



SHELL & TUBE HEAT EXCHANGER – STEADY STATE

This case study demonstrates the steady-state thermal fluid simulation of a shell and tube heat exchanger. The shell and tube heat exchanger model can also be used in cycle analysis where it is used in conjunction with other models (See "Start-up of two-shaft High-Temperature Gas-Cooled Nuclear Power plant" case study).

GENERAL INDUSTRIES

CHALLENGE:

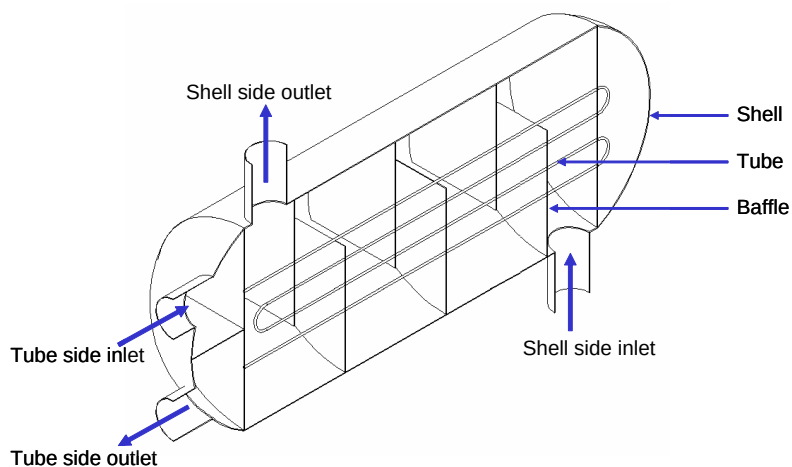
The objective of the simulation is to simulate the shell and tube heat exchanger to determine the tube wall temperature variation along the flow length and the pressure difference across the tube wall.

BENEFITS:

This case study demonstrates the steady-state thermal fluid simulation of a shell and tube heat exchanger. The shell and tube heat exchanger model can also be used in cycle analysis where it is used in conjunction with other models (See "Start-up of two-shaft High-Temperature Gas-Cooled Nuclear Power plant" case study).

SOLUTION:

The thermal fluid steady-state simulation of a shell and tube heat exchanger was discussed. The results provided for the incremented heat exchanger network can be used to do material selection or assess the design of a heat exchanger under certain conditions.



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INTRODUCTION

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SYSTEM DESCRIPTION

The thermal hydraulic conditions of a typical shell and tube heat exchanger are simulated. Figure 1 shows a schematic of a typical shell and tube heat exchanger. It is assumed that the outside of the heat exchanger is adiabatic.

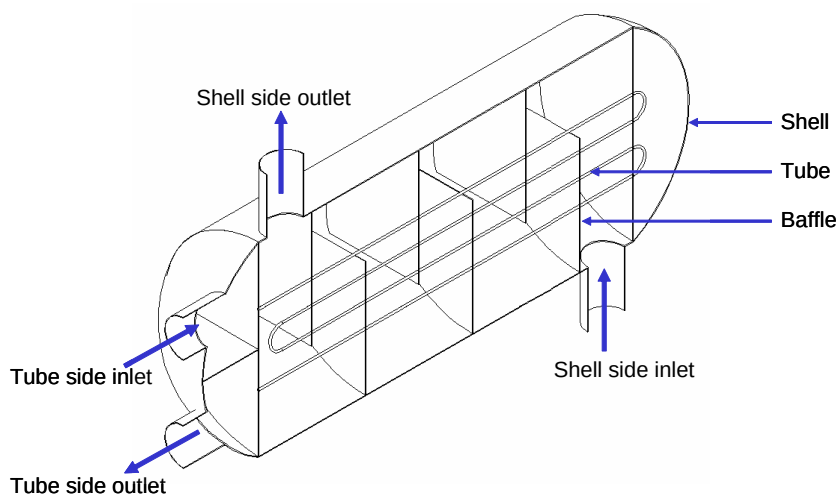


Figure 1: Schematic layout of a typical shell and tube heat exchanger.

OBJECTIVE OF SIMULATION

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FLOWNEX MODEL

The Flownex model on the graphical user interface is shown in Figure 2.

The thermal inertia of the solid tube wall material and fluid volume are taken into account in the modeling of transient simulations. The shell and tube heat exchanger model can also be used in cycle analysis where it is used in conjunction with other models.

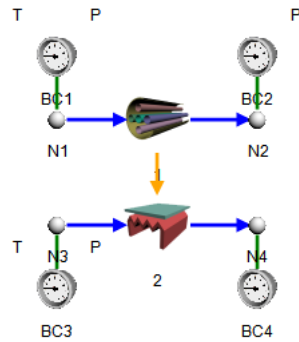


Figure 2: Flownex shell and tube heat exchanger graphical user interface representation.

The Flownex shell and tube heat exchanger model is a distributed model that is build up from an integrated network of one-dimensional elements. These elements represent either the flow paths on the shell or tube side or the heat transfer from the fluid on the tube side, through the tube wall to the fluid on the shell side. In Figure 3 it is shown that each intersection between the shell side fluid path and the tube side fluid path is considered as a control volume and the typical element network of a single control volume is shown. The thermal inertia of the solid tube wall material and fluid volume are taken into account in the modeling of transient simulations.

