IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 01 | July 2015
ISSN (online): 2349-784X

Analysis of Dished Head and Skirt Joint of Pressure Vessel using FEA Method

Mahesh C. Agiwale
PG Student M. Tech
Department of Production Engineering
V.J.T.I, Matunga

Prof. P. R. Attar
Assistant Professor
Department of Production Engineering
V.J.T.I, Matunga

Abstract

There is no any industry without Pressure vessel. Pressure vessel has wide applications as nuclear power plants, thermal power plants, refinery and many other such industries. Usually the design of pressure vessel is according to codes like ASME, British standards etc. In pressure vessel, dish is supported to skirt by weld. Which have applied by internal pressure load, self-weight, weight of fluid used in vessel, wind load and seismic load. This joint should be important while designing so that it can withstand that various load. The analysis is carried out in ASME section VIII, Div I. The model made in Creo/Pro-E and then imported in ANSYS R15 and simulation checked with ASME code.
Keywords: Dish End, Skirt, Ansys R15, Simulation

I. INTRODUCTION

Horizontal and vertical, these are two types of vessels used in pressure vessel. The skirt is usually used in vertical pressure vessel, to withstand load of shell, dish and nozzle mounting. Skirt can be taper or straight, it depends on height, thickness and diameter of dish head. Skirt include top ring, base ring, gussets. Base ring contains bolts, varies from 4 to 120. These bolts are refer from AISI (American Iron and Steel Institute). This base ring is attached to foundation via these bolts. Ultimately all load transfer to foundation via skirt. It is not necessary that material of skirt and dish should be same. They may have different material, depending on several condition. Basically skirt does not suffer internal pressure and load.

The dish can be of five type i.e. ellipsoidal, torispherical, hemispherical, conical and toriconical. The use of it depends upon size, pressure, and fluid using in it. Dish is attached to the shell and other element by welding. Dish can be produced by forming method, it may be cold forming or hot forming, depending on thickness used. These dish and skirt is attached by welding. Welding technique may be SAW, SMAW processes. Here is no need of separate V preparation for weld at this joint.

The dish has inside temperature greater than outside temperature. While skirt is at normal atmospheric temperature and pressure. Due to temperature difference there have chances of developing thermal stress. From the above description it signifies that skirt to dish joint is more important in pressure vessel.

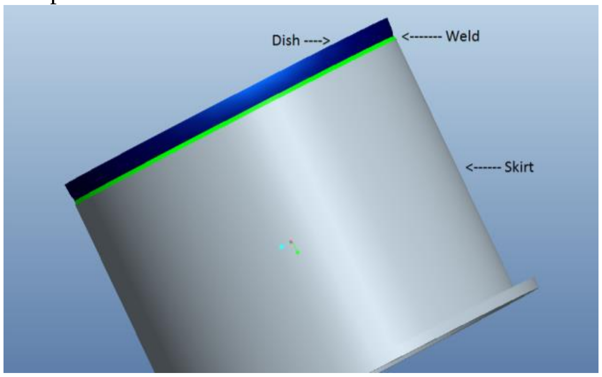

Fig. 1: Dish To Shell Joint Assembly (Pro-E model)

II. DESIGN SPECIFICATION

A. Skirt

Table - 1
Skirt Specification

Element type	*Skirt suppo*
Length (mm)	*1200.00*
Skirt inside diameter (mm)	*1600.00*

Skirt thickness (mm)	*12.00*
Internal corrosion allowance (mı	*0.00*
Material name	*SA-516 GR*
Allowable stress (N/mm²)	*260.00**
Material density (kg/cm³)	*0.007750**

*Allowable stress and density as per ASME Section II, Div –D, table 1A
This is specification of the skirt which is attached to the dish end having same inside diameter.

