Analysis of Pressure Vessel Head using ANSYS

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Abstract- A pressure vessel is closed container which is used for the storage of highly pressurized fluid; fluid may be gaseous or liquid. The pressure inside of the Container is always much greater than the outside pressure called ambient pressure. This also termed as Storage tank as it is used to keep the fluids under pressure. Pressure vessels are highly used in industries and in commercial purposes such as filtration, boiling, softening and hot water storage tanks. Pressure vessels are subjected to thermal loads and structural loads such as internal and external pressures which leads to its deformation. Present work focusses on the modeling of the pressure vessel according to standard dimensions using ANSYS software and analyzing it for three different shapes of pressure values Flat pressure Head, Hemispherical pressure Head, Conical pressure Head using finite element approach. The finite element analysis results have been presented in graphical form. Results indicated that, All the Pressure heads are their own application and advantage which type of materials and which geometry used for a particular work. Also heads are Major and Minor axis which they build and give the required strength.

Keywords: ANSYS, Pressure Vessel.

I. INTRODUCTION

The work of this dissertation is focused for the structural optimization of Pressure vessel used for LPG storage by means of modifying the existing geometry as per the ASME standards, ASME(BPVC) Sec-VIII Div-I and II along with ASME(BPVC) Sec-II Part- A and D was followed.

ASME standards

These are the sets of codes and standards of ASME BPVC:

- ASME BPVC Section I - Rules for Construction of Power Boilers ASME BPVC
- Section II – Materials
  - Part A - Ferrous Material Specifications
  - Part B - Nonferrous Material Specifications
  - Part C -Specifications for Welding Rods, Electrodes and Filler Metals Part D - Properties (Customary)
  - Part D - Properties (Metric)
- ASME BPVC Section III - Rules for Construction of Nuclear Facility Components
  - Subsection NCA - General Requirements for Division 1 and Division 2
  - Appendices
  - Division 1
    - Subsection NB - Class 1 Components
    - Subsection NC - Class 2 Components
    - Subsection ND - Class 3 Components
    - Subsection NE - Class MC Components
    - Subsection NF – Supports
    - Subsection NG - Core Support Structures
  - Division 2 - Code for Concrete Containments
  - Division 3 - Containment Systems for Transportation and Storage of Spent Nuclear Fuel andHigh-Level Radioactive Material
  - Division 5 - High Temperature Reactors
- ASME BPVC Section IV - Rules for Construction of Heating Boilers ASME BPVC
- Section V –Nondestructive Examination ASME BPVC
- Section VI - Recommended Rules for the Care and Operation of Heating Boilers ASME BPVC
- Section VII - Recommended Guidelines for the Care of Power Boilers ASME BPVC
- Section VIII - Rules for Construction of Pressure vessels
  - Division 1

- Division 2 - Alternative Rules
- Division 3 - Alternative Rules for Construction of High Pressure vessels

➢ ASME BPVC Section IX - Welding, Brazing, and Fusing Qualifications

➢ ASME BPVC Section X – Fibre-Reinforced Plastic Pressure vessels

➢ ASME BPVC Section XI - Rules for In service Inspection of Nuclear Power Plant Components
- Division 1 - Rules for Inspection and Testing of Components of Light-Water-Cooled Plants
- Division 2 - Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants

➢ ASME BPVC Section XII - Rules for the Construction and Continued Service of Transport Tanks

II. COMPONENTS OF PRESSURE VESSEL

1. There is no significant difference between Social status of male, and female actors of television.

2. There is no significant difference between Economical status of male, and female actors of television.

3. There is no significant difference between Socio-Economic status of male, and female actors of television.

III. METHODOOGY AND TOOL OF STUDY

A Pressure vessel has nos. of components attached along with the major components; here only major components are discussed.

➢ **Shell-** A shell of the Pressure vessel is a rectangular plate folded and welded into cylindrical shell. A shell is a primary component that contains the pressure and the high volume of the fluid which is formed in the several plates welded together.

