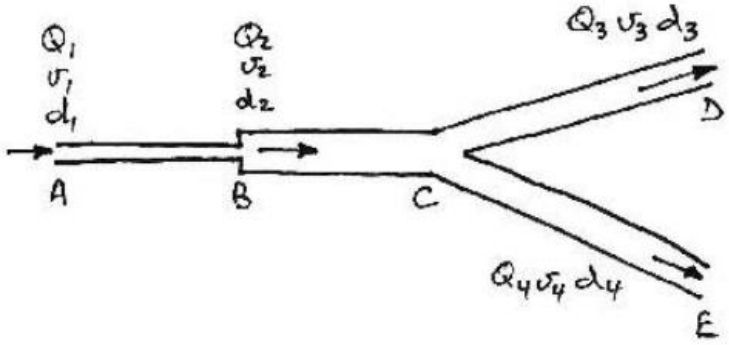
Fluid Mechanics

Asst. Lec. Safa Ali Hussein

Problem: Water flows from point A to points D and E as shown. Some of the flow parameters

are known, as shown in the table. Determine the unknown parameters.



Section	Diameter (mm)	Flow Rate (m^3/s)	Velocity (m/s)
AB	300	?	?
BC	600	?	1.2
CD	?	$Q_3 = 2Q_4$	1.4
CE	150	$Q_4 = 0.5Q_3$	?

Solution:

From the continuity equation for pipes we can see:

$Q_1 = Q_2$

And as total inflow must equal total outflow:

$Q_1 = Q_{out}$

$= Q_3 + Q_4 = Q_3 + 0.5Q_3 = 1.5\,Q_3$

We must also work out the areas of the pipes, $A = \pi d^2/4$ and therefore;

$A_1 = 0.0707\ m^3$ $A_2 = 0.2827\ m^3$ $A_4 = 0.0177\ m^3$

Starting with our basic equation, $Q = Av$, we can only solve for Q_2 from the table:

$Q_2 = (0.2827)(1.2) = 0.3393\ m^3/s$

We know that $Q_1 = Q_2$ and so we can now calculate Q_3 from previous:

$$Q_1 = 1.5Q_3$$

$$Q_3 = \frac{Q_1}{1.5} = \frac{0.3393}{1.5} = 0.2262\ m^3/s$$

$$Q_4 = \frac{Q_3}{2} = \frac{0.2262}{2} = 0.1131 \text{ m}^3/\text{s}$$

Thus we have all the flows. The unknown velocities are:

$$v_1 = \frac{Q_1}{A_1} = \frac{0.3393}{0.0707} = 4.8 \text{ m/s}$$

$$v_4 = \frac{Q_4}{A_4} = \frac{0.1131}{0.0177} = 6.4 \text{ m/s}$$

And lastly, the diameter of pipe *CD* is:

$$A_3 = \frac{Q_3}{v_3} = \frac{0.2262}{1.4} = 0.1616 \text{ m}^2$$

$$d_3 = \sqrt{\frac{4A_3}{\pi}} = 0.454 \text{ m}$$