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Design and analysis of compressor suction knock-out drum

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Abstract: The major purpose of this work is to design and evaluate the important components of a compression suction knockout drum using the internal design pressure. Compression suction knockout drums are closed containers that store gas or liquid at much greater pressures than the surrounding environment. As a result, they are widely employed in a variety of industrial applications, including as the chemical industry, thermal and nuclear power plants, food processing, and aircraft manufacturing. As a result, knockout drums must be meticulously engineered to minimize failures, which are typically stress-related. Stress analysis is necessary to prevent pressure vessel failures and deadly accidents. This research examined critical pressure vessel components, such as a shell flange. The American Society of Mechanical Engineers Code mandated that certain eye bolts, drain pipes, drain pipe flanges, and pressure vessel connection locations be expressly built using dependable materials. A stress study was carried out using the ASME Code for boilers and pressure vessels, which included internal pressure and heat loads. Finally, the study findings for normal operating circumstances are within acceptable limits, suggesting that the pressure vessel design is appropriate for the design load.

Index Terms -Pressure vessel, Finite element method (FEM), internal design pressure, Design temperature, Hydrostatic Pressure, Total Deformation.

I INTRODUCTION

Elimination Drums are potentially hazardous instruments, and catastrophic events have happened during the development and use of these instruments. Pressure vessel design, production, and maintenance are so essential. Legislation supports the oversight of activities by engineering authority. As a result, different countries have different definitions of pressure vessels. When designing, take into account the safety factor, the minimum design temperature (for brittle fracture), the maximum safe operating pressure and temperature, and the allowance for corrosion. While air or another gas is utilized in pneumatic pressure tests, water is typically employed in hydrostatic pressure tests. Hydraulic testing is safer because the energy released by a fracture is much lower. (Gases expand greatly when depressurized quickly, whereas water does not.) In order to guarantee quality, a representative sample of mass or batch production goods is often put through destructive testing under controlled circumstances.

II LITERATURE REVIEW

Stress analysis, non-linear analysis, fatigue analysis, and thermal analysis are among the subjects covered in the literature study. The pressure generation and stress analysis inside the vessel are the main areas of interest for the researchers. It was found that not a single researcher concentrated on nozzle position and support enhancement. It is necessary to look into how the position of the nozzle and support affects the creation of stress in the shell. The assisting position has an impact on the concentration of stress. The nozzle's positioning will help to lessen the concentration of stress in one area. This discrepancy has caused the focus to turn to optimizing the structural area by optimizing the positions of the nozzle and support.

III METHODOLOGY

Taking pressure and temperature limits into account, it may be possible to design the dimensions of the knockout drum based on those values.

Table1: Pressure Vessel Design Data values

Pressure vessels			
Description	**Operating mechanical Data**	**Value**	**Units**
Working temperature	Max/ Normal /Min	331/310/284	K
Working Pressure	Max/Normal/Min	12.7/2.05/0.67	K pa
Design temperature	Max / Min	616/270	K

Design Pressure	Internal / External	33.4/FV 412K	K pa
Liquid	Quantity/ Density / Density at working Pressure	41136/1013/999	Kg / m^3
Vapour	Quantity/Molecular weight/ Density at working pressure	357131/374/0.92	Kg/m^3