B. Dish End

Table – 2
Dish End Specification

Element type	*Elliptical di*
Inside diameter (mm)	*1600.00*
Element thickness (mm)	*16.00*
Internal corrosion allowance (mı	*1.00*
Nominal thickness (mm)	*18.00**
External corrosion allowance	*0.00*
Design internal pressure (bar)	*9.800*
Design internal temperature (°C	*110.00*
External pressure (bar)	*0.00*
Material name	*SA-516 GR*
Yield stress (N/mm²)	*260.00****
Seam efficiency	*1*

*****ASME Section VIII, 4.3.2.2; ** ASME Section II, div D, table 1B;
*** ASME Section II Table 1A

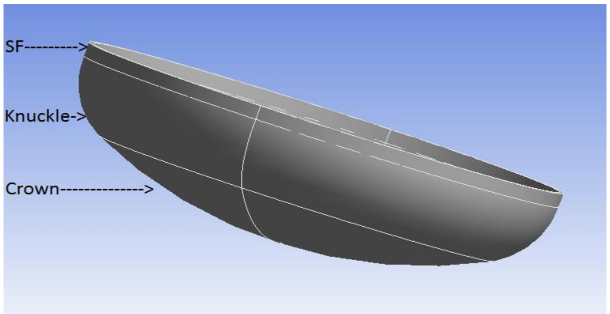

Fig. 2: Dish End

Minimum required thickness: section VIII, 4.14, UG-32;
= (P*D*Kcor) / (2*S*E-0.2*P) …………………………Appendix 1-4(c)
= (10.123*1602.0000*0.998) / (2*137.90*1.00-0.2*10.123)
= 5.8752 + 1.0000 = 6.8752 mm.
Maximum Allowable Pressure
= (2*S*E*t) / (K*D+0.2*t)…………………………….. Appendix 1-4 (c)
= (2*137.90*1.00*16.0000)/(1.000*1600.0000+0.2*16.0000)
= 27.523 bars
Actual stress
Actual stress at given pressure and thickness,
= (P*(Kcor*D+0.2*t))/(2*E*t)
= (10.123*(0.998*1602.0000+0.2*15.0000))/(2*1.00*15.0000)
= 54.074 N/mm²

III. METHODOLOGY

Dish end and skirt assembly is carried out in Creo Elements/ Pro-E.. Due to excess meshing full assembly was not considered; only dish, skirt and weld joint was created in assembly. Assembly was imported in ANSYS R15. The static structure analysis was carried using given data. By using FEA method simulation were carried out and compared it with allowable code values.

Table – 3
Methodology

Element	*Dish to skirt weld joint*
Assembly	*Creo Elements /Pro-E*
Analysis software	*ANSYS R15*

Analysis method	Static structural method

A. Material Specification:

For skirt and dished head
Material: SA 516 GR 70; Temperature: 110 °C; allowable stress :137.9 N/mm².

B. Design Specification:

Design Code: ASME Section VIII
Design Pressure: 9.8 bar
Design Temperature: 110 °C

C. Meshing Model

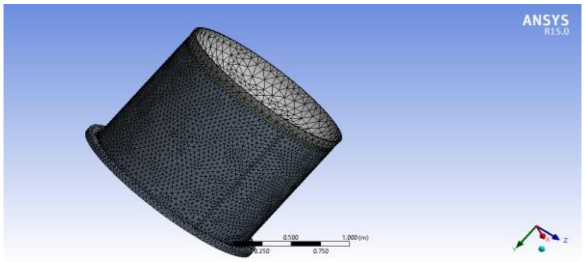

Fig. 3: Mesh Model

D. Other Loads:

- Fabricated weight: 24348 N
- Weight including fluid: 84189 N
- Longitudinal stress:
- PD/ 4t = (0.9 × 1600) /(4×16) =22.5 MPa
- Stress due to weight:
- Weight / cross sectional area = $\frac{84348}{\pi\frac{(1632-1600)^2}{4}}$ =104 N/mm²
- Wind load: NA

IV. RESULTS

Following diagram shows results of strain and stress distribution at various points of dish to skirt joint.

