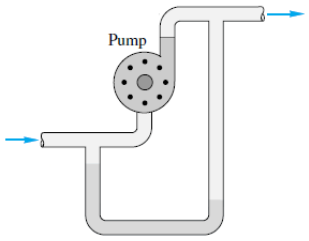

بسم الله الرحمن الرحيم

Mechanical Engineering (2)



Fayoum University

Faculty of Engineering
Mechanical Engineering Dept.

Lecture (7)

on

Application of Fluid Mechanics

(Energy Loss in Pipes and Fittings)

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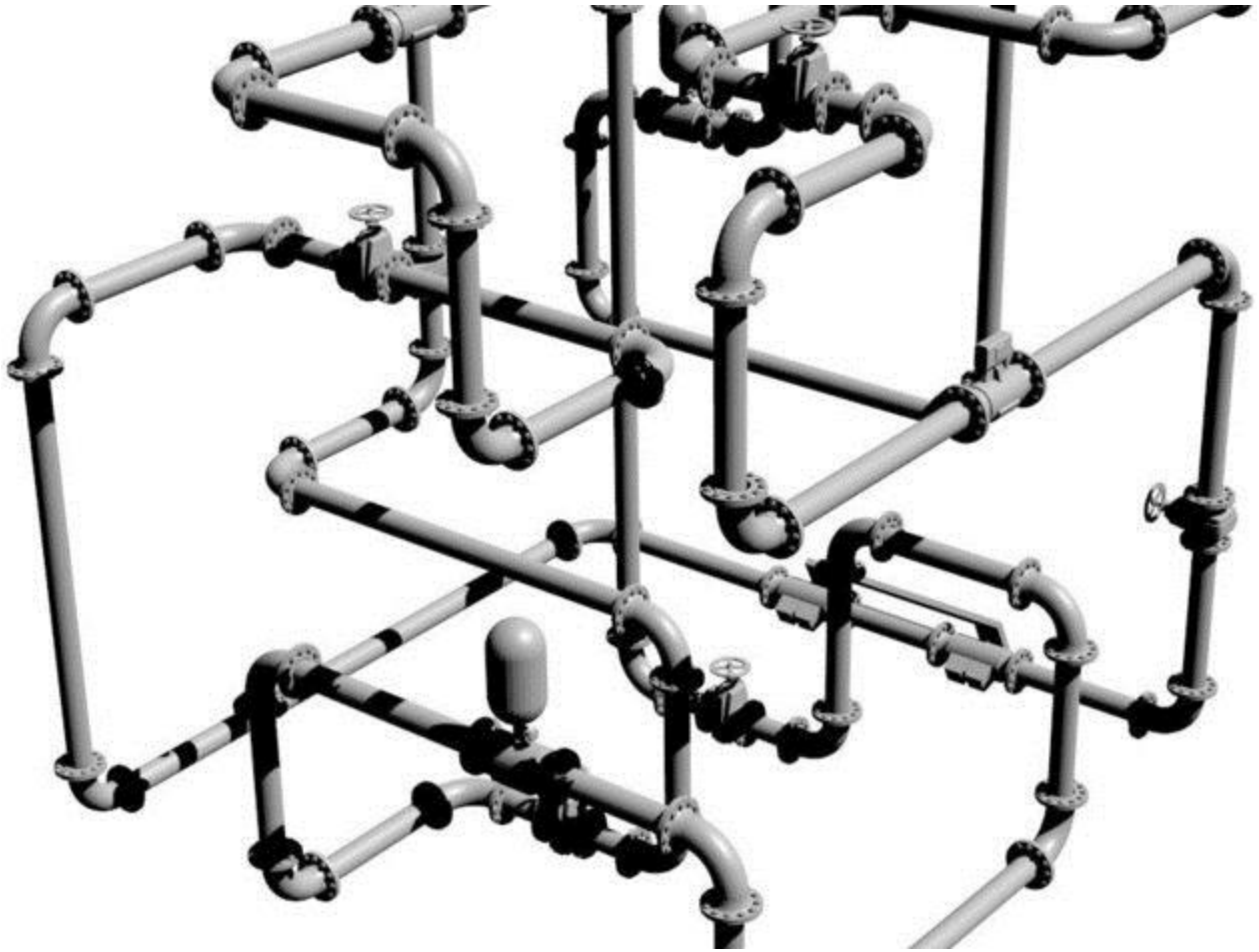
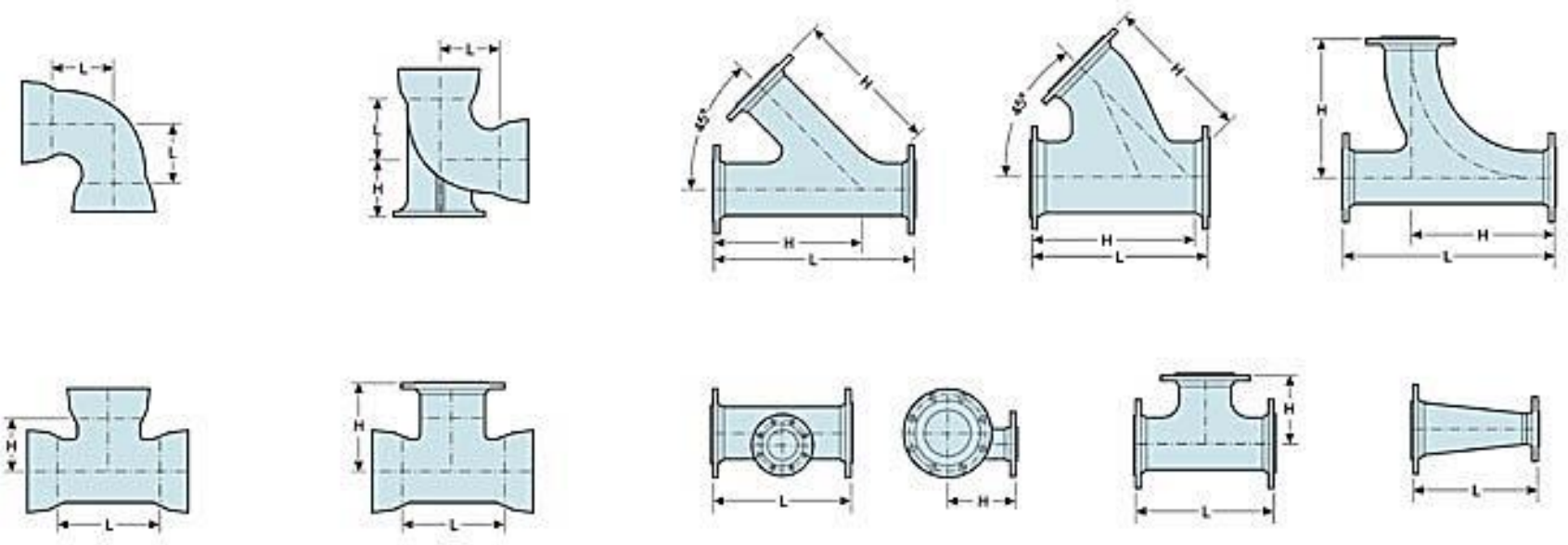
Pipe Network