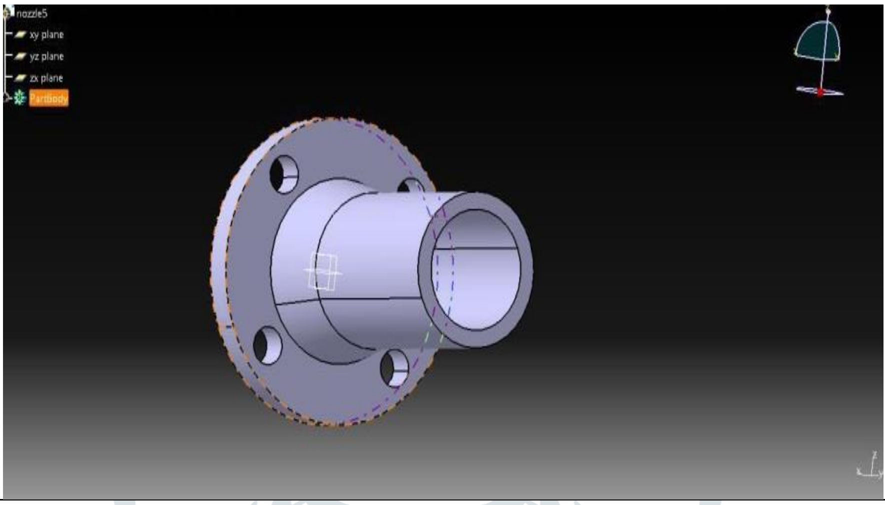

Fig 1 Part Model of Shell

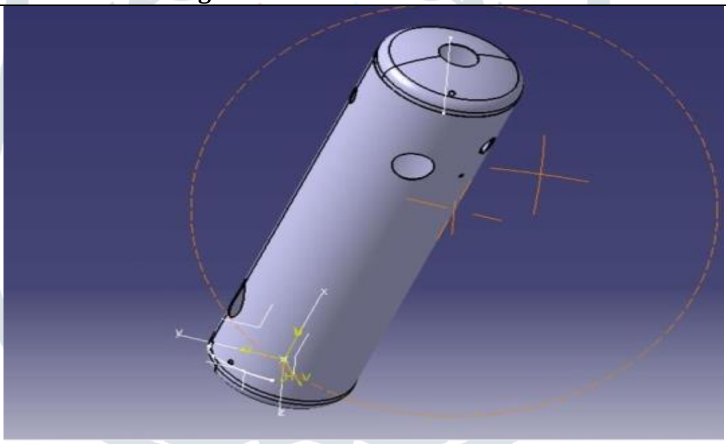

Fig 2 Part Model of Shell

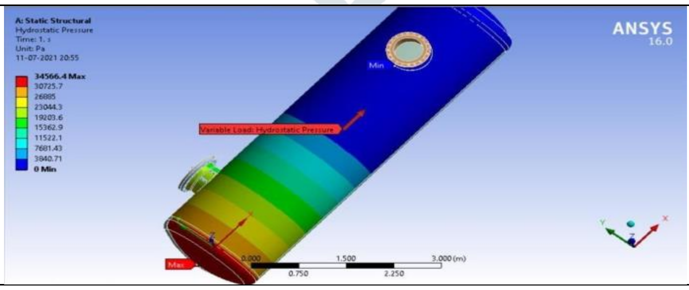

Fig 3 Estimating Hydrostatic Pressure

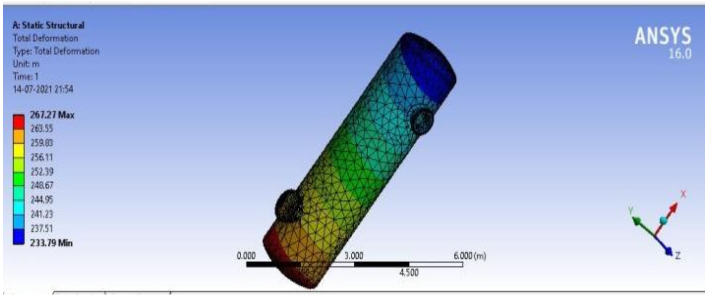

Fig4 Solution of Total Deformation

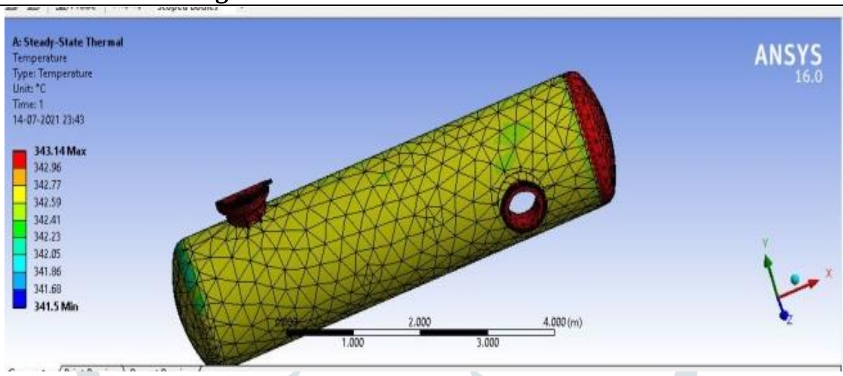

Fig 5 Temperature Solution

IV RESULTS

Hydrostatic pressure calculation formula

The formula for determining the P pressure on an object submerged in a liquid is

P =Q×g×h………………………………………………………………………… (1)

Q = Fluid density,

g = Acceleration due to gravity,

h = Height of the fluid above the object.

