MS Excel and VBA for Chemical Engineers

TSEC - Online Certificate Course

PROJECT 2

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1 Heat Exchanger Network

A train of Shell and Tube Heat Exchangers (1-shell, 2-tube) are used to preheat crude oil before it reaches the distillation unit. The crude oil splits into 3 streams with the split ratio of 0.3, 0.3 and 0.4 for stream 1, 2 and 3 respectively. This crude is being heated by the distillates that come directly from the distillation unit. These distillates are supposed to be cooled down, so the heat liberated from them is used to preheat the crude oil. The setup is show in the figure below.

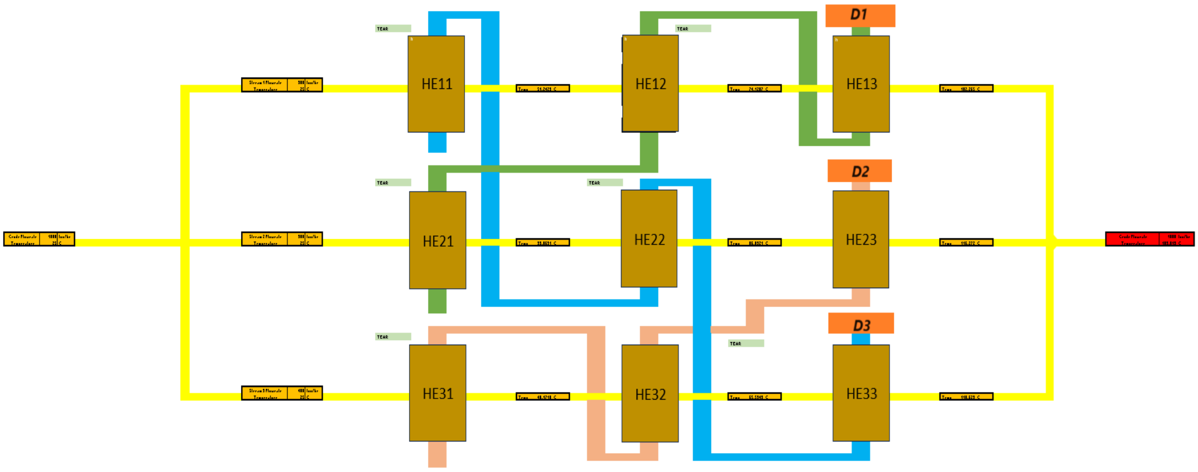

Figure 1: Train of heat exchangers

Distillates 1, 2 and 3, are labelled as D1, D2, D3 respectively. Heat exchangers are labelled as the HE_{ij} where i represents the stream number and j represents the heat exchanger number in that stream. The specific heat values for the crude, D1, D2 and D3 are 0.45, 0.6, 0.59 and 0.58 Mcal/ton-C respectively. The initial conditions are as follows

Component	Flowrate (ton/hr)	Temperature (C)
Crude	1000	25
D1	100	180
D2	100	200
D3	150	250

Table 1: Flowrates and temperatures at their respective origins

The exit temperatures at the hot side and cold side are calculated by the Effectiveness-NTU method. The only additional data required here is the formula for ϵ, which is dependent on the type of heat exchanger used. This is given by the following equation [J.P. Holman (2018), Heat Transfer, Table 10.3]

$$\epsilon = \frac{2}{1 + C + \sqrt{1 + C^2} \cdot \dfrac{1 + \exp\left(-NTU\sqrt{1 + C^2}\right)}{1 + \exp\left(-NTU\sqrt{1 + C^2}\right)}} \tag{1}$$

The UAF values for all the 9 heat exchangers are given below. (U = Overall heat transfer coefficient, A = Area of the Heat exchanger, F = Correction factor; the units are Gcal/hr-C)

$$UAF = \begin{bmatrix} 0.01 & 0.01 & 0.001 \\ 0.005 & 0.05 & 0.05 \\ 0.005 & 0.01 & 0.1 \end{bmatrix} \tag{2}$$

Once the stream end temperatures are calculated, they are mixed once again. This mixing is calculated by the following formula

$$T_{mix} = \frac{\sum_i m_i C_{p,i} T_i}{\sum_i m_i C_{p,i}} \tag{3}$$

Calculate the final temperature of the crude oil. Also, remove heat exchangers from the line and find out the exit temperatures of this network.