➢ **Head-**The closing side of the cylindrical shell from both the side not to allow to stored fluid flowing outside is called head. The head of the Pressure vessel may be configured in various shapes like Elliptical, Hemispherical, Tori spherical and Flat end. The heads are typically curved and act as close end for the shell. The curved section of head allows it to be thinner and lighter. Heads are also used inside of the shell called intermediate heads.

➢ **Nozzle-** The channel to pass the storing fluid(Liquid or Gas) to inside of the vessel while keeping or to store or throwing outside while delivering the fluid, a neck like structure is attached to the Pressure vessel shell is called nozzle. It is a cylindrical component that penetrates into shell or head of Pressure vessel. It is used for the attachments of pipes for the flow of fluids and also may be used for the attachments of instruments.

➢ **Saddle-** To hold the entire Pressure vessel unit a support system is required so it can stop the distortion or buckling of the Pressure vessel, the base which is used to support this Pressure vessel is called saddle. A half round structural support system which is used to hold the cylindrical shell to be fitted is called horn and this horn is welded with the leg support. A saddle is used for the bear all the loads of the Pressure vessel. The saddle of the modified vessel has wide horn with a wide support but height is reduced and this can be seen in the fig.

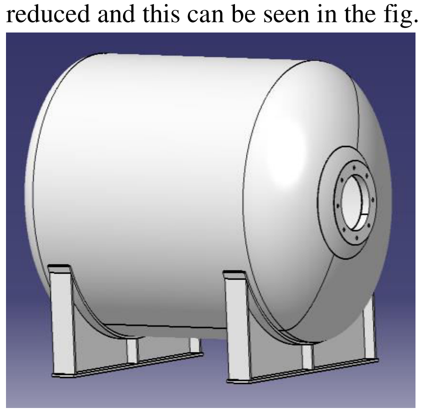

Figure 2: Pressure vessel saddle view

Analysis of Different Pressure Head

Flat pressure Head

Hemispherical pressure Head

Conical pressure Head

Static Analysis of Different Pressure Head

Conical pressure Head

Given:- Dimensions Conical pressure Head

Volume = V= 0.31628 m³

Surface area = A_s= 8.4349 m²

Step 1- Geometry

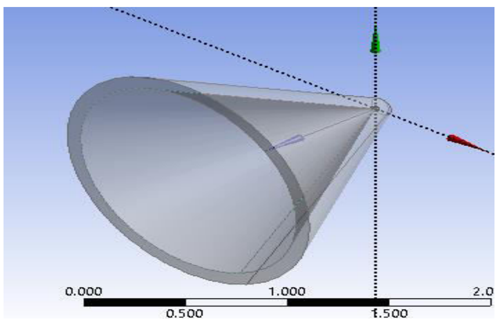

Figure 3: Conical pressure Head Geometry

Step 2- Meshing

1) Face sizing of element sizeis 0.1

2) Whole body meshing by automatic method

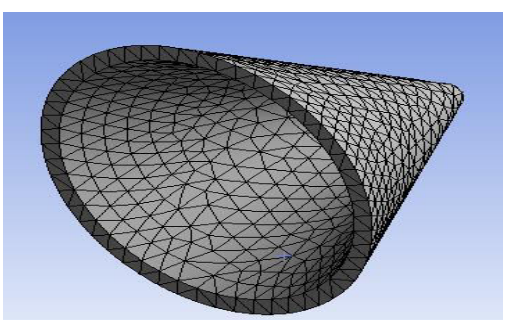

Figure 4: Conical pressure Head Meshing

Naming of geometry

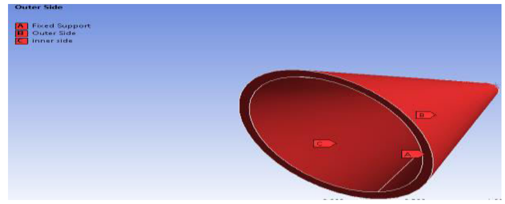

Figure 5: Conical pressure Head Naming of geometry

Step 3 – Setup

Boundary condition

1) Compression support at circular portion

2) Normal force of -500 N

3) Material is taken as default structural steel having tensile yield strength = $2.5*10^8$ Pa

