# Tutorial 9: Steam Generator Modeling

# Problem Description:

A counter-current straight vertical shell and tube heat exchanger (without baffles) with liquid sodium on the shell side and water on the tube side is considered. On the shell side, sodium enters at 525 °C with a mass flow rate of 730 kg/s from top to bottom. On the tube side, water enters at a temperature of 235 °C, a pressure of 170 bar, and a mass flow rate of 70.3 kg/s from bottom to top. The active heat transfer length is 22 m. The tube inner and outer diameters are 12.6 mm and 17.2 mm, respectively. There are 547 tubes in the heat exchanger arranged with a pitch of 32.2 mm. The shell's inner diameter is 0.831 m. The regime-dependant heat transfer coefficient correlations as described in [20] shall be used to estimate the heat transfer rates in the shell and tube sides. It is required to estimate the temperature and pressure profiles in the heat exchanger. The material properties for sodium shall be used as given in Table 12, while that for water can be imported from the CoolProp database. The thermal conductivity for the tube material can be taken as 23.2 Wm-1K-1.

# Steps:

This validation problem is a severe test of convergence due to the complex heat transfer coefficient correlations for boiling heat transfer that must be solved on the tube side. The steady-state temperature and pressure profiles are shown in Figure 13 and Figure 14, respectively. The results are compared against Flownex code [18] results. It is seen that the results match precisely, giving confidence in the two-phase heat exchanger modeling.

Chart, line chart

Description automatically generated

Figure 13: Steady-State Temperature Profile for Problem 3.4.2

Chart, line chart

Description automatically generated

Figure 14: Steady-State Pressure Profile for Problem 3.4.2