Fittings



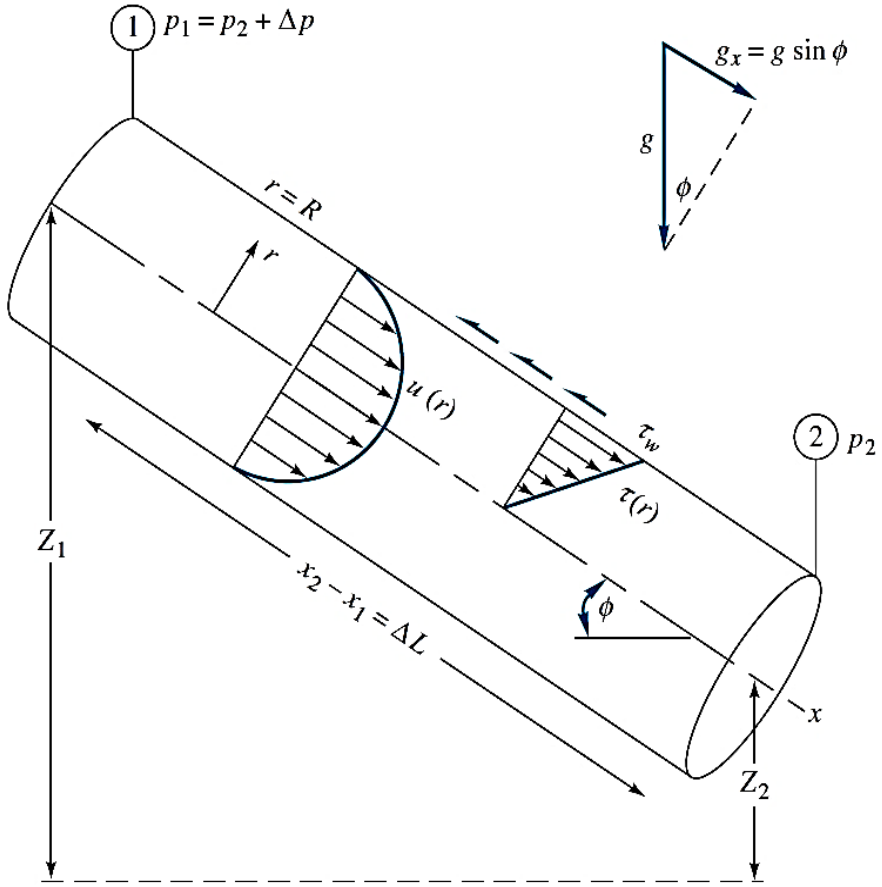
Circular pipes loss

$$Q_1 = Q_2 = const$$

$$u_1 = \frac{Q_1}{A_1} = u_2 = \frac{Q_2}{A_2}$$

$$\frac{u_1^2}{2g} + \frac{p_1}{\rho g} + z_1 = \frac{u_2^2}{2g} + \frac{p_2}{\rho g} + z_2 + h_f$$

$$h_f = \left(z_1 + \frac{p_1}{\rho g}\right) - \left(z_2 + \frac{p_2}{\rho g}\right) = \Delta z + \frac{\Delta p}{\rho g}$$



Circular pipes loss

$$\Delta p \pi R^2 + \rho g \left(\pi R^2\right) \Delta L \sin\phi - \tau_w \left(2\pi R\right) \Delta L = \dot{m}\left(u_2 - u_1\right) = 0$$

where τ_w is wall shear stress

$$h_f = \Delta z + \frac{\Delta p}{\rho g} = \frac{2\tau_w}{\rho g}\frac{\Delta L}{R} \quad \text{where} \quad \Delta z = \Delta L \sin\phi$$

