Optimization of Condenser Shell Using ANSYS

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Abstract- One of the major preoccupations of condenser technologists has been -and-still is- the preventions of failures. Very often, however, due to severe problems like leaks or immense pressure which cannot be sustained then it results the bursting of condenser. In order to avoid such situation, the analysis should be done. The present work puts thrust on relation between pressure and stress distribution. Here focus is on pure mechanical analysis and hence thermal effect are not considered. In this project we will optimize the thickness of condenser shell by reducing its thickness, checking its failure using advance FEA, ANSYS software.

Indexed Terms- Condenser, shell, stiffener, thickness

I. INTRODUCTION

- Condenser is a device in which steam is condensed to water at a pressure less than atmosphere.
- Condensation can be done by removing heat from exhaust steam using circulating cooling water.
- During condensation, the working substance changes its phase from vapor to liquid and rejects latent heat.

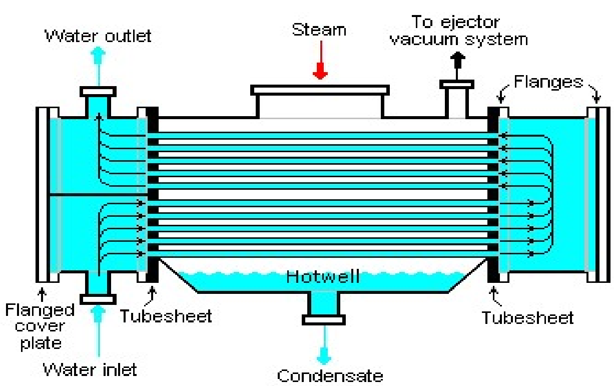


Figure shows the construction and working of condenser. The main components of condenser are

- Shell
- Nozzle
- Tubes
- Hot well
- Support

The shell is cylindrical casing which encloses tubes. A number of tubes is placed in the shell. The cold water flows through tubes which exchanges heat with steam, steam is condensed. The steam is supplied through nozzle from top and the condensate is collected at bottom in hot well. The shell is supported on saddles. Vacuum ejectors are provided to extract water from steam and prevents shell from corrosion.

The steam from the exhaust of turbine is supplied to condenser. The steam through nozzle enters shell. The cold water is flowing through tubes. The steam comes in contact with the cold water and exchanges latent heat and gets condensed. Now the water inside the tubes gets heated by absorbing heat from heat and hot water comes out from other end. Spacing of equal length is provided between tubes to increase heat transfer rate so maximum amount of steam is condensed. The tubes are supported properly with the help of baffles and the condensate in hot well is removed with drain plug.

II. OBJECTIVE

Our main objective of this project is to reduce the shell thickness of the condenser for a pressure of 0.10787 Mpa and temperature of 120^0 C. By reducing the thickness of shell following aspects are obtained:

1. Mass reduction
2. At what pressure shell bursts outs
3. Shows where the pressure of steam is acting maximum and minimum

III. MATERIAL PROPERTIES

MECHANICAL PROPERTIES	VALUE
Tensile strength	410 Mpa
Yield strength	240 Mpa
% Elongation	23
Modulus of elasticity	210 Gpa

IV. PROCESS PARAMETERS

Code stamp	ASME sec vii div 1
Design pressure (G)	0.10787 Mpa
Maximum allowable working pressure(internal) (G)	0.10787 Mpa
Maximum allowable working pressure(internal) (A)	0.2092 Mpa
Joint efficiency	0.8
Test temperature (min)	Ambient
Design temperature internal	120^0 C
Corrosion allowance	3 mm
Test position	Horizontal

1. GEOMETRY DATA

Pressure (p) – 0.10787 Mpa
Diameter ofshell (Ds) - 1385 mm
Allowable working stress(S) – 240 N/mm^2
Joint efficiency(E) - 0.8