Table 2 Design Considerations

Design Considerations			
S.No	**Description**	**Value**	**Units**
1	Design Pressure	34.5	K Pa
2	Fluid Density	997	Kg /m^3
3	Height of Fluid in Vessel	3.1	m

Calculating Theoretical Pressure

Theoretical Pressure = Q×g×h= 997×9.81×3.1= 33.3 K Pa

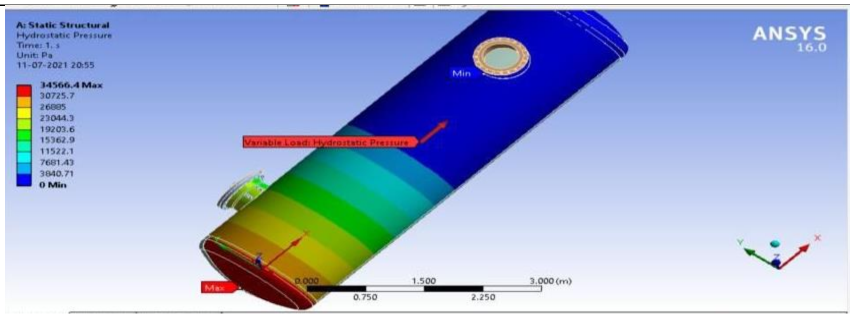

Fig 7 Hydrostatic Pressure

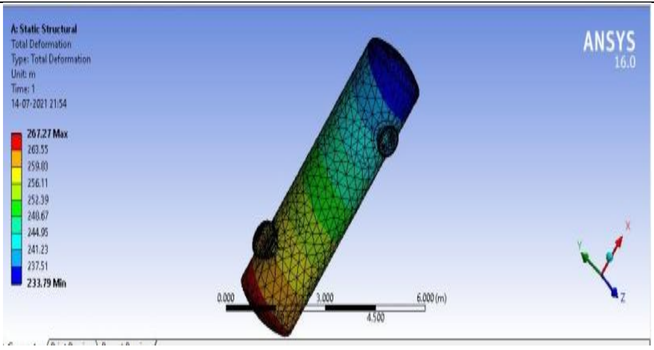

Fig 8 Total Deformation

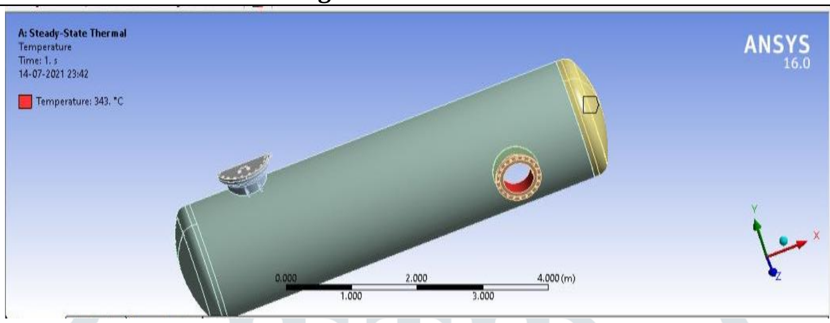

Fig 9 Temperature

Hence the Estimated value of Hydrostatic Pressure through simulation is 34.5 KPa.