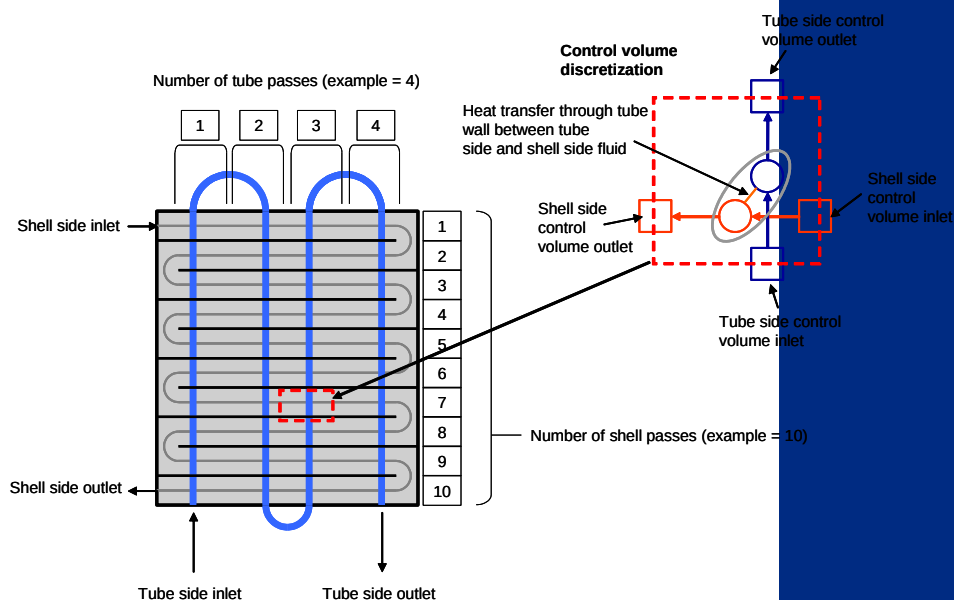


Figure 3: Discretized Flownex shell and tube heat exchanger model.

DESCRIPTION OF SIMULATION

In this case, a shell and tube heat exchanger with four tube passes (120 tubes per pass) and five shell side passes were simulated. Both

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RESULTS

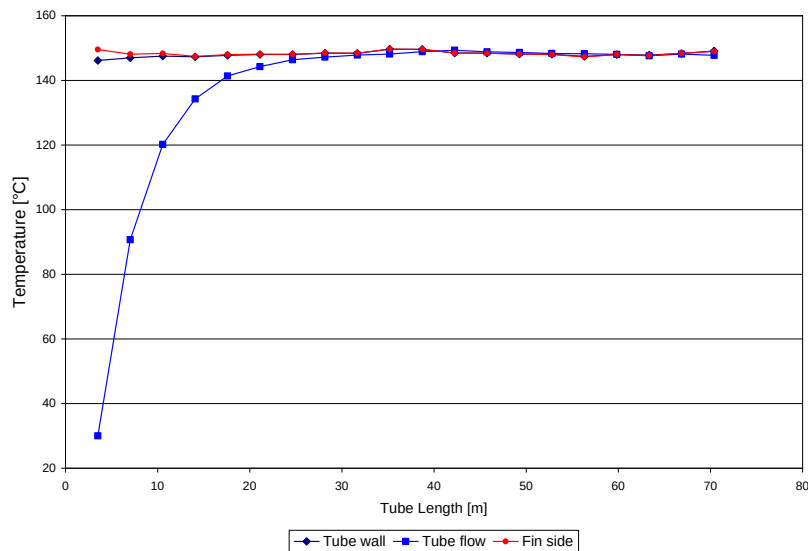


Figure 4: Temperature distribution along the flow length of the tube.

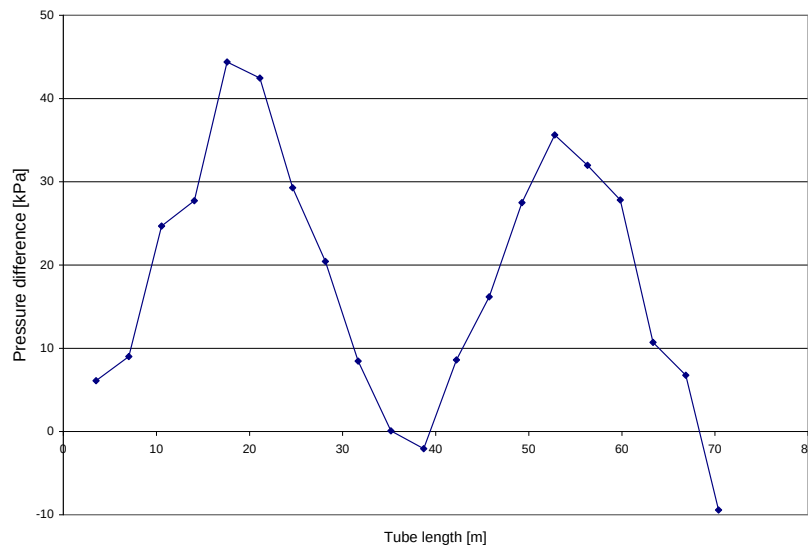


Figure 5: Pressure difference across tube wall along the tube length.

The temperature distribution of the air on the shell side, the tube wall and the air on the tube side (along the flow length of one of the parallel tubes) is presented in Figure 4. It can be seen that from about tube length 30 m onwards no effective heat transfer occurs and that the heat exchanger seems too big for the heat duty specified in the simulation. The pressure difference across the tube

wall, along the length of the tube, is shown in Figure 5. These typical results will determine whether the tube material and/or thickness are sufficient to handle the pressure and temperature constraints.

CONCLUSION

The thermal fluid steady-state simulation of a shell and tube heat exchanger was discussed. The results provided for the incremented heat exchanger network can be used to do material selection or assess the design of a heat exchanger under certain conditions.

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