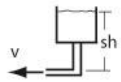
Gravity system output velocity iterative calculation

energy balance *friction factor* *friction parameter - Swamee-Jain*



$$\frac{v^2}{2g} = sh - hf \qquad hf = \frac{1200 \times fac \times v^2 \times L}{2g \times dia \times 100}$$

$$fac(v) = \frac{0.25}{\left[\log_{10}\left(\frac{eps}{3.7 \times dia} + \frac{5.74}{Re^{0.9}}\right)\right]^2} = \frac{0.25}{\left[\log_{10}\left(\frac{eps}{3.7 \times dia} + \frac{5.74}{(7745.8 \times v\ dia)^{0.9}}\right)\right]^2}$$

Reynolds number *viscosity*

$$Re = \frac{7745.8 \times v(ft/s) \times dia(in)}{\nu\ (cSt)} \qquad \nu\ (cSt) = 1 \text{ for water} \qquad g = 32.17\ ft/s^2$$

$$v^2 = 2g \times (sh - hf) \qquad F = 2g \times (sh - hf) - v^2 = 0$$

C_1 C_2 C_3

$$F = 2g \times \left[sh - \left[\frac{1200 \times L \times 0.25}{2g \times dia \times 100} \times \frac{\overbrace{v^2}^{f(v)}}{\underbrace{\left[\log_{10}\left(\frac{eps}{3.7 \times dia} + \frac{5.74}{(7745.8 \times v\ dia)^{0.9}}\right)\right]^2}_{g(v)}} \right]\right] - v^2$$

$$F = 2g \times \left[sh - \frac{1200 \times L \times 0.25}{2g \times dia \times 100} \times \frac{f(v)}{g(v)} \right] - v^2 \qquad f(v) = v^2 \qquad \frac{d\,f(v)}{dv} = 2v$$

$$g(v) = \left[\log_{10}\left(\frac{eps}{3.7 \times dia} + \frac{5.74}{(7745.8 \times v\ dia)^{0.9}}\right)\right]^2 \qquad \frac{dF}{dv} = \left[- \frac{1200 \times L \times 0.25}{dia \times 100} \times \frac{d\,f/g}{dv} \right] - 2v$$

differentiation rules

$$F = C_1 \times \left(C_2 - C_3 \times \frac{f(v)}{g(v)}\right) - v^2$$

$$\frac{dF}{dv} = -C_1 \times C_3 \times \frac{d\,f/g}{dv} - 2v$$

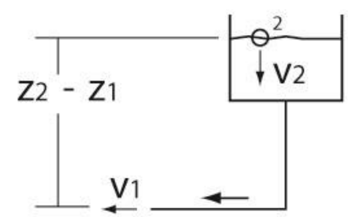
$$\frac{d\,f/g}{dv} = \frac{\frac{df}{dv} \times g - \frac{dg}{dv} \times f}{g^2}$$

$$\frac{d \log_a g(v)}{dv} = \frac{1}{g(v)\ \ln a}$$

$$\frac{d\,g(v)}{dv} = 2 \times \left[\log_{10}\left(\frac{eps}{3.7 \times dia} + \frac{5.74}{(7745.8 \times v\ dia)^{0.9}}\right)\right] \times (\ln 10)^{-1} \times 5.74 \times -0.9 \times (7745.8 \times v\ dia)^{-1.9} \times (7745.8 \times dia)$$

Newton-Raphson iteration technique

$$v_n = v_{n-1} - res \qquad res = \frac{F}{\frac{dF}{dv}}$$



$$\frac{v_2^2}{2g} + z_2 - z_1 = hf + \frac{v_1^2}{2g}$$

$$v_2 = 0$$

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