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Technologies for Future Generation

CONJUGATE HEAT TRANSFER IN A SHELL AND TUBE HEAT-EXCHANGER

Objective

To model the process of heat transfer within a shell and tube heat exchanger for predicting the change in temperature of hot & cold fluid medium and estimate its Overall Heat Transfer (Q)

Challenges

- To create right type of interfaces at the boundary layer to model the heat transfer between hot and cold fluid
- Modeling convective heat transfer process within the fluid mediums
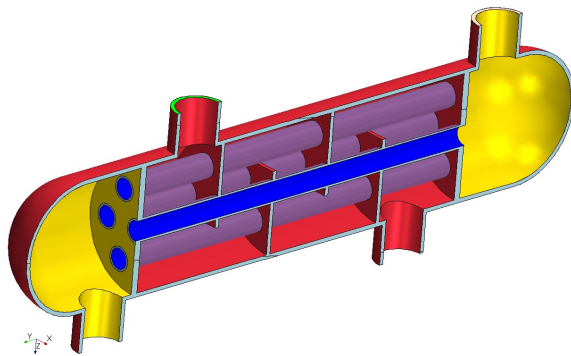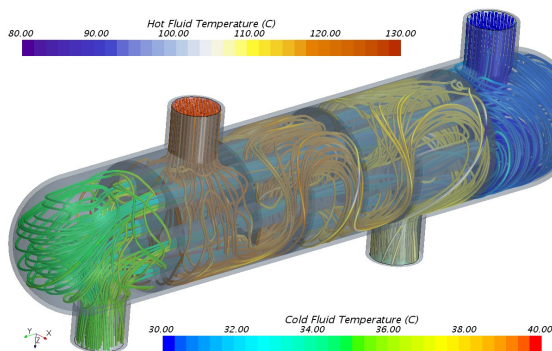
CFD Model

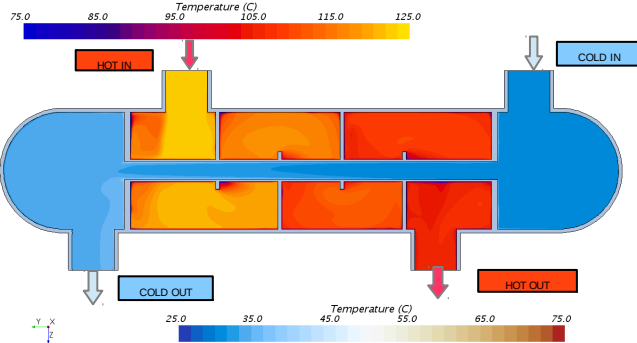**Fig-1 Geometry – Heat Exchanger**

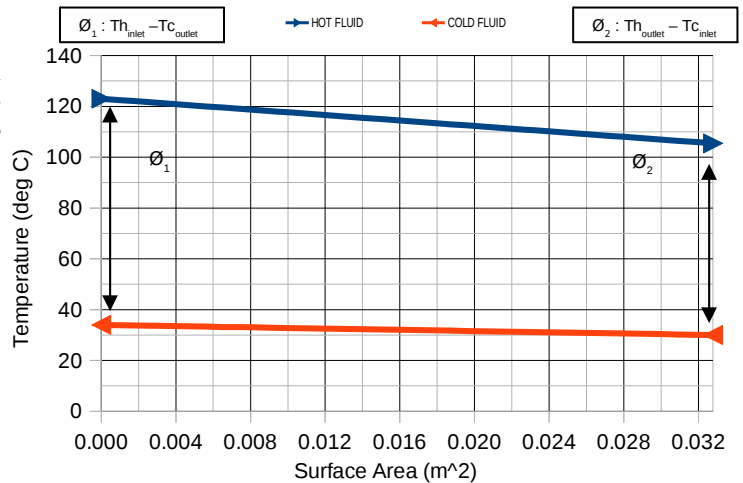**Fig-2 Velocity Contours**

Fig-3 Temperature Contours

Graph 1 – Temperature Change with Area

Approach

A typical shell and tube heat exchanger **(Fig-1)** with one shell and seven tubes (transfer units) with intermediate half baffles in the outer shell was considered for the CFD analysis. **Engine oil (SAE-15 W40) @100° C and Water (H20) @30°C** were used as the working fluids and **Copper (Cu)** for heat exchanger material. 3-D unsteady turbulent flow along with heat transfer was simulated using RANS approach with **k-ε turbulence model [1]**. Appropriate interface type boundaries were used between the solid and fluid interaction zones to simulate the heat transfer between tube surface and fluids **(Graph-1).**

Conclusion

The resulting pressure drop, outlet temperature, fluid velocity, flow distributions and heat transfer co-efficeint were obtained from CFD simulation results. The details of the results obtained and visualization options available in CFD proves that it can be used as an effective tool to improve the quality of design of heat exchangers at the very early stages of design process.

Benefits

- Effective Prototyping is feasible during Heat Exchanger design phase
- Visualize flow patterns and alter the geometry of the HEx to suit the temperature requirements
- Enhance Baffle designs to reduce system pressure drop, choosing an optimized shape and weight for the shell casing
- Simulation of complex processes such as condensation and vapourisation inside the system

Applications

- Automotive radiators and oil coolers
- Powerplant components such as Boiler Pressure Parts, Air cooled condensers and Cooling towers
- Condensers and Evaporators in Refrigeration units

1) *"CFD simulation of Heat Exchanger used in Pulse tube "*, Sanjay Gaikwad et.al, International Conference on Recent Technology 2012.

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