I. Introduction

Vacuum vessel provides high level vacuum environment to reach and maintain fusion plasma with high quality.

- Like ITER, the vacuum vessel is made of austenitic steel, SS316, since this material has high neutron activation. Future material for ARIES will be 3Cr-3W steel.
- The vacuum vessel includes an inner cylinder attached to large maintenance ports. The fusion core is divided into 16 sectors.
- Vacuum vessel with different wall thicknesses are designed and analyzed to see if they can accommodate atmospheric pressure plus the weight of vessel or not.
- Parametric 3D finite element analysis is done to identify locations of high stress areas on the vessel under applied loads. Working temperature is 300 °C.

II. Thick solid single wall vacuum vessel, 10cm.

- A solid single wall vacuum vessel with 10cm wall thickness is analyzed under applied loads (Atmospheric pressure on the outer surface and gravity).
- Because of symmetry, 1/16 of sectors is picked up for analysis (Frictionless BC).

10cm thick wall solid single wall vacuum vessel can tolerate the atmospheric and gravity loads.

III. Very thin solid single wall vacuum vessel (5cm)

- The very thin vacuum vessel has lots of overstressed areas (>140 MP), not able to tolerate the desired loads.

IV. Ribbed Structure (Double Wall Structure)

- The need for using He coolant throughout the vessel and reducing stress intensity besides the need for designing vacuum vessel with thinner wall will lead us towards the ribbed structure model analysis.
- Ribbed structure, increases the strength of structure and provides sufficient space for the coolant He to follow between the ribs.
- Rib configuration on the port and door (the largest area of vacuum vessel) is to be determined which includes ribs thickness, ribs direction, distance between ribs and thickness of sheet wall.
- A simplified structure model for this optimization is considered which includes the detachment of port and door from the main body and using fixed BC.

V. Mixed Ribbed Structure (Vertical & Horizontal)

- Leading cooling channels from the main body to ports and doors.

Summary & Conclusion

- 3D finite element analysis is performed on different models of solid single wall vacuum vessel subjected to atmospheric pressure and gravity.
- High stress regions were identified. 5cm solid single wall vacuum vessel cannot tolerate the desired loads unlike the 10cm one.
- OOS normal loads such as disruption loads are not considered here.
- Ribbed structure configuration on the port and door, as a way to minimize the vacuum vessel thickness and cooling the system is designed and optimized.
- Result show that there is a substantial reduction in stress intensity on the outer wall (sheet) comparing to the inner wall.