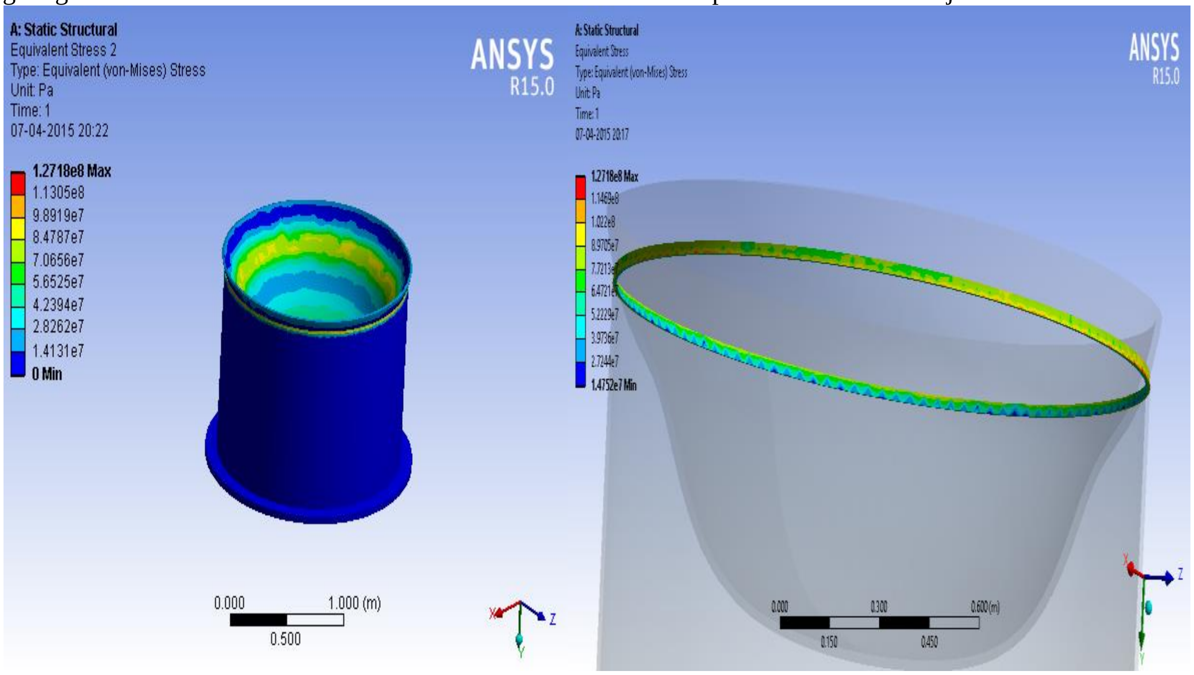

Fig. 4: Von-mises Stress Analysis

In static structural analysis by importing assembly model and giving various load condition and barrier it gives the von-mises stress distribution. The meshing have elements 33897 and nodes 69551. Here it showed that maximum stress is 127 Mpa. Actual allowable stress is 138 MPa.

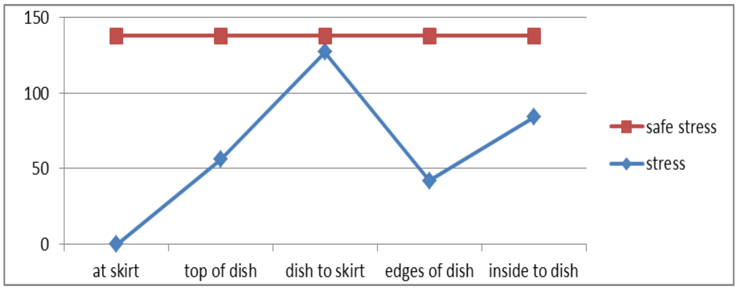

Fig. 5: Graph of Stress Induced In Assembly

Stress induced at skirt is minimum while at dish to skirt is maximum.

V. Conclusion

1) Graph shows that at the dish to skirt joint maximum stress is induced, which can be dangerous at the time of working condition.
2) Doing proper design it can reduced the stress at the joint. By which life of vessel can be increases.
3) Before fabricating of vessel it should check on ANSYS so that it clarifies induced stress n helps in reducing weld size at joint.

Acknowledgement

Authors are appreciating to M/S Lloyds Steel Ind. Ltd, Parel for carry out researched work during this project.

References

[1] Boiler and Pressure Vessel design Code 2010, A-11, ASME code, Section VIII, ASME Publication 2011.
[2] American Society for Testing and Materials, Volume 0.1.04, A516/A516M.
[3] Casty guide book for pressure vessel for ASME section VIII.
[4] Jerzy Lewinski "Shaping of a middle surface of dished head of a circular cylindrical pressure vessel" Poznan university of technology, institute of applied mechanics, Poznan, Poland .
[5] Kiran Parmar, Kiran Patel, Dinesh Mevada "Thermal analysis for skirt dished end joint of pressure vessel using finite element analysis approach" Mechanical Engineering department LDRP institute, Gandhi nagar ,India.
[6] G Venkatachalam, Varanasi Shri Aditya, Harshal Upadhyay "Design and simulation of metal forming process" VIT university, Vellore, India.