Formulario BeTech

1. 1ª Ley de la termodinámica

$$\Delta U = Q - W$$

2. 2ª Ley de la termodinámica

$$dS \geq \frac{\delta Q}{T}$$

3. 3ª Ley de la termodinámica

$$\Delta S = k_B * ln(\Omega)$$

4. Correcciones de caudal:

$$Q_{v,corr} = \frac{Q_{v,medido}}{\sqrt{\frac{\rho_{aire}(P,T)}{\rho_{aire}(20°C, 1\ atm)}}} \qquad \rho = \frac{(P \cdot PM)}{R \cdot T} \qquad P = P_{bar} + \Delta P$$

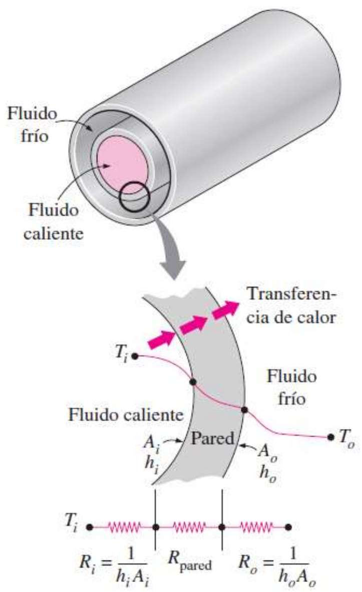
5. Ecuación fundamental de transmisión de calor

$$\Delta H_f = m_f \cdot C_{pf} \cdot \Delta T_f = U \cdot A_{TQ} \cdot \Delta T_{ml} = \Delta H_c$$

6. Nusselt

$$Nu = \frac{h \cdot L}{K_{TF}} = f(Re, Pr)$$

7. Resistencias térmicas



8. Correlaciones de Nusselt

Authors	Correlation	Range	Remarks
Dittus and Boelter [50]	$\overline{Nu} = 0.23Re^{0.8}Pr^{n}$	$Re > 10^4$ $0.7 < Pr < 100$	n = 0.4—heating n = 0.3—cooling
Kraußold [51]	$\overline{Nu} = 0.032Re^{0.8}Pr^{n}\left(\frac{L}{D}\right)^{-0.054}$	$Re > 10^4$	n = 0.37—heating n = 0.3—cooling
Sieder and Tate [52]	$\overline{Nu} = 0.027Re^{4/5}Pr^{1/3}\left(\frac{\mu_f}{\mu_w}\right)^{0.14}$	$Re > 10^4$ $0.7 < Pr < 16{,}700$	T_w = const.
Mikhejev [53]	$\overline{Nu} = 0.021Re^{0.8}{Pr_f}^{0.43}\left(\frac{Pr_f}{Pr_w}\right)^{0.25}\varepsilon_L$	$10^4 < Re < 5 \times 10^6$ $0.6 < Pr < 2500$	$\varepsilon_L = f(L/D, Re)$
Petukhov [54]	$\overline{Nu} = \frac{(f/8)RePr}{1.07+12.7(f/8)^{\frac{1}{2}}\left(Pr^{\frac{2}{3}}-1\right)}$	$10^4 < Re < 5 \times 10^6$ $0.5 < Pr < 2000$	$f = (1.82lnRe - 1.64)^{-2}$
Notter and Sleicher [55]	$\overline{Nu} = 4.8 + 0.0156Pe^{0.85}Pr^{0.08}$ $\overline{Nu} = 6.3 + 0.0167Pe^{0.85}Pr^{0.08}$	$10^4 < Re < 10^6$ $0.004 < Pr < 0.1$	T_w = const. q_w = const.
Churchill and Ozoe [56]	$\overline{Nu} = \frac{0.3387Pr^{1/3}Re^{1/2}}{\left[1+(0.0468/Pr)^{2/3}\right]^{1/4}}$	$Re > 100$ $10^{-4} < Pr \to \infty$	q_w = const.
Hausen [57]	$Nu = 0.0235\left[1+\left(\frac{d}{L}\right)^{2/3}\right]$ $\left[Re^{0.8} - 230\right]{Pr_f}^{0.3}\left(\frac{\mu_f}{\mu_w}\right)^{0.14}$	$2300 < Re < 2 \times 10^6$ $1.5 < Pr < 500$ $d/L < 1$	
Gnieliński [58]	$\overline{Nu} = \frac{(f/8)(Re-1000)Pr}{1+12.7(f/8)^{0.5}\left(Pr^{\frac{2}{3}}-1\right)}$	$3 \times 10^3 < Re < 5 \times 10^6$ $0.5 < Pr < 2000$	$f = (0.79lnRe - 1.64)^{-2}$
Kutateladze [59]	$\overline{Nu} = 1.61\left(Pe\frac{D}{L}\right)^{1/3}$	$Pe > 12$ $d/L < 12$	