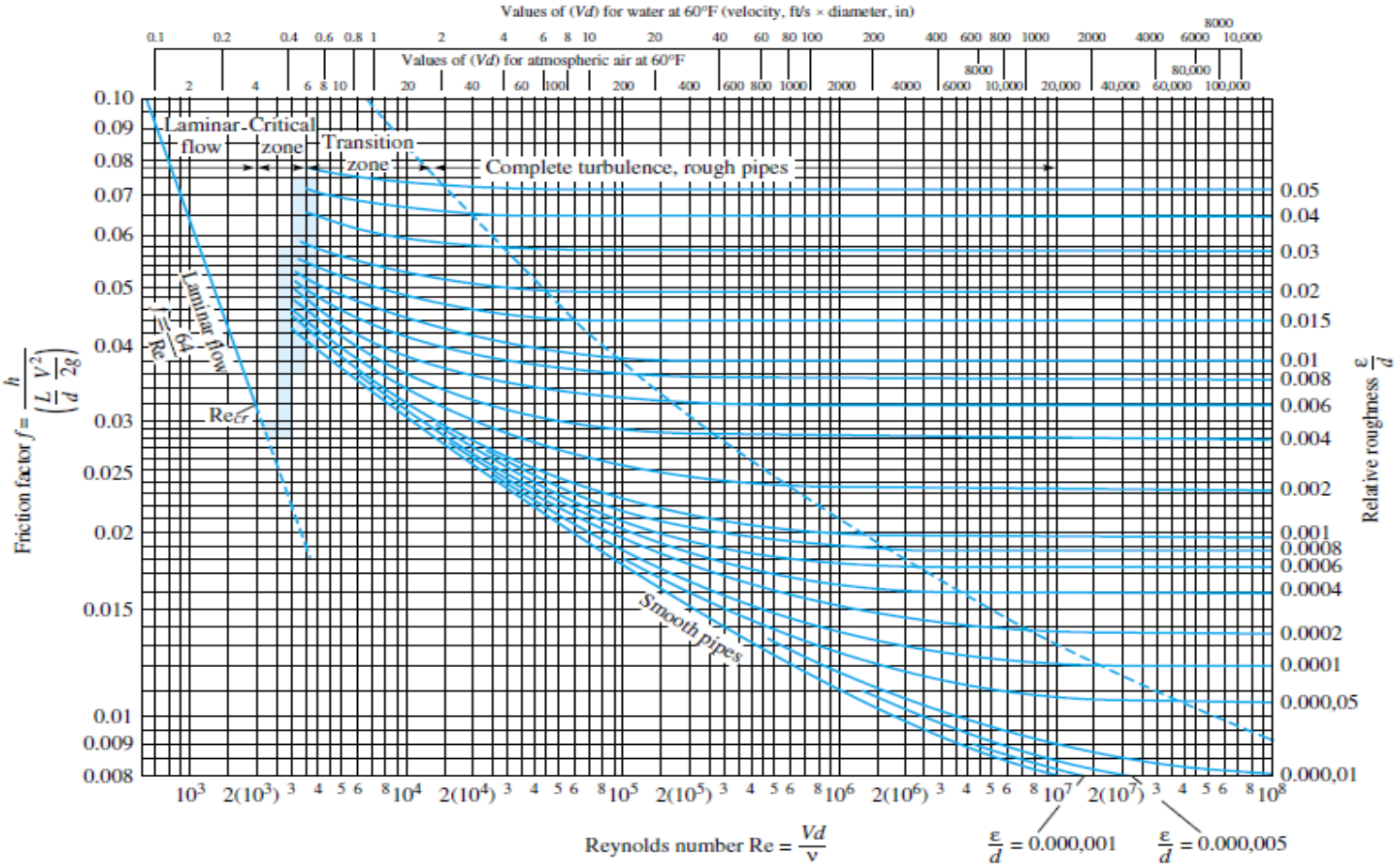
$$\tau_w = f(\varepsilon, \rho, \mu, u, d)$$

where ε is the wall-roughness height (see Appendix (A4)). Then dimensional analysis tells us that

$$f = \frac{8\tau_w}{\rho u^2} = f\left(\mathrm{Re}_d, \frac{\varepsilon}{d}\right)$$

$$h_f = f\frac{L}{d}\frac{u^2}{2g}$$

Circular pipes loss



Minor Losses in Fittings

The measured minor loss is usually given as a ratio of the head loss $h_m = \Delta p / \rho g$ through the device to the velocity head $u^2/(2g)$ of the associated piping system

