Topic - Heat Exchanger Analysis-NTU - Effectiveness

Effectiveness of A HX

- Ratio of the actual heat transfer rate to maximum available heat transfer rate.

$$\varepsilon = \frac{\dot{Q}_{act}}{\dot{Q}_{\max}}$$

- Maximum available temperature difference of minimum thermal capacity fluid.

$$\Delta T_{\max,fluid} = T_{h,i} - T_{c,i}$$

- Actual heat transfer rate:

$$\dot{Q}_{act} = UA\Delta T_{LMTD}$$

Dimensionless Groups for HXs

- Thermal capacity Ratio:

$$R = \frac{(\dot{m}c_p)_{\min}}{(\dot{m}c_p)_{\max}} = \frac{C_{\min}}{C_{\max}}$$

- $R = 0$ corresponds to condensing or evaporating HX.
- $R < 1$ *a general heat exchanger.*

- Exchanger heat communicative Effectiveness:

$$\varepsilon = \frac{\dot{Q}_{act}}{\dot{Q}_{\max}}$$

$\dot{Q}_{\max}$: Thermodynamically limited maximum possible heat transfer

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Number of Transfer Units

$$\varepsilon = \frac{UA\Delta T_{LMTD}}{(\dot{m}c_p)_{\min}(T_{h,i} - T_{c,i})}$$

$$\varepsilon = NTU_{\max}\frac{\Delta T_{LMTD}}{(T_{h,i} - T_{c,i})}$$

$$\varepsilon = NTU_{\max}\frac{\dfrac{(\Delta T_{comm,2} - \Delta T_{comm,1})}{\ln\left[\dfrac{\Delta T_{comm,2}}{\Delta T_{comm,1}}\right]}}{(T_{h,i} - T_{c,i})}$$

Arithmetic of A Simple Counter Flow HX

Gn	UA
1	26587
2	26467
3	26541

$$\varepsilon = \frac{1 - \exp\left[NTU \times \left[R - 1\right]\right]}{1 - R \times \exp\left[NTU \times \left[R - 1\right]\right]} = 0.86$$

$$NTU = \frac{\ln\left\{\dfrac{(1-\varepsilon)}{(1-R\varepsilon)}\right\}}{1-R}$$

$$R = \frac{(\dot{m}c_p)_{\min}}{(\dot{m}c_p)_{\max}} = \frac{C_{\min}}{C_{\max}} = 0.57$$

$$NTU = \frac{UA}{C_{\min}} = 3.195$$

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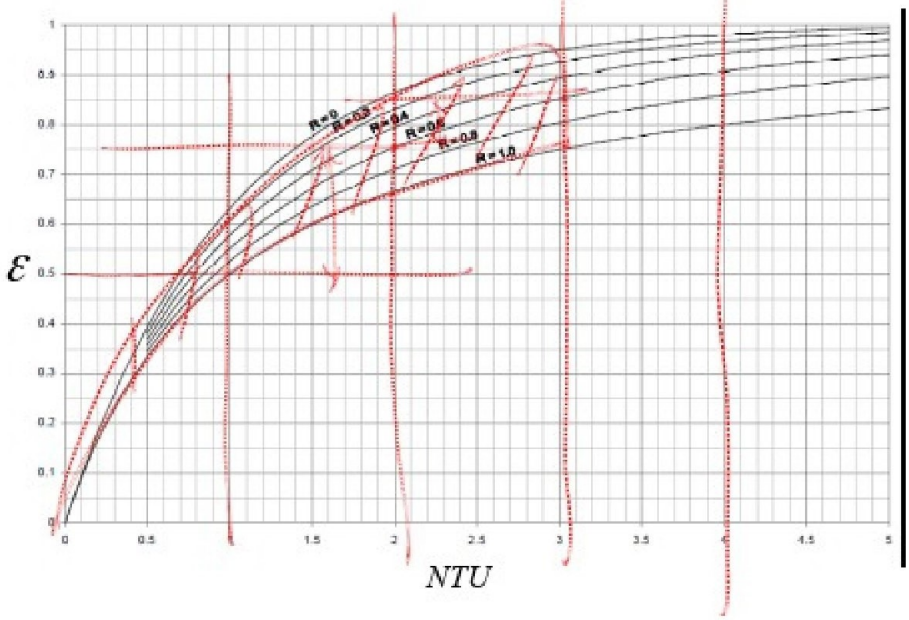
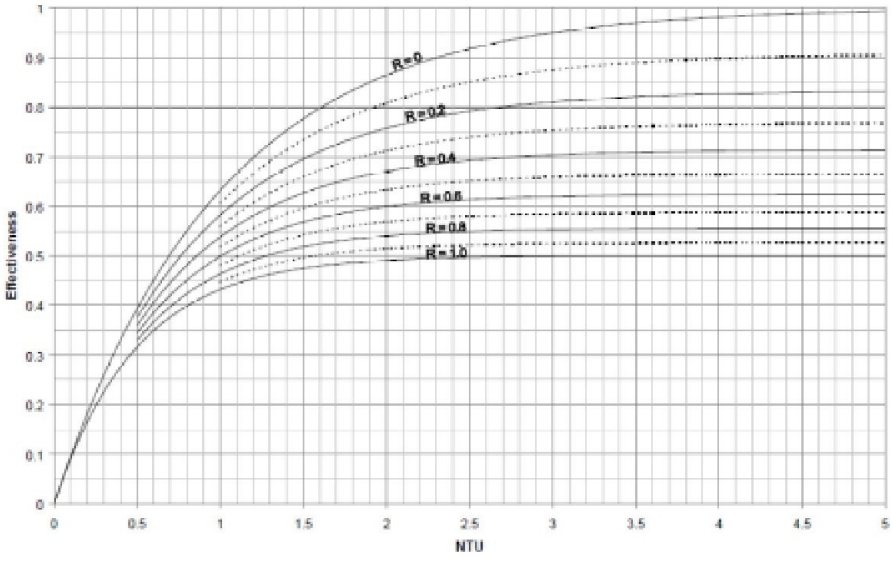
ε- NTU Curves: Counter flow



ε- NTU Curves: Counter Vs parallel flow



References:

Topic - Heat Exchanger Analysis-NTU - Effectiveness

1. Kothandaraman C.P "Fundamentals of Heat and Mass Transfer" New Age International, New Delhi,4th Edition 2012 (Unit I, II, III, IV, V).
2. Frank P. Incropera and David P. DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, New Jersey,6th Edition1998(Unit I,II,III,IV, V)
3. MIT open courseware – https://ocw.mit.edu/courses/mechanical-engineering

Other web sources