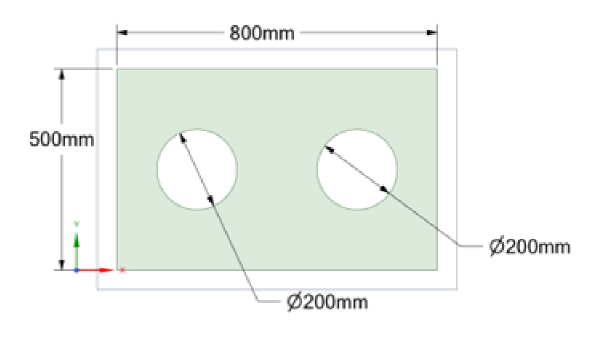
Project –Analysis of Heat Exchanger

Academic Project

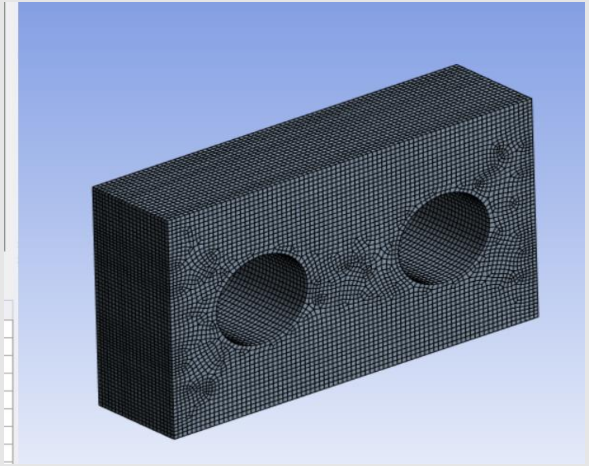


- **Overview**:

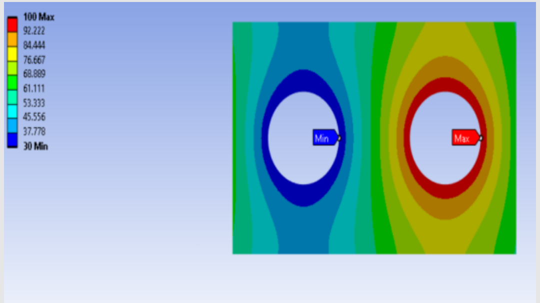
•Finite Element Analysis (FEA) of a heat exchanger’s temperature distribution.
•Evaluation of temperature gradients and heat transfer efficiency.
•Comparison between 2D and 3D modeling approaches.

- **Key Contributions**:

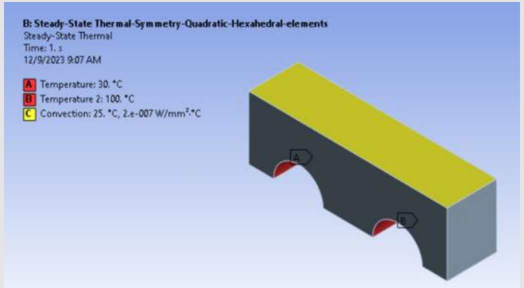
✓ Implemented symmetry in modeling for computational efficiency.
✓ Conducted numerical analysis using ANSYS.
✓ Investigated the impact of different meshing techniques on accuracy.



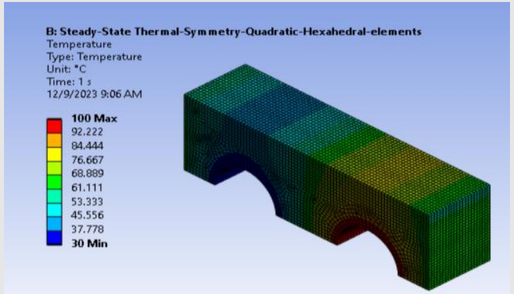
Results



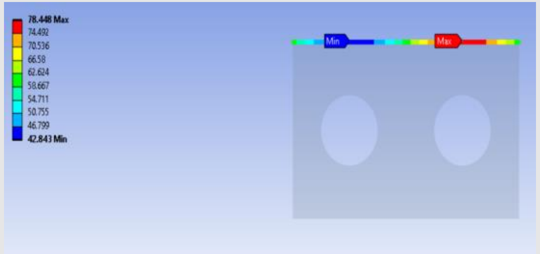
100 Max
92.222
84.444
76.667
68.889
61.111
53.333
45.556
37.778
30 Min
Min
Max



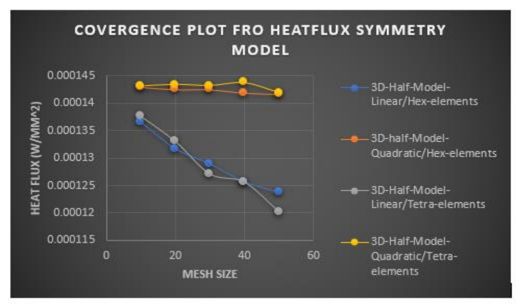
B: Steady-State Thermal-Symmetry-Quadratic-Hexahedral-elements
Steady-State Thermal
Time: 1. s
12/9/2023 9:07 AM
A Temperature: 30. °C
B Temperature 2: 100. °C
C Convection: 25. °C, 2.e-007 W/mm²·°C



