ESCOLA POLITÉCNICA DA UNIVERSIDADE DE SÃO PAULO

# PQI 3202 Fenômenos de Transporte I

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ESCOLA POLITÉCNICA DA UNIVERSIDADE DE SÃO PAULO

# Aula 31.5 – Equações para leitos

PQI 3202 Fenômenos de Transporte I

# Equações para perda de carga

1. D'Arcy
2. Ergun



# D'Arcy – Permeabilidade (1830)

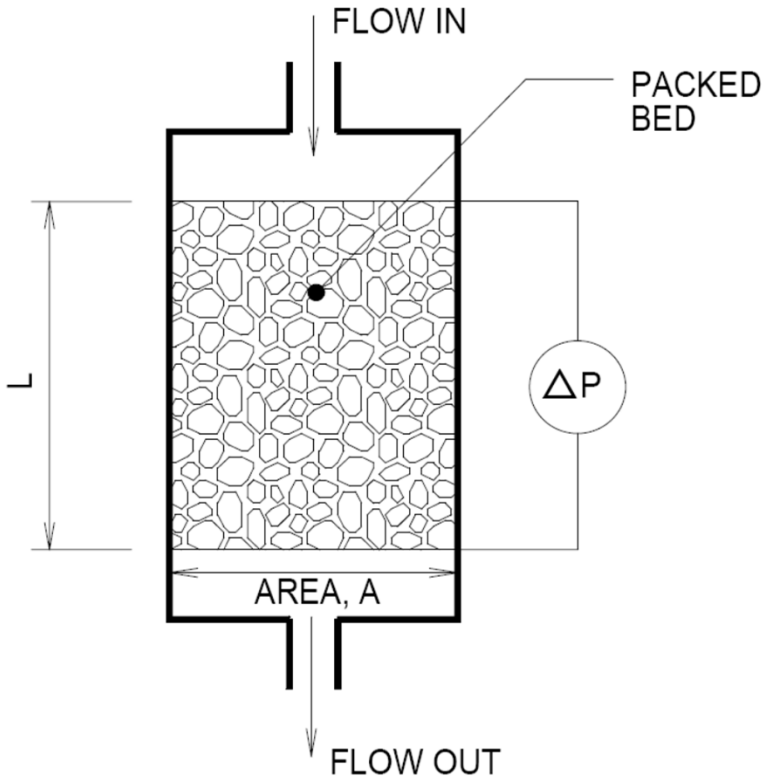
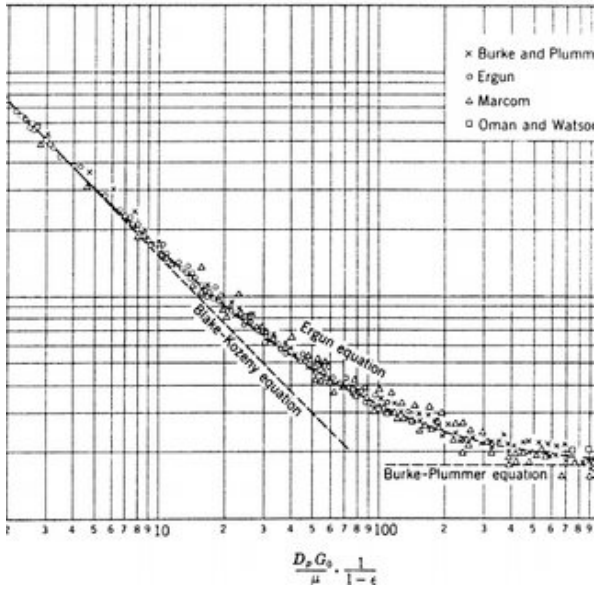



Figure 4-10. Typical Packed Bed.

$$\frac{Q}{A} = \frac{k}{\mu}\left(\frac{P_0 - P_L}{L}\right)$$

# Ergun

$$\frac{-\Delta \mathcal{P}}{L} = \frac{150\,\mu\,q\,(1-\varepsilon)^2}{(\psi D_P)^2\,\varepsilon^3} + \frac{1.75\,\rho\,q^2\,(1-\varepsilon)}{\psi D_P \varepsilon^3}$$



# Ergun

$$\frac{-\Delta \mathcal{P}}{L} = \frac{150\,\mu\,q\,(1-\varepsilon)^2}{(\psi D_P)^2\,\varepsilon^3} + \frac{1.75\,\rho\,q^2\,(1-\varepsilon)}{\psi D_P \varepsilon^3}$$

- Ou

- $$\frac{-\Delta \mathcal{P}}{\rho\,q^2}\frac{\psi D_P}{L}\frac{\varepsilon^3}{(1-\varepsilon)^2} = \frac{150(1-\varepsilon)}{\rho\,q\,\psi D_P/\mu} + 1.75$$



