material selection is also one the most important step while designing the Three Phase Separator.

ASME Code, SEC. VIII DIV. I vs. DIV. II

ASME codes section VIII division I does not explicitly consider the effects of combined stress. Neither does it give detailed methods hoe stresses are combined . ASME codes section VIII division II , on other hand provides specific guidelines for stresses for catenaries of combined stresses. Division II is design by analysis while Division I us design by rules. Division II considers the triaxial state for loading with maximum shear stress theory while division I consider two state of loading with maximum stress theory. [1]

Case Study

The case study is conducted in manufacturing company. The project Engineering Business (PEB) division of ADOR WELDING LIMITED is totally dedicated towards Pressure Vessel, Heat Exchanger, Static Equipment etc. manufacturing.

The proposed work is to design Three phase Separator for Oil and Gas industries for a given requirement.

- Shell Length = 3910 mm.
- Shell inside diameter = 1120 mm.
- joint efficiency = 1
- Design pressure = 26 bar
- Design temperature = 110F

Material selection

Several material are used for fabrication of Three Phase Separator. the material selection is a designer's choice. designers should check the sustainability of the material with maximum working pressure. the selected material is SA 516 Gr 70 for Shell and Dish end.

Material Composition

- C = 0.27
- Si = 0.15-0.4
- Mn = 0.85-1.2
- P max. = .035
- S max. = 0.04

Allowable Stress = 137.90 MPA (Sec II part D)

Design Of Ellipsoidal Left Dish End

Factor K, corroded condition [Kcor]:
= (2 + (Inside Diameter/(2 x Inside Head Depth))^2)/6
= (2 + (1126.000/(2 x 283.000))^2)/6
= 0.992952

Required Thickness due to Internal Pressure [tr]:
=(PxDxKcor)/(2xSxE-0.2xP) Appendix 1-4(c)
= (26.000x1126.0000x0.993)/(2x137.90x1.00-0.2x26.000)
= 10.5606 + 3.0000 = 13.5606 mm.

Figure:1 Dish End (Ellipsoidal)

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
= (2xSxExt)/(KcorxD+0.2xt) Appendix 1-4 (c)

=(2x137.90x1.00x11.0000)/(0.993x1126.0000+0.2x11.0000)
= 27.080 bars

Maximum Allowable Pressure, New and Cold [MAPNC]:
= (2xSxExt)/(KxD+0.2xt) Appendix 1-4 (c)

=(2x137.90x1.00x14.0000)/(1.000x1120.0000+0.2x14.0000)
= 34.387 bars

Actual stress at given pressure and thickness, corroded [Sact]:
= (Px(KcorxD+0.2xt))/(2xExt)

=(26.000x(0.993x1126.0000+0.2x11.0000))/(2x1.00x11.000)
= 132.402 N./mm²

Straight Flange Required Thickness:
= (PxR)/(SxE-0.6xP) + c (UG-27 (c)(1))
= (26.000x563.0000)/(137.90x1.00-0.6x26.000)+3.000
= 13.737 mm.

Straight Flange Maximum Allowable Working Pressure:
= (SxExt)/(R+0.6xt) (UG-27 (c)(1))
= (137.90 x 1.00 x 13.0000)/(563.0000 + 0.6 x 13.0000)
= 31.405 bars

Design of Cylindrical Shell

Required Thickness due to Internal Pressure [tr]:
= (PxR)/(SxE-0.6xP) (UG-27 (c)(1))
= (26.000x563.0000)/(137.90x1.00-0.6x26.000)
= 10.7370 + 3.0000 = 13.7370 mm.

Figure:2 Cylindrical Shell

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
= (SxExt)/(R+0.6xt) (UG-27 (c)(1))
= (137.90x1.00x11.0000)/(563.0000+0.6x11.0000)
= 26.629 bars

Maximum Allowable Pressure, New and Cold [MAPNC]:
= (SxExt)/(R+0.6xt) (UG-27 (c)(1))
= (137.90x1.00x14.0000)/(560.0000+0.6x14.0000)
= 33.964 bars

Actual stress at given pressure and thickness, corroded [Sact]:
= (Px(R+0.6xt))/(Ext)
= (26.000x(563.0000+0.6x11.0000))/(1.00x11.0000)
= 134.641 N./mm²

Design Of Ellipsoidal Right Dish End

Factor K, corroded condition [Kcor]:
= (2 + (Inside Diameter/(2 x Inside Head Depth))^2)/6
= (2 + (1126.000/(2 x 283.000))^2)/6
= 0.992952

