

You are required to design a shell and tube heat exchanger having a rectangular cross section as shown in figure 1 below. The heat exchanger uses water as the cooling fluid to reduce the temperature of exhaust air from a natural gas furnace that is flowing through the tube. The target effectiveness is 48%.

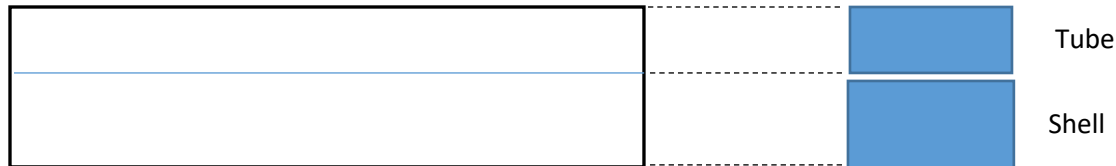


Figure 1: Geometry for Heat Exchanger

**The design constraints are as follows:**

Tube Side (Upper Channel)

Input

$$\dot{m} = 0.01 \text{ kg / s}$$

$$\text{Temperature} = 458.2K$$

$$\text{pressure} = 1.82 \text{ atm}$$

Output

$$\dot{m} = 0.01 \text{ kg / s}$$

$$\text{pressure} = 1.0 \text{ atm}$$

Shell Side (Lower Channel)

Input

$$\dot{m} = 2.5 \text{ kg / s}$$

$$\text{Temperature} = 292.2K$$

Output

$$\dot{m} = 2.5 \text{ kg / s}$$

$$\text{pressure} = 1.0 \text{ atm}$$

Wall Thickness: 1.5 mm for both Shell and Tube

Geometry: Must remain a Single Flow, Single Pass system in the stacked configuration shown in Figure 1. i.e. tube cannot be encapsulated with shell.

Velocity U: Both shell and tube sides should a minimum value of at least 1.0 m/s and a maximum value between 2.5-3.0 m/s.

Tube and Shell Dimensions: You may vary tube and shell dimensions (but the wall thickness must be constant). The height of either the tube or shell must not fall below 30 mm.

Tube Length: minimum of 600 mm and a maximum of 1200 mm.

Material: You may also vary the material of which the heat exchanger is made.

Internal Profile: Additional geometries may be added to the tube and shell to enhance the effectiveness as needed.

Manufacturability: The design must be manufacturable.

**Procedure:** Using SolidWorks Flow Simulation, create a model of your design and determine the effectiveness of the heat exchanger.