Compressive yield strength = $2.5*10^8$ Pa

Step 4- Solution and result

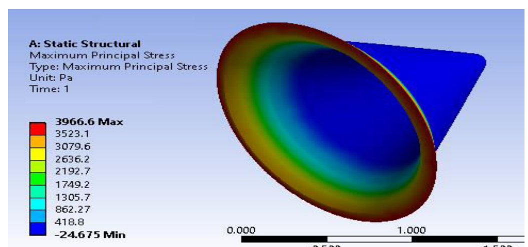

Figure 6: Conical pressure Head max principal stress

Mini = -24.675 Pa

Max = 3966.6 Pa

Avg = 717.03 Pa

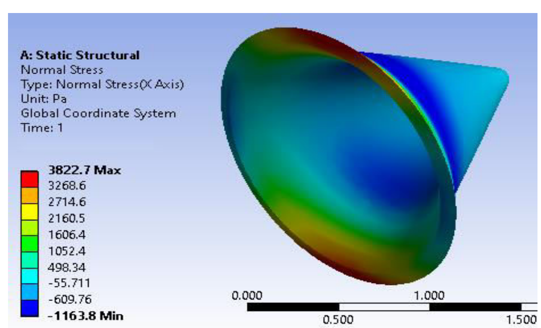

Figure 7: Conical pressure Head normal stress

Mini = -1163.8 Pa

Max = 3822.7 Pa

Average = 33.074 Pa

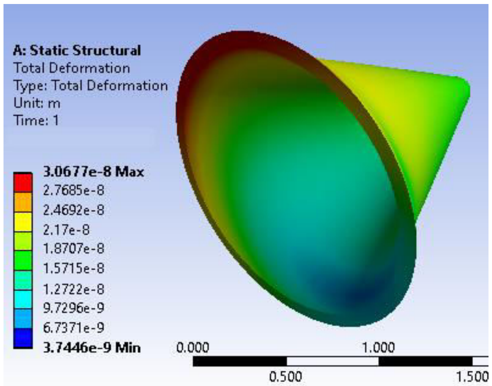

Figure 8: Conical pressure Head total deformation

Mini = 3.7446e-009 m

Max = 3.0677e-008 m

Average = 1.7326e-008 m

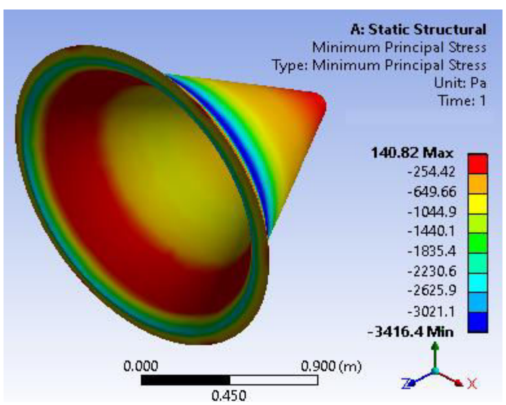

Figure 9: Conical pressure Head min principal stress

Mini=-3416.4 Pa

Max = 140.82 Pa

Average = -1040.1 Pa

Conclusion- As all the values of stress are below the value which is given for material so our design is safe.

VI. CONCLUSIONS

The outcome of this design and analysis work leads to the following key factor:

All the designs are taken according to the American Society for Testing and Materials (ASTM) also from past research no work was done in Pressure vessel heads and important outcomes are taken into consideration.

1. Minimum deformation is seen for Hemi-spherical pressure heads

2. In Maximum Principal Stress theory the Minimum and Maximum stress is seen for Hemispherical (-2433.8 Pa) and Conical pressure (3966.6 Pa) heads.

3. In Minimum Principal Stress theory the Minimum and Maximum stress is seen for Hemispherical and Flat pressure heads.

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