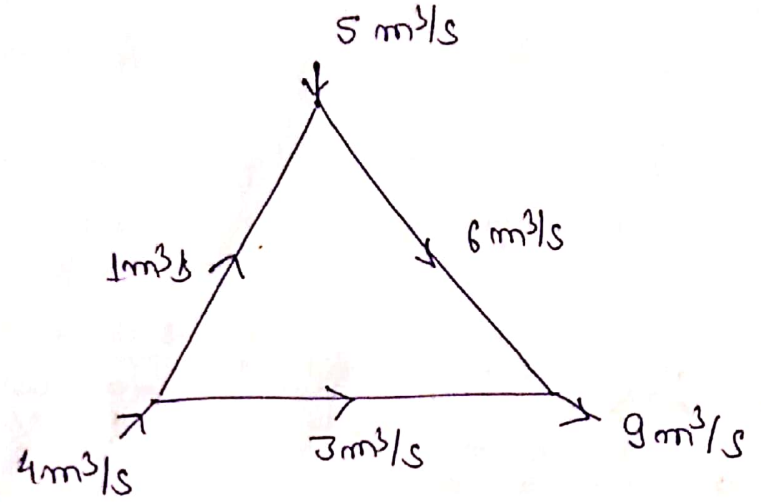
19 A pipe network in the form of a triangle ABC has inflow of $5 m^3/s$ and $4 m^3/s$ at A and B respectively. The outflow at C is $9 m^3/s$. given $K_{AB} = 10$, $K_{BC} = 50$, $K_{AC} = 20$, Compute discharge in each pipe line $[h_f = KQ^2]$

Solution



• First of all, the magnitude as well as direction of the possible flow in each pipe are assumed keeping in consideration the law of continuity at each junction.

The assumed flows are given in the fig:

so,

$$h_f = KQ^2$$

1st iteration for loop BACB

Pipe	Assumed flow Q_a	K	$H_L = KQ_a^2$	$\left\lvert \frac{H_L}{Q_a} \right\rvert$	Corrected Q after first correction $Q_{a_1} = Q_a + \Delta$
BA	1	10	10	10	0.5
AC	6	20	720	120	5.5
CB	-3	50	-450	150	-3.5
			$\Sigma H_L = 280$	$\Sigma \left\lvert \frac{H_L}{Q_a} \right\rvert = 280$	

$$\Delta = -\frac{\Sigma H_L}{2\Sigma\left|\frac{H_L}{Q_a}\right|}$$

$$= \frac{-280}{2\times 280} = -0.5\,m^3/s$$

2nd iteration for the loop BACB

Pipe	Assumed flow Q_a	K	$H_L = KQ_a^2$	$\left\|\frac{H_L}{Q_a}\right\|$	Corrected Q after second correction $Q_{a_1} = Q_a + \Delta$
BA	0.5	10	2.5	5	0.5086
AC	5.5	20	605	110	5.5086
CB	-3.5	50	-612.5	175	-3.4914
			$\Sigma H_L = -5$	$\Sigma\left\|\frac{H_L}{Q_a}\right\| = 290$	

$$\Delta = -\frac{\Sigma H_L}{2\Sigma\left|\frac{H_L}{Q_a}\right|} = \frac{-5}{2\times 90} = 0.0086\,m^3/s$$

So the Discharge in pipe BA, AC, and CB are 0.5086 m^3/s, 5.5086 m^3/s and 3.4914 m^3/s respectively Ans

Q Derive equation for settling of a discrete particle

Solution →

When a discrete particle settle down in water, its downward settlement is opposed by the drag force offered by the water the effective wt of the particle (actual wt − buoyancy) cause the particle to accelerate in the begining, still it attain a sufficient velocity (V_s) at which the drag force became equal to the effective wt of the particle.

After attaining that velocity (V_s), the particle falls down with that constant velocity Now

Effective wt of the particle = Total wt − Buoyancy

$$= \frac{4}{3}\pi r^3 \times \gamma_s - \frac{4}{3}\pi r^3 \times \gamma_w$$

where is radius of particle, γ_s is unit wt of particle and γ_w is unit wt of water

$$\text{Drag force} = C_D \times A \times \rho_w \times \frac{V^2}{2}$$

Now V became equal to V_s, the drag force became equal to the effective wt of the particle

$$\therefore\ C_D \cdot A \cdot \rho_w \cdot \frac{V_s^2}{2} = \frac{4}{3}\pi r^3(\gamma_s - \gamma_w)$$

$$C_D \cdot \pi r^2 \cdot \rho_w \cdot \frac{V_s^2}{2} = \frac{4}{3}\pi r^3(\gamma_s - \gamma_w)$$

$$V_s^2 = \frac{4}{3} \times \frac{2r(\gamma_s - \gamma_w)}{\rho_w \cdot C_D}$$

$$V_s^2 = \frac{4}{3} \times \frac{d(\gamma_s - \gamma_w)}{\rho_w \cdot g \cdot C_D}$$

$$V_s^2 = \frac{4}{3} \times \frac{d(\rho_s g - \rho_w g)}{\rho_w \cdot C_D}$$

$$V_s^2 = \frac{4}{3} \times g \times d \times (S_s - 1) \times \frac{1}{C_D}$$

(d = dia of particle
S = sp. gr. of the particle)

$$C_D = \frac{24}{Re}$$

$$Re = \frac{V_s \cdot d}{\nu}$$, where ν is the kinematic viscosity

$$V_s^2 = \frac{4}{3} \times g \times d \times (S_s - 1) \times \frac{1}{24/Re}$$

$$V_s^2 = \frac{4}{3} \times g \times d \times (S_s - 1) \times \frac{V_s \times d}{\nu \times 24}$$

$$\boxed{V_s = \frac{g}{18} (S_s - 1) \frac{d^2}{\nu}}$$

above equation valid for laminar flow and when particle dia is less than 0.1 mm