**Projeto de permutadores pela média logarítmica da diferença de temperaturas**

$$q = UAF(\Delta T)_{ml}$$

Co-corrente

$$\Delta T_{ml} = \frac{(T_{Ae} - T_{Be}) - (T_{As} - T_{Bs})}{\ln \frac{(T_{Ae} - T_{Be})}{(T_{As} - T_{Bs})}}$$

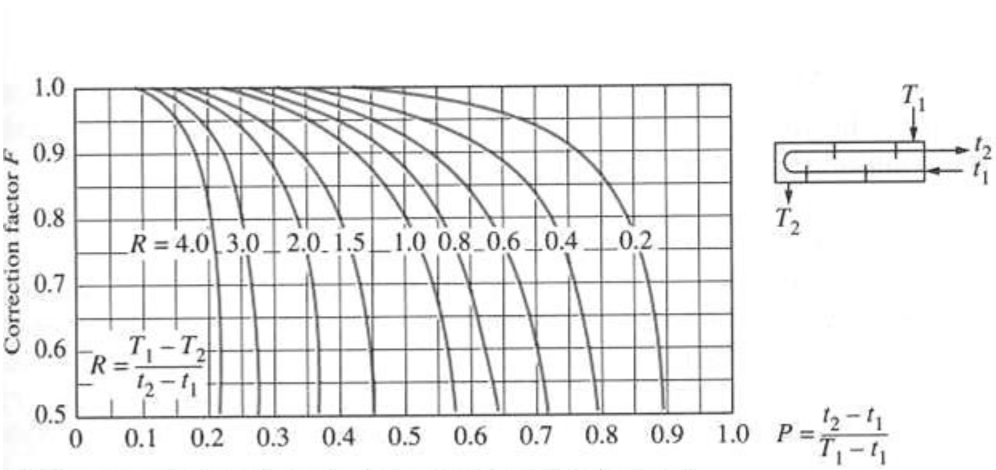
Contra-corrente

$$\Delta T_{ml} = \frac{(T_{Ae} - T_{Bs}) - (T_{As} - T_{Be})}{\ln \frac{(T_{Ae} - T_{Bs})}{(T_{As} - T_{Be})}}$$

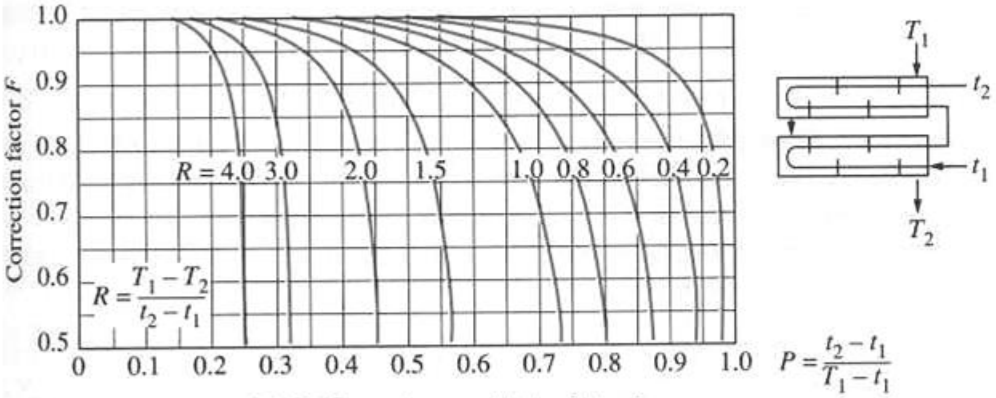
A: fluido quente; B: fluido frio e: entrada; s: saída