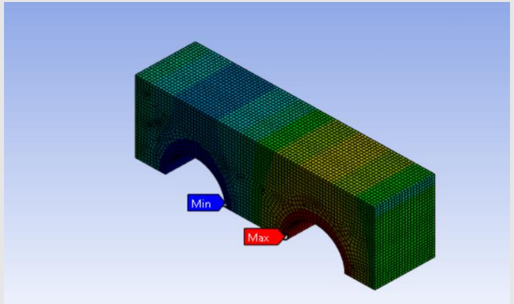
B: Steady-State Thermal-Symmetry-Quadratic-Hexahedral-elements
Temperature
Type: Temperature
Unit: °C
Time: 1 s
12/9/2023 9:06 AM
100 Max
92.222
84.444
76.667
68.889
61.111
53.333
45.556
37.778
30 Min



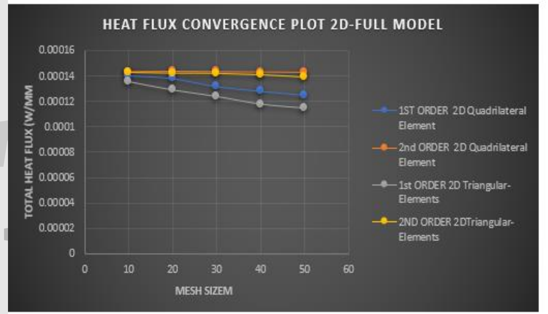
78.448 Max
74.492
70.536
66.58
62.624
58.667
54.711
50.755
46.799
42.843 Min
Min
Max



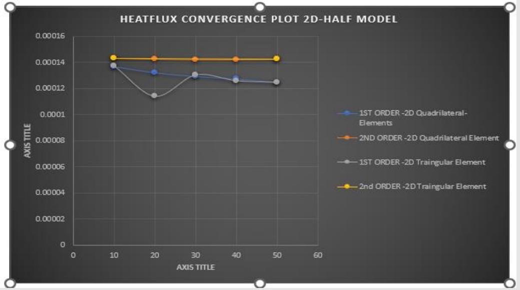
COVERGENCE PLOT FRO HEATFLUX SYMMETRY MODEL
HEAT FLUX (W/MM^2)
MESH SIZE
3D-Half-Model-Linear/Hex-elements
3D-half-Model-Quadratic/Hex-elements
3D-Half-Model-Linear/Tetra-elements
3D-Half-Model-Quadratic/Tetra-elements



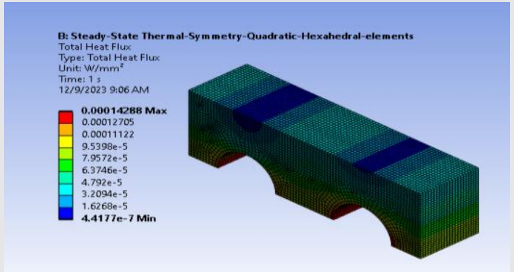
Min
Max



HEAT FLUX CONVERGENCE PLOT 2D-FULL MODEL
TOTAL HEAT FLUX (W/MM
MESH SIZEM
1ST ORDER 2D Quadrilateral Element
2nd ORDER 2D Quadrilateral Element
1st ORDER 2D Triangular-Elements
2ND ORDER 2DTriangular-Elements



HEATFLUX CONVERGENCE PLOT 2D-HALF MODEL
AXIS TITLE
1ST ORDER -2D Quadrilateral-Elements
2ND ORDER -2D Quadrilateral Element
1ST ORDER -2D Traingular Element
2nd ORDER -2D Traingular Element



B: Steady-State Thermal-Symmetry-Quadratic-Hexahedral-elements
Total Heat Flux
Type: Total Heat Flux
Unit: W/mm²
Time: 1 s
12/9/2023 9:06 AM
0.00014288 Max
0.00012705
0.00011122
9.5398e-5
7.9572e-5
6.3746e-5
4.792e-5
3.2094e-5
1.6268e-5
4.4177e-7 Min

Conclusion and Observations

Consistency in Temperature & Heat Flux:
All four cases showed similar temperature and heat flux distributions.
Temperature and heat flux behaved identically under the same constraints.

Smooth Plots & Mesh Convergence:
- Smooth temperature and heat flux curves due to averaged nodal values.
- Mesh refinement affected heat flux accuracy, especially at extreme values.

3D Model Assumptions:
- Constant temperature and heat flux gradients along the Z-axis.
- Plane strain assumption ensured accurate heat transfer modeling.

2D Symmetric Model Efficiency:
- Least computation time with high mesh quality.
- Reduced element count and symmetry led to faster convergence.

Element Type & Heat Flux Accuracy:
- Second derivatives of temperature impacted heat flux accuracy.
- Triangular elements were less accurate due to averaging effects.

Best Model for FEM:
- 2D symmetric model was the most efficient for heat exchanger analysis.
- Simplicity, symmetry, and reduced computation made it optimal.

Accuracy of 2nd Order Elements:
- Second-order Hexahedral, Tetrahedral, Quadrilateral, and Triangle elements showed high accuracy.
- Converged well at refined mesh sizes for reliable results.