ME 423: FLUIDS ENGINEERING

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Lecture-09-10 (19/10/2024)

Hydraulics of Pipeline Systems

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Problem

11.18 Determine the flow distribution of water in the parallel piping system shown in Fig. P11.18.

(a) $Q_{in} = 600$ L/min

Pipe	*L* (m)	*D* (mm)	*f*	Σ *K*
1	30	50	0.020	3
2	40	75	0.025	5
3	60	60	0.022	1

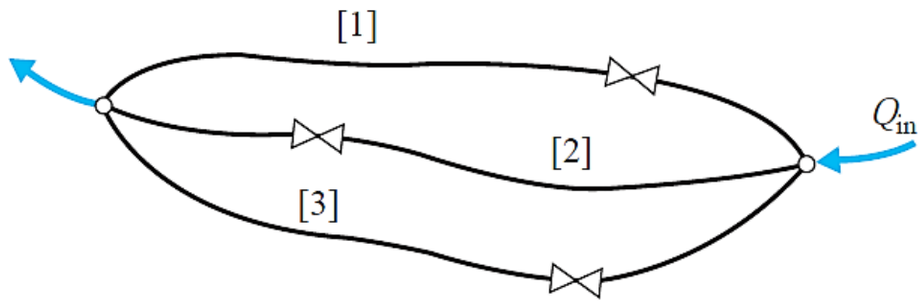

Fig. P11.18

Solution:
Follow class note

Problem

11.10 Find the water flow distribution in the parallel system shown in Fig. P11.10, and the required pumping power if the discharge through the pump is $Q_1 = 3\ m^3/s$. The pump efficiency is 0.75. Assume constant friction factors.

Pipe	*L* (m)	*D* (mm)	*f*	Σ *K*
1	100	1200	0.015	2
2	1000	1000	0.020	3
3	1500	500	0.018	2
4	800	750	0.021	4

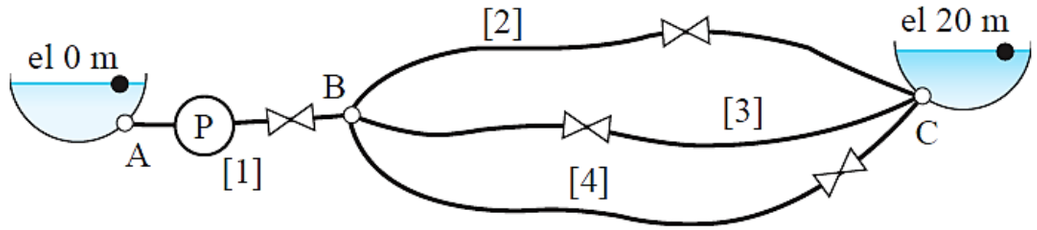

Fig. P11.10

Solution:
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Problem

11.14 The water sprinkling system shown in Fig. P11.14 is applied from a large diameter pipe with constant internal pressure $p_0 = 300$ kPa. The system is positioned in a horizontal plane. Determine the flow distribution Q_1, Q_2, Q_3, Q_4 for the given data. Valve losses are included in the $\overline{R}$, values. (*Hint:* If you are clever, no trial-and-error solution is necessary!)