Required Thickness due to Internal Pressure [tr]:
= (PxDxKcor)/(2xSxE-0.2xP) (Appendix 1-4(c))
= (26.000x1126.0000x0.993)/(2x137.90x1.00-0.2x26.000)
= 10.5606 + 3.0000 = 13.5606 mm.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
= (2xSxExt)/(KcorxD+0.2xt) (Appendix 1-4 (c))

=(2x137.90x1.00x11.0000)/(0.993x1126.0000+0.2x11.0000)
= 27.080 bars

Maximum Allowable Pressure, New and Cold [MAPNC]:
= (2xSxExt)/(KxD+0.2xt) (Appendix 1-4 (c))

=(2x137.90x1.00x14.0000)/(1.000x1120.0000+0.2x14.0000)
= 34.387 bars

Actual stress at given pressure and thickness, corroded [Sact]:
= (Px(KcorxD+0.2xt))/(2xExt)
=(26.000x(0.993x1126.0000+0.2x11.0000))/(2x1.00x11.000)
= 132.402 N./mm²

Straight Flange Required Thickness:
= (PxR)/(SxE-0.6xP) + c (UG-27 (c)(1))
= (26.000x563.0000)/(137.90x1.00-0.6x26.000)+3.000
= 13.737 mm.

Straight Flange Maximum Allowable Working Pressure:
= (SxExt)/(R+0.6xt)
(UG-27 (c)(1))
= (137.90 x 1.00 x 13.0000)/(563.0000 + 0.6 x 13.0000)
= 31.405 bars

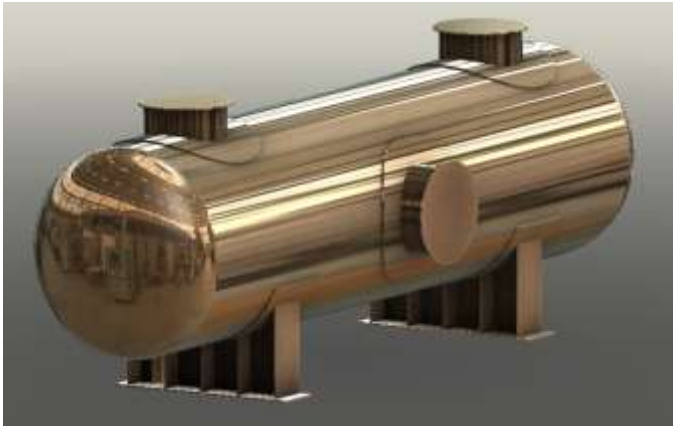

Figure:3 Proposed Design Of Three Phase Separator

Result summary

Required Thickness for left dish end = 13.56mm
Required Thickness for cylindrical shell = 13.73mm
Required Thickness for right dish end = 13.56mm

Table 1: Result summary

	Allowable stress(MPA)	Stress due to thickness(MPA)
Left dish end	137.90	132.402
Shell	137.90	134.641
Right dish end	137.90	132.402

II. CONCLUSION

The thickness calculation required for three phase separator has done successfully. All the pressure vessel parts are selected on the basis of ASME standard. The maximum allowable stress due to thickness is less than the allowable stress by the ASME standard. Regarding storage of a fluid pressure vessel system should be preferred due to its simplicity, higher reliability and low maintenance.

ACKNOWLEDGMENT

I would like to express my deep sense of gratitude to my supervisor Prof.M.M.Mirza, for his inspiring & invaluable suggestions. I am deeply indebted to him for giving me a chance to study this subject & providing constant guidance throughout this work.
I would like to express my deep sense of gratitude to my Co-guide Mr Ravindra Jambhorkar(PEB. Design Head), Ador Welding Ltd Chinchwad Pune, for his inspiring & invaluable suggestions. I acknowledge with thanks, the assistance provided by all PEB team for their valuable support during this dissertation work.
I acknowledge with thanks, the assistance provided by the Department staff, Central library, staff & computer faculty staff. Finally, I would like to thank my colleagues & friends directly or indirectly helped me for the same.

REFERENCES

[1] Dennis Moss."Pressure Vessel Design Mannual"
[2] V.B. Bhandari, “Design of Machine Elements”, McGraw-Hill publication, Third edition.
[3] Apurva R. Pendbhaje "Design and Analysis Of Pressue Vessel" IJIRTS ,ISSN2321-1156
[4] Dr. R .K. Bansal, “Strength of Materials”, Laxmi publications Ltd, Fourth edition.
[5] ASME BPVC(2015) Sec VIII Div I.

