Cálculo de un intercambiador strawoil-nafta: Ejemplo 11-1 Kern Página 277

Se quieren calentar 103000 lb/hr de una nafta de 48° API de 200 °F a 230 °F usando 29800 lb/hr de un aceite de 35° API de 340 °F a 240 °F

Fluido Caliente: Aceite 35° API

$Wc := 29800 \ \frac{lb}{hr}$

$Cpc := 0.58 \ \frac{Btu}{lb°F}$

$kc := 0.0735 \ \frac{Btu}{hr \cdot ft^2\left(\frac{°}{ft}\right)}$

$\mu c := 1.5 \cdot 2.42 \ \frac{lb}{ft(hr)}$

$\rho c := 45 \ \frac{lb}{ft^3}$

$T1 := 340 \ °F$

$T2 := 240 \ °F$

$Tc := \frac{T1 + T2}{2} \qquad Tc = 290.00 \ °F$

Fluido Frio: Nafta 48° API

$Wf := 103000 \ \frac{lb}{hr}$

$Cpf := 0.56 \ \frac{Btu}{lb°F}$

$kf := 0.082 \ \frac{Btu}{hr \cdot ft^2\left(\frac{°}{ft}\right)}$

$\mu f := 0.54 \cdot 2.42 \ \frac{lb}{ft(hr)}$

$\rho f := 47.4 \ \frac{lb}{ft^3}$

$t1 := 200 \ °F$

$t2 := 230 \ °F$

$tc := \frac{t1 + t2}{2} \qquad tc = 215.00 \ °F$

Calor $\qquad Qc := Wc \cdot Cpc \cdot (T1 - T2) \qquad Qf := Wf \cdot Cpf \cdot (t2 - t1)$

$Qc = 1728400.00 \ \frac{Btu}{hr} \qquad Qf = 1730400.00 \ \frac{Btu}{hr}$

$MLDT := \frac{(T1 - t2) - (T2 - t1)}{\ln\left[\frac{(T1 - t2)}{(T2 - t1)}\right]} \qquad R := \frac{(T1 - T2)}{(t2 - t1)} \qquad S := \frac{(t2 - t1)}{(T1 - t1)}$

$MLDT = 69.20 \ °F \qquad R = 3.33 \qquad S = 0.21$

$$Ft := \frac{\sqrt{R^2+1}\cdot\ln\left[\frac{(1-S)}{(1-R\cdot S)}\right]}{(R-1)\cdot\ln\left[\frac{\left[2-S\cdot\left(R+1-\sqrt{R^2+1}\right)\right]}{\left[2-S\cdot\left(R+1+\sqrt{R^2+1}\right)\right]}\right]} \qquad Ft = 0.88$$

Datos del equipo:

$De := \frac{3}{4}\ plg$ $\quad BWG := 16$ $\quad Di := \frac{0.62}{12}\ plg$

Arreglo en cuadro $\quad Pt := 1$ $\quad Nt := 124$ $\quad L := 16\ ft$

$np := 2$ $\quad aft := 0.302\ plg^2$ $\quad aet := 0.1963\ \frac{plg^2}{ft}$

$Ds := 15.25\ plg$ $\quad B := 3.5\ plg$ $\quad Des := 0.95\ plg$

$$At := Nt\cdot aet\cdot L$$

area total del intercambiador $\quad At = 389.46\ ft^2$

Tubos: fluido frío

$at := \frac{Nt\cdot aft}{144\cdot np}$ $\quad at = 0.13\ plg^2$

$Gt := \frac{Wf}{at}$ $\quad Gt = 792138.43\ \frac{lb}{(hr)ft^2}$

$Ret := \frac{Di\cdot Gt}{\mu f}$ $\quad Ret = 31318.60$

$Prt := \frac{Cpf\cdot\mu f}{kf}$ $\quad Prt = 8.92$

$$hi := \left(0.027\cdot Ret^{0.8}\cdot Prt^{0.333}\right)\cdot\left(\frac{kf}{Di}\right)$$

Coraza: fluido caliente

$as := \frac{Ds\cdot(Pt-De)\cdot B}{144\cdot Pt}$ $\quad as = 0.09\ plg^2$

$Gs := \frac{We}{as}$ $\quad Gs = 321588.76\ \frac{lb}{(hr)ft^2}$

$Res := \frac{\frac{Des}{12}\cdot Gs}{\mu c}$ $\quad Res = 7013.53$

$Prs := \frac{Cpc\cdot\mu c}{kc}$ $\quad Prs = 28.64$

$$ho := \left(0.36\cdot Res^{0.55}\cdot Prs^{0.333}\right)\cdot\left(\frac{12\cdot kc}{Des}\right)$$

$hi = 350.88$ $\quad hio := hi \cdot \left(\frac{12 \cdot Di}{De}\right)$ $\quad ho = 133.20 \ \frac{Btu}{hr ft^2 °F}$

$hio = 290.06 \ \frac{Btu}{hr ft^2 °F}$

$Uc := \frac{hio \cdot ho}{hio + ho}$ $\quad Ud := \frac{Qf}{At \cdot Ft \cdot MLDT}$

$Uc = 91.28 \ \frac{Btu}{hr ft^2 °F}$ $\quad Ud = 73.16 \ \frac{Btu}{hr ft^2 °F}$

$Rd := \left(\frac{1}{Ud} - \frac{1}{Uc}\right)$ $\quad Rd = 0.0027 \ \frac{hr ft^2 °F}{Btu}$

Pérdidas de carga

Tubos: fluido frío

$fft := 0.0002 \ \frac{ft^2}{plg^2}$

$sf := \frac{pf}{62.4}$

$\Delta Pt := \frac{fft \cdot Gt^2 \cdot L \cdot np}{5.22 \cdot 10^{10} \cdot Di \cdot sf}$

$\Delta Pt = 1.96 \ psi$

Coraza: fluido caliente

$ffs := 0.00225 \ \frac{ft^2}{plg^2}$

$se := \frac{pc}{62.4}$

$Nb := round\left(\frac{12 \cdot L}{B}\right)$

$Nb = 55.00$

$\Delta Ps := \frac{ffs \cdot Gs^2 \cdot Ds \cdot (Nb + 1)}{5.22 \cdot 10^{10} \cdot Des \cdot se}$

$\Delta Ps = 5.56 \ psi$