2. CALCULATION

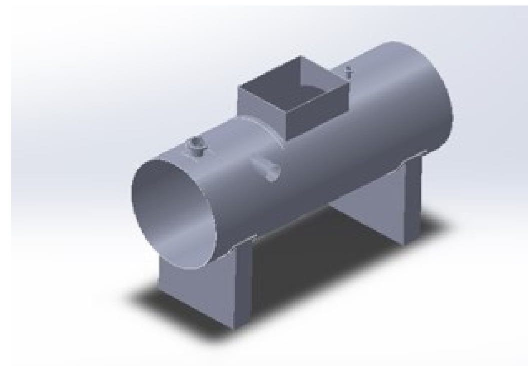
1. Shell thickness (ts) (As perASME)

$$t_s = \frac{pDs}{SE-0.6p} + c$$

2.84 ≈ 4 mm
By adding the corrosion allowance thickness – **7 mm**
Now according to ASME standard thickness - **10mm**

V. MODELING OF CONDENSER

For optimizing shell thickness, a condenser is made in solid works software



VI. FINITE ELEMENT ANALYSIS

Finite element analysis (FEA) is a method in which a component or design to be optimized is differentiated in finite (countable) number of elements, and then analysis is done on each element giving accurate and precision in results.

VII. BOUNDARY CONDITIONS

- The fixed support is provided to both the saddles.
- The standard earth gravity is given 9.81 m^2/s.
- Displacement is given to each nozzle.
- Pressure is given 0.10787 Mpa internally to shell.

- ANALYSIS ON SHELLS

The optimization on different thickness of shell is as under;

1. Shell of 10 mm thickness
2. Shell of 8 mm thickness
3. Shell of 8 mm thickness with single stiffener
4. Shell of 8 mm thickness with double stiffener

We will optimize the stresses generated and total deformation on each shell and select the most appropriate shell which is safe.

➢ ANALYSIS OF 10 mm THICKNESS:

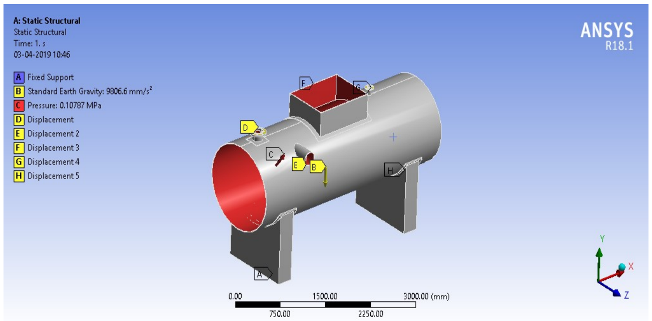


Fig.1 Boundary conditions

VIII. RESULTS

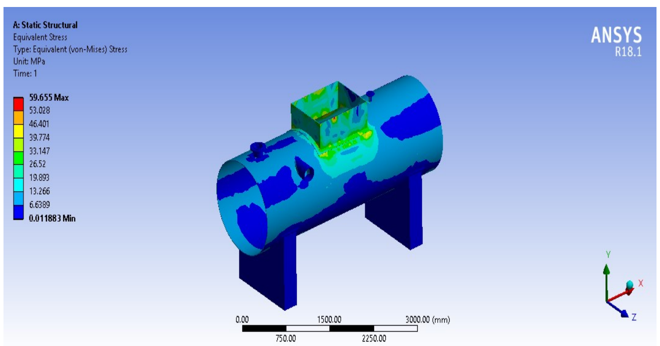


Fig.2 Equivalent stress (10 mm thickness)

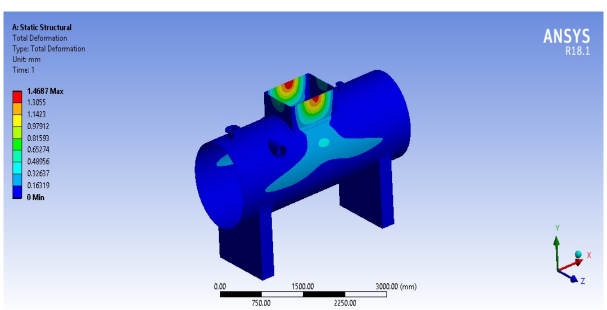


Fig.3 Total deformation (10 mm thickness)