9. Reynolds y Prandtl

$$Re = \frac{v{*}D{*}\rho}{\mu} \qquad Pr = \frac{Cp\cdot\mu}{K_{TF}}$$

10. Resistencias térmicas en paralelo

$$\frac{1}{U} = \frac{1}{h_{aire}} + \frac{e}{K_{TM}} + \frac{1}{h_{agua}}$$

11. NTU y balance de energía

$$NTU = \frac{U\cdot A_{TQ}}{m\cdot C_p}$$

$$\partial q = U\cdot\left(T_c - T_f\right)\cdot\partial A = m_c\cdot Cp_c\cdot\partial T_c = m_f\cdot Cp_f\cdot\partial T_f \rightarrow$$

$$\int_{T_{c,i}}^{T_{c,o}} \frac{-\partial T_c}{T_c - T_f} = NTU_c = \frac{U}{m_c\cdot Cp_c}\cdot\int_{A=0}^{A}\partial A = \frac{U\cdot A_{TQ}}{m_c\cdot Cp_c}$$

$$\int_{T_{f,i}}^{T_{f,o}} \frac{-\partial T_f}{T_c - T_f} = NTU_f = \frac{U}{m_f\cdot Cp_f}\cdot\int_{A=0}^{A}\partial A = \frac{U\cdot A_{TQ}}{m_f\cdot Cp_f}$$

12. Elementos en conducción

$$\vec{q} = -\ k\nabla T$$

$$Q\ = \frac{K_{TM}}{e} \cdot A_{TQ} \cdot \Delta T$$

13. ΔT_{ML}

$$\Delta T_{ml} = \frac{\left(T_{c,1} - T_{f,2}\right) - \left(T_{c,2} - T_{f,1}\right)}{ln\left(\frac{\left(T_{c,1} - T_{f,2}\right)}{\left(T_{c,2} - T_{f,1}\right)}\right)}$$

14. Diámetro hidráulico

$$D_h = \frac{4A}{P}$$

15. Caudal volumétrico

$$Q_v = v\ *\ A$$

16. Ley de enfriamiento de Newton

$$\frac{dT}{dt} = K(T\ -\ Tm)$$

17. Ley de Boltzmann

$$Q\ =\ e\sigma A\ *\ (T^4 - T_c^4)$$

18. Datos diseño de Radiador

FPI (sinoidal)	13
Distancia entre canales	5,5 mm
Espesor del radiador	26 mm
Largo de tubo	280 mm
Caudal de agua	16,3 LPM
Número de canales	15
Alto de canal	2 mm
Espesor de la pared	0,2 mm

19. Datos del diseño del motor

Espesor de aluminio de la camisa	20 mm
Espesor plástico	10 mm
Área de intercambio de camisa	1 m^2
Conductividad etileno	0,1 W/m.K
Conductividad aluminio	217 W/m.K
Conductividad del cobre	385 W/m.K