Table 3 Stress Values

S.No	Description	Max Value	Min Value	Units
1	Total deformation	257.27	223.79	m
2	Equivalent Stress	3.4438e-01	9837.8	Pa

Table 4 Temperature Values

S.No	**Description**	**Value**
1	Temperature	341^0C
2	Convection	W / m^0C

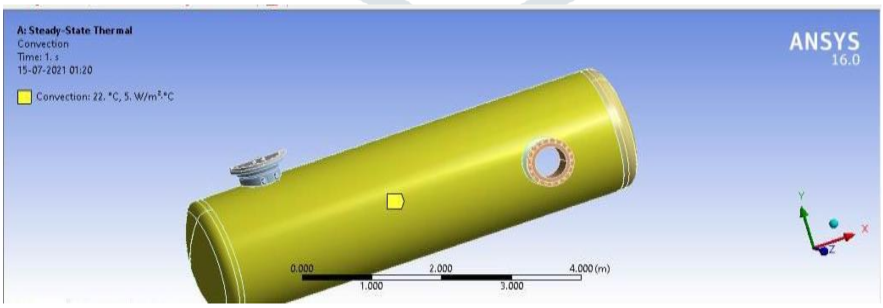

Fig 10 Convection

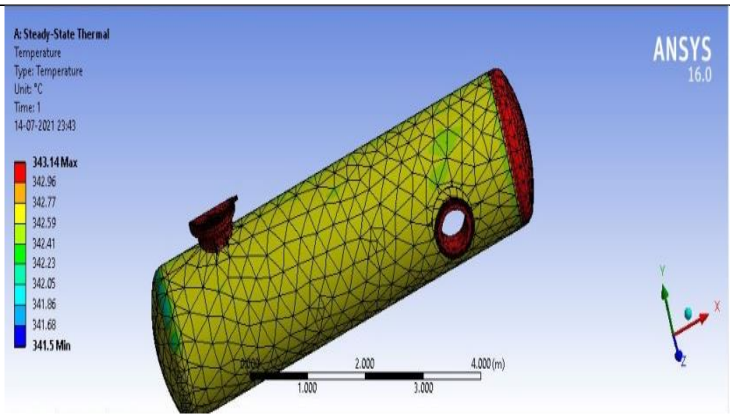

Fig 11 Temperature Result

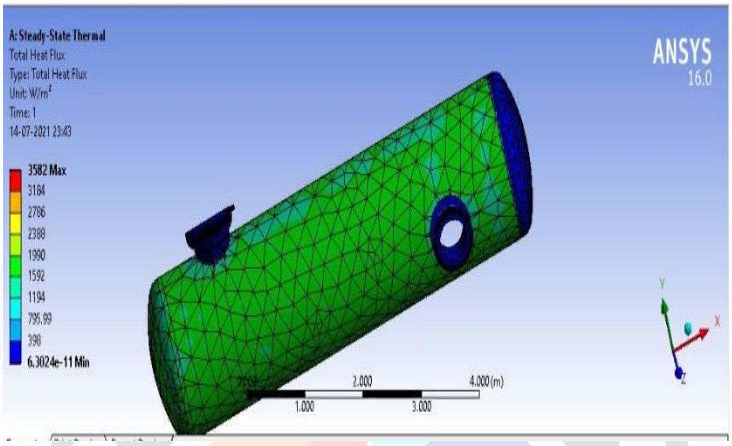

Fig 12 Total Heat Flux Result

Table 5 Temperature Values

SNo	Description	Max Value	Min Value	Units
1	Temperature	340.14	341.5	C0
2	Total Heat Flux	3575	6.3024e-11	W/m^2

V CONCLUSION

The internal design pressure, design temperature, and component dimensions of a pressure vessel meet ASME boiler and pressure vessel requirements. Under the specified particular load conditions, the material's allowable stress is less than the stress equivalent and stress classification lines for pressure vessel components. The blind flange, shell flange, eye boil, drain pipe, drain pipe flange, and junction area of the pressure vessel were analyzed using FEA (Finite Element Analysis) and ASME techniques. The analytical results for the normal operating state were within acceptable limits. As a consequence, the present blind flange, shell flange, and eye bolt designs are robust enough to sustain the specified stress requirements. Because the analysis is quite near to the analytical design, both data are verified. The design is regarded safe, with no breakdowns in the pressure vessel.

VI FUTURE SCOPE

The report contains a market overview, research goals, product definitions, and market concentrations. The report is superbly illustrated with a range of graphs, charts, and tables, depending on the quantity of data and information contained. The study gives essential information on market share, revenue, and profitability. The market size and growth rate will be estimated during the forecast period. It reveals worldwide Pressure Vessels industry information, enabling firms to obtain a thorough picture of the market and make key business choices.

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