Exam 2 Cheat Sheet.

- $$\frac{P_2 - P_1}{\rho} + \frac{V_2^2 - V_1^2}{2} + g(z_2 - z_1) = \frac{\dot{W}}{\dot{m}} - \frac{\dot{F}}{\dot{m}}$$ • number in Direction of Flow
- $$\frac{\Delta P}{\rho} + \frac{\Delta V^2}{2} + g\Delta z = \frac{\dot{W}}{\dot{m}} - \frac{fLV^2}{2D} - \frac{KV^2}{2}$$

- $W = \Delta P \cdot \dot{V}$
- $\dot{V} = AV = \dot{m}/\rho$

- minor Losses V goes with smaller of two pipes
- Sudden expansions, $K_L = \alpha = 1$ for turbulent ; $\alpha = 2$ for lam.

- Flow meters: $$\dot{V} = A_o C_d \sqrt{\frac{2(P_1 - P_2)}{\rho(1-\beta^4)}}$$; • A_o is Throat • $\beta = d/D$

- $$D_H = \frac{4A_c}{P_w}$$

- For Turbines use $-\dot{W}$ not $\dot{W}$ in energy equation.

- Colbrook: $$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\epsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}}\right)$$
- Haaland: $$\frac{1}{\sqrt{f}} = -1.8\log_{10}\left(\frac{6.9}{Re} + \left(\frac{\epsilon/D}{3.7}\right)^{1.11}\right)$$

- Type II Find $\dot{V}$: Guess f, V from E.E., Re, $f = f(Re, \frac{\epsilon}{D})$, Repeat 2-3 Digits on f.
- Type III Find D: Guess D, get Re, $f = f(Re, \frac{\epsilon}{D})$, D from E.E. Repeat

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- $V_{econ} = 6$ ft/s

- Series flow: $\Delta P_{tot} = \sum \Delta P_i$; $\dot{V}$ const.
- Parallel flow: ΔP = const in each joining branch, $\dot{V}_{tot} = \sum \dot{V}_i$
- $(\Delta P)_{loops} = 0$; $(\sum \dot{V})_{node} = 0$

Similarity: match Π's, n params j dim, $n - j = k$ Π's

Select j repeating vars, Then other k vars → Π

$$\Pi = (\text{Var}1)\underbrace{(\text{Var}2)^a(\text{Var}3)^b}_{\text{rep.}}$$

- $$f = \frac{4\tau_w}{\frac{1}{2}\rho V^2}$$