Pipe	$\overline{R}$ (s^2/m^5)
1	1.6×10^4
2	5.3×10^5
3	1.0×10^6
4	1.8×10^6

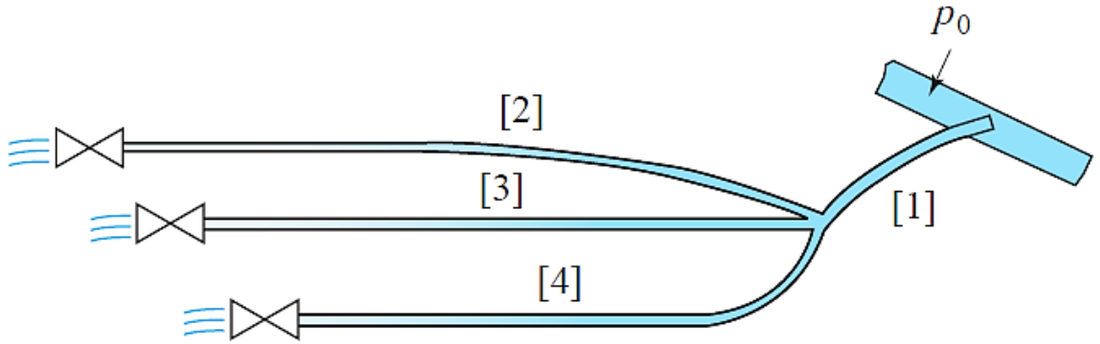


Fig. P11.14

Solution:
Follow class note

Problem

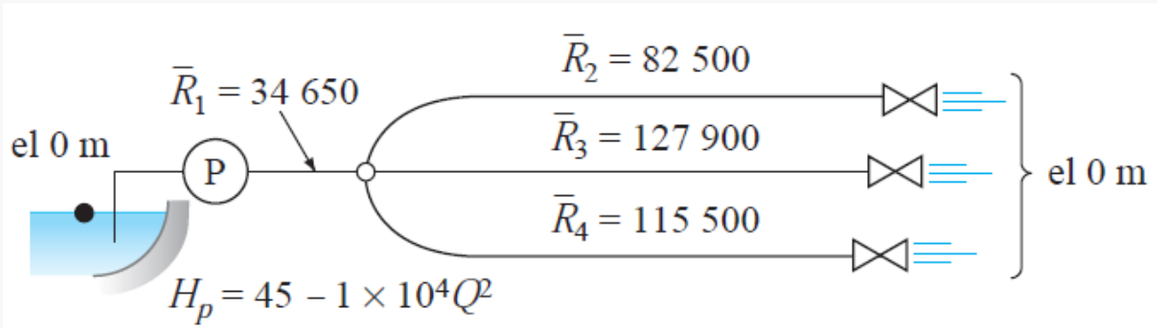
11.16 A proposed water irrigation system consists of one main pipe with a pump and three pipe branches (Fig. P11.16). Each branch is terminated by an orifice, and each orifice has the same elevation. It is apparent that the flow distribution can be solved by treating the piping arrangement as a branched system. However, the piping can also be treated as a parallel system in order to determine the flows.

(a) Identify the equations and unknowns to satisfy the solution for a parallel system. Why is it possible to treat the irrigation system as a parallel piping problem?

(b) Why would the solution to a parallel system be preferred to that of a branching system?

(c) Determine the flow distribution and sketch the hydraulic grade line.

(d) What part of the piping would one change to approximately double the discharge, assuming that the individual lengths and pump curve could not be altered?



(H_p in m; Q in m³/s; $\bar{R}$ in s²/m⁵, orifice loss included in $\bar{R}$)

Fig. P11.16

Homework

Problem

11.20 A pipeline consists of two pipe segments in series (Fig. P11.20). The specific gravity of the fluid is 0.81. If pump A has a constant power input of 1 MW, find the discharge, the pressure head in pumps A and B, and the required power for pump B. The minimum allowable pressure on the suction side of pump B is 150 kPa, and both pumps have an efficiency of 0.76.

Pipe	L (m)	D (mm)	ΣK	f
1	5000	750	2	0.023
2	7500	750	10	0.023

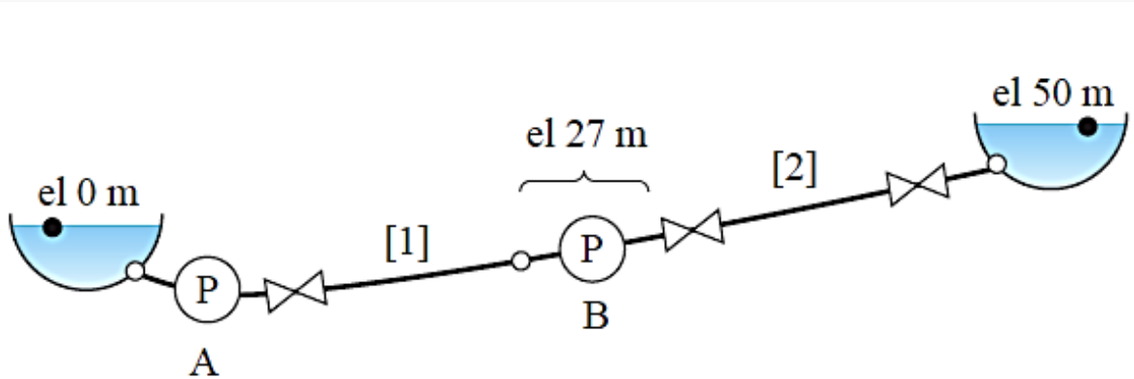


Fig