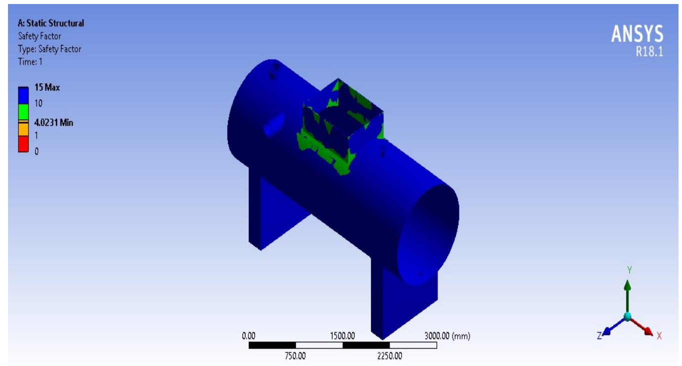


Fig.4 Factor of safety (10 mm thickness)

➢ ANALYSIS OF 8 mm THICKNESS:

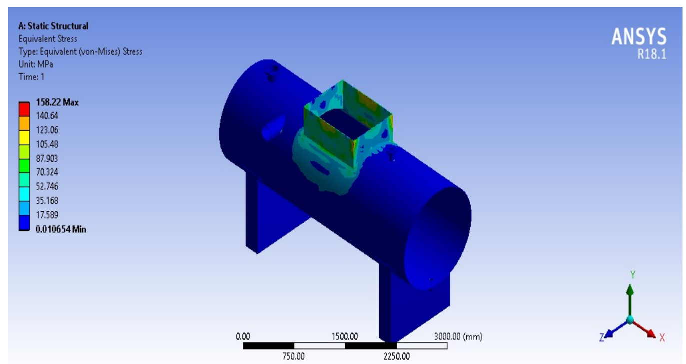


Fig.5 Equivalent stress (8 mm thickness)

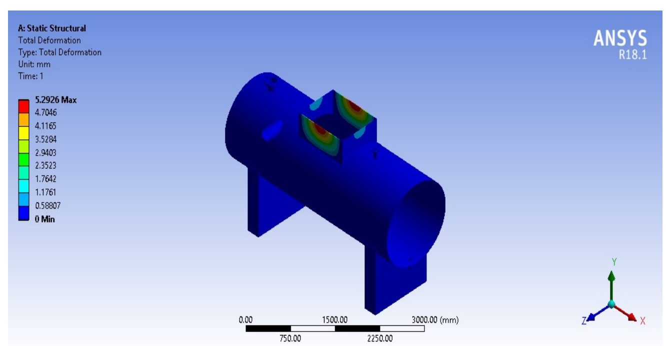


Fig.6 Total deformation (8 mm thickness)

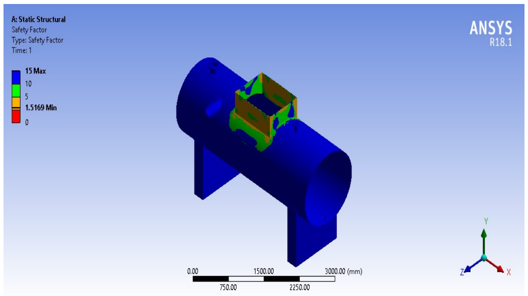


Fig.7 Factor of safety (8 mm thickness)

- ANALYSIS OF 8 mm THICKNESS WITH SINGLE STIFFENER:

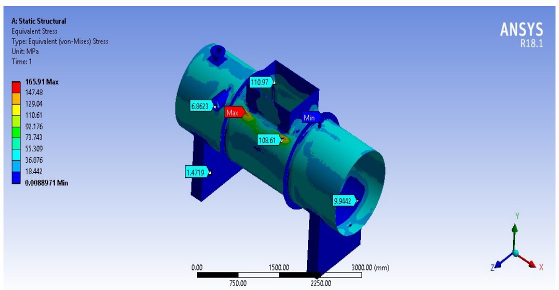


Fig.8 Equivalent stress (8 mm thickness with single stiffener)

