## Question #78789

A double pipe heat exchanger has an effectiveness of 0.5 when the flow is counter- current and the thermal capacity of one fluid is twice that of the other fluid. Calculate the effectiveness of the heat exchanger if the direction of flow of one of the fluids is reversed with the same mass flow rates as before?

**Answer:**

For a given geometry of a heat exchanger the effectiveness is a function of the heat capacity ratio $C_r$:

$$C_r = \frac{C_{min}}{C_{max}} = 0.5, \quad (1)$$

and the number the number of transfer units *NTU*:

$$NTU = \frac{UA}{C_{min}}, \quad (2)$$

where $C_{min}$ and $C_{max}$ – respectively, the smaller and the lager heat capacity of the fluids,

*U* – the overall heat transfer coefficient,

*A* – the heat transfer area.

Since the geometry, fluids and their flowrates are the same for the both cases (co- and counter-current flow), the values of $C_r$ and *NTU* are the same too.

The effectiveness $\varepsilon$ of a double pipe counter-current heat exchanger is given by:

$$\varepsilon_{counter} = \frac{1-e^{-NTU(1-C_r)}}{1-C_r e^{-NTU(1-C_r)}}, \quad (3)$$

The effectiveness $\varepsilon$ of a double pipe co-current heat exchanger is given by:

$$\varepsilon_{co} = \frac{1-e^{-NTU(1+C_r)}}{1+C_r}. \quad (4)$$

Solving equations (3) and (4) graphically (see Figure 1 on the page 2), we obtain the following value of the co-current heat exchanger:

$$\varepsilon_{co} = 0.47.$$

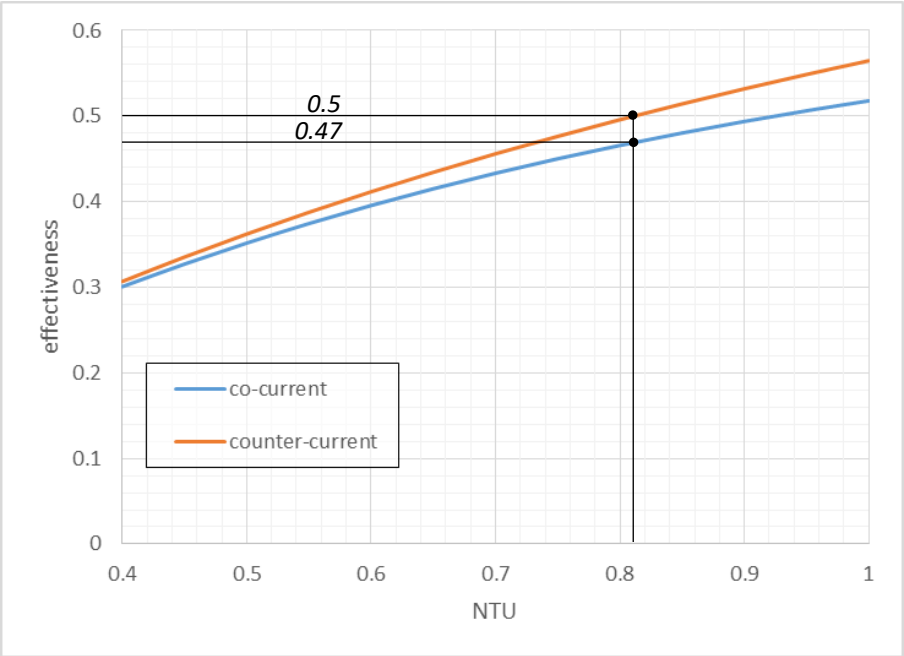


FIGURE 1. Effectiveness $\varepsilon = f(NTU)$ of the given heat exchangers for $C_r = 0.5$