# Ergun

- $\frac{-\Delta\mathcal{P}}{\rho\, q^2}\frac{\psi D_P}{L}\frac{\varepsilon^3}{(1-\varepsilon)^2} = \frac{150(1-\varepsilon)}{\rho\, q\, {\psi D_P}/{\mu}} + 1.75$

- Onde: fator de fricção e Reynolds para a partícula

- $f_p = \frac{-\Delta\mathcal{P}}{\rho\, q^2}\frac{\psi D_P}{L}\frac{\varepsilon^3}{(1-\varepsilon)^2}$ $\quad Re = \frac{150(1-\varepsilon)}{\rho\, q\, {\psi D_P}/{\mu}}$ $\quad f_p = \frac{150}{Re_P} + 1.75$



# Ergun

- Ergun

$$\frac{-\Delta\mathcal{P}}{L} = \frac{150\,\mu\,q\,(1-\varepsilon)^2}{(\psi D_P)^2\,\varepsilon^3} + \frac{1.75\,\rho\,q^2\,(1-\varepsilon)}{\psi D_P \varepsilon^3}$$

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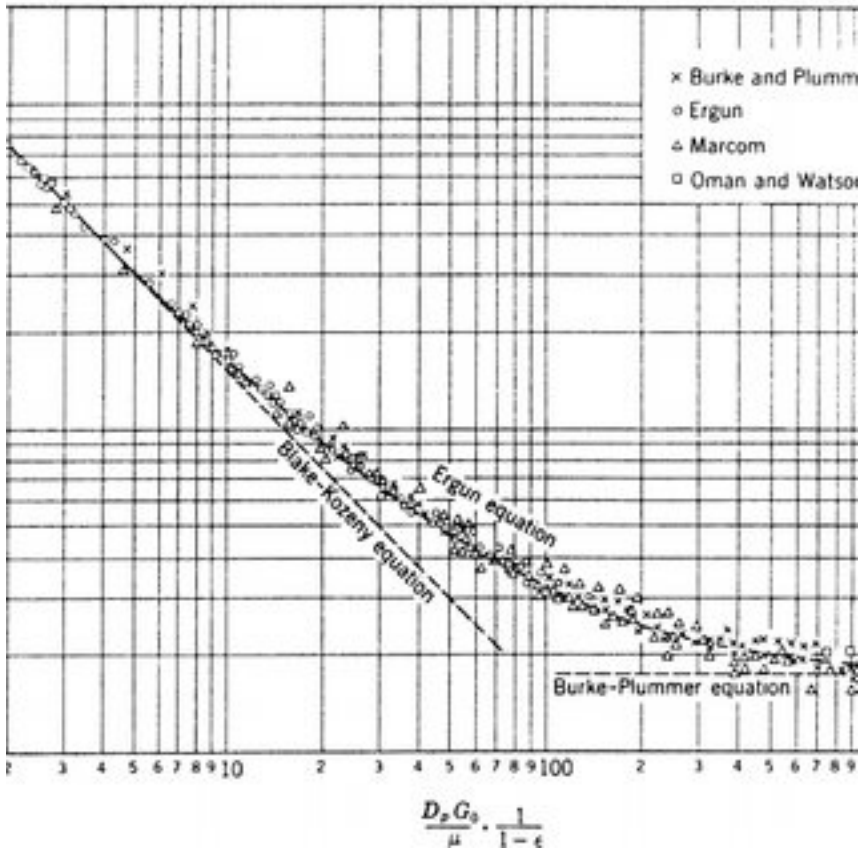
- $\frac{-\Delta\mathcal{P}}{\rho\,q^2}\frac{\psi D_P}{L}\frac{\varepsilon^3}{(1-\varepsilon)^2} = \frac{150(1-\varepsilon)}{\rho\,q\,\psi D_P/\mu} + 1.75$

- Onde

- $f_p = \frac{-\Delta\mathcal{P}}{\rho\,q^2}\frac{\psi D_P}{L}\frac{\varepsilon^3}{(1-\varepsilon)^2}$ $\quad Re = \frac{150(1-\varepsilon)}{\rho\,q\,\psi D_P/\mu}$ $\quad f_p = \frac{150}{Re_P} + 1.75$



# Conclusões

- Perda de carga em leito fixo
- Regimes laminar e turbulento
- Fluidodinâmica através de leito sólido



# Bibliografia


- JM Coulson, JF Richardson, JR Backhurst, JH Harker, Chemical Engineering: Vol. 2. Particle Technology and Separation Processes, 6th ed., Butterworth-Heinemann, 2019.

- Foust, Wenzel, Clump et al., Princípios das Operações Unitárias, LTC; 2ª edição, 1982.