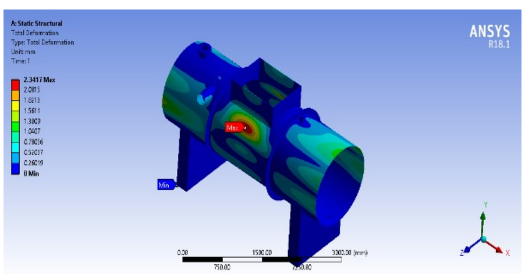


Fig.9 Total deformation (8 mm thickness with single stiffener)

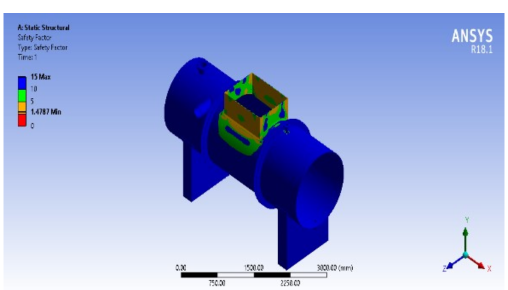


Fig.13 Factor of safety (8 mm thickness with double stiffener)

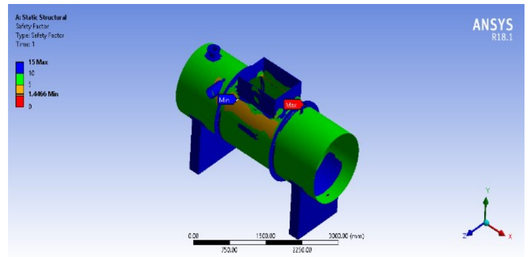


Fig.10Factor of safety (8 mm thickness with single stiffener)

- ANALYSIS OF 8 mm THICKNESS WITH DOUBLE STIFFENER:

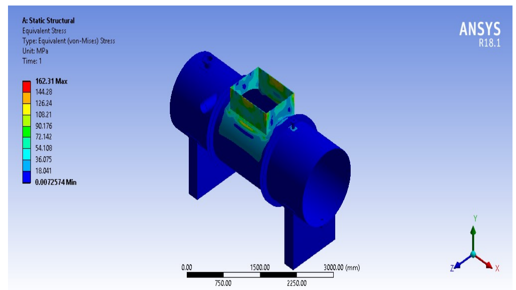


Fig.11 Equivalent stress (8 mm thickness with double stiffener)

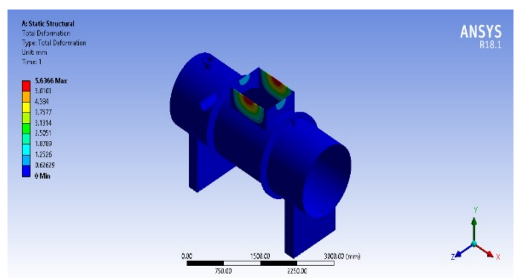


Fig.12 Total deformation (8 mm thickness with double stiffener)

IX. RESULTS SUMMARY

X. CONCLUSION

- From the graph, it is concluded that the stresses induced in 8 mm shell are higher than stresses induced in 10 mm thickness shell but the stress value is within yield limit. So, condenser will be safe during operation in 8 mm thickness shell.
- Moreover, as an additional safety stiffener rings are used.
- The shell of 8 mm thickness with single stiffener is preferred against shell of double stiffener, because though stress value is almost equal for both the shells, total deformation is less in single stiffener shell.
- So, shell of 8 mm with single stiffener is preferred.
- Furthermore , by reducing thickness of shell, mass reduction of 1300 kg is achieved.

XI. REFERENCES

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