$$P = \frac{t_2 - t_1}{T_1 - t_1} \quad R = \frac{T_1 - T_2}{t_2 - t_1}$$

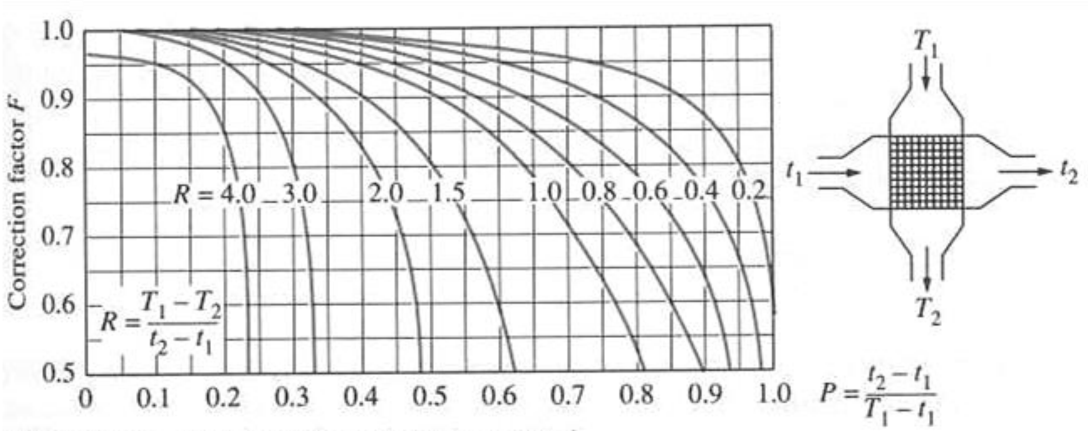
1 e 2 representam entrada e saída, respetivamente; T fluido que circula na carcaça; t fluido que circula nos tubos independentemente de serem quentes ou frios



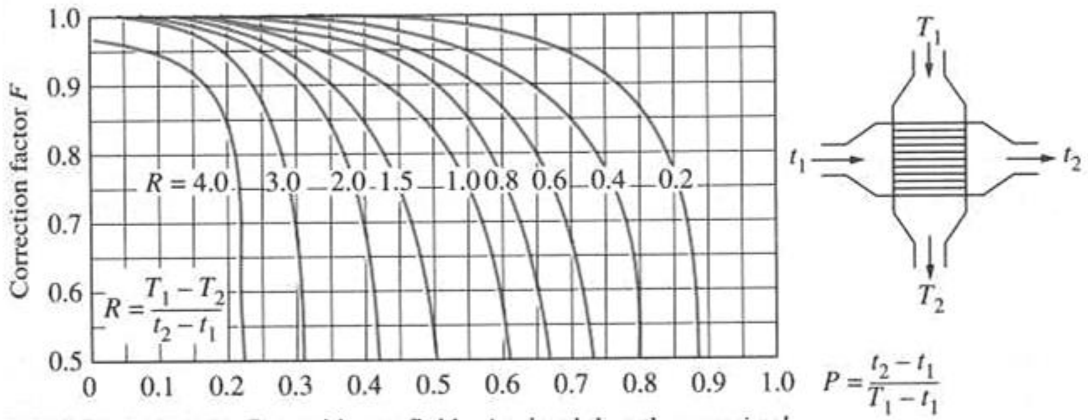

(a) One-shell pass and 2, 4, 6, etc. (any multiple of 2), tube passes




(b) Two-shell passes and 4, 8, 12, etc. (any multiple of 4), tube passes




(*c*) Single-pass cross-flow with both fluids *unmixed*




(*d*) Single-pass cross-flow with one fluid *mixed* and the other *unmixed*

**Método NUT**

$q_{máx} = (MCp)_{min}\ \Delta T_{máx}$

$\mathcal{E} = q/q_{máx} \quad 0 < \mathcal{E} < 1$

$NUT = UA / (Mcp)_{min}$

$C = (MCp)_{min}/(MCp)_{máx}$

| Heat exchanger type | NTU relation |
|---|---|
| 1 *Double-pipe:* | |
| Parallel-flow | $NTU = -\frac{\ln[1-\varepsilon(1+C)]}{1+C}$ |
| Counter-flow | $NTU = \frac{1}{C-1}\ln\left(\frac{\varepsilon-1}{\varepsilon C-1}\right)$ |
| 2 *Shell and tube:* | |
| One-shell pass 2, 4, . . . tube passes | $NTU = -\frac{1}{\sqrt{1+C^2}}\ln\left(\frac{2/\varepsilon-1-C-\sqrt{1+C^2}}{2/\varepsilon-1-C+\sqrt{1+C^2}}\right)$ |
| 3 *Cross-flow* (*single-pass*) | |
| $C_{max}$ mixed, $C_{min}$ unmixed | $NTU = -\ln\left[1+\frac{\ln(1-\varepsilon C)}{C}\right]$ |
| $C_{min}$ mixed, $C_{max}$ unmixed | $NTU = -\frac{\ln[C\ln(1-\varepsilon)+1]}{C}$ |
| 4 *All heat exchangers with C = 0* | $NTU = -\ln(1-\varepsilon)$ |

*Source:* Kays and London, Ref. 7.