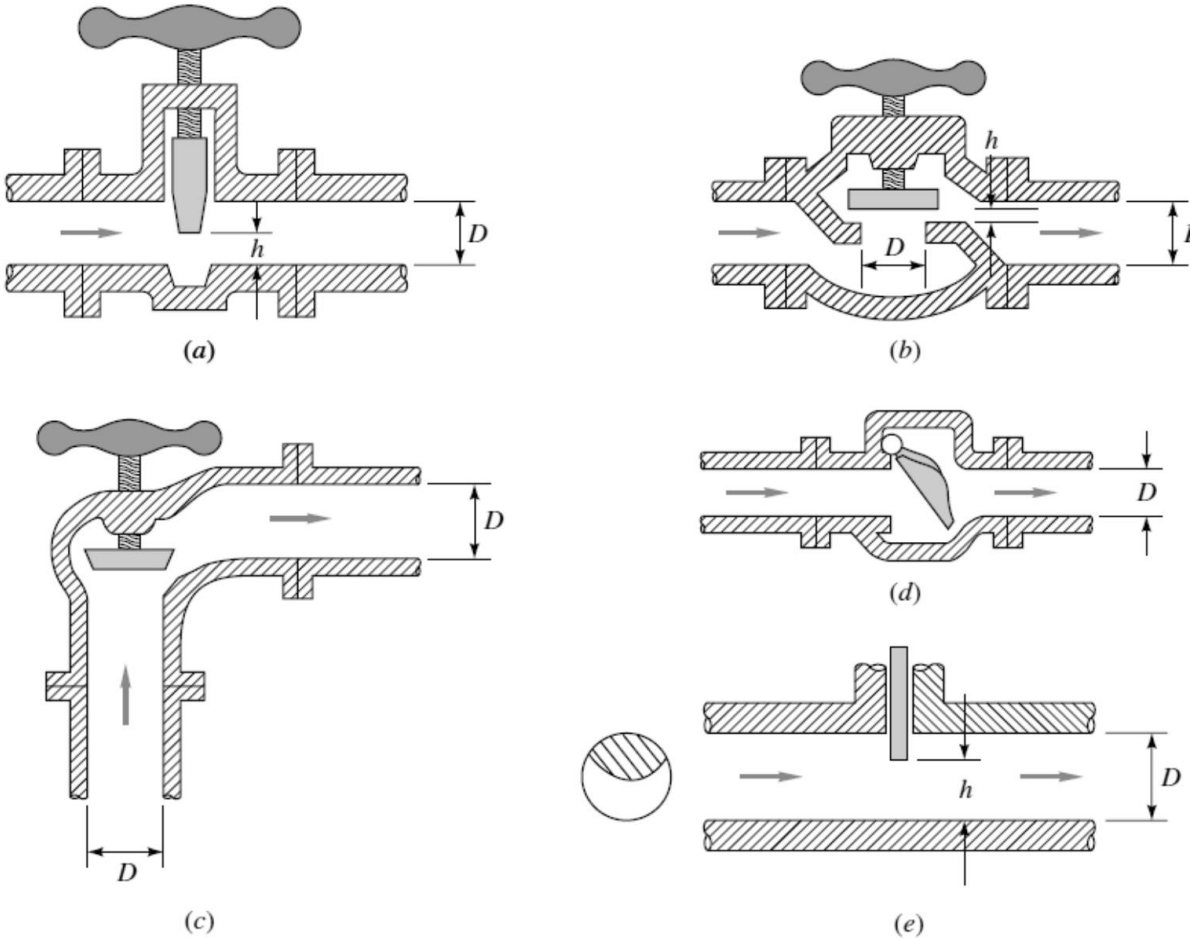
$$Loss\ coefficient \quad K = \frac{h_m}{u^2/2g} = \frac{\Delta p}{\frac{1}{2}\rho u^2}$$

Although K is dimensionless

OR $$h_m = f\frac{L_{eq}}{d}\frac{u^2}{2g} = K\frac{u^2}{2g}$$

$$L_{eq} = \frac{Kd}{f}$$

Minor Losses in Fittings



Total Energy Losses in Pipes and Fittings

$$\Delta h_{tot} = h_f + \sum h_m = \frac{u^2}{2g}\left(\frac{f\,L}{d} + \sum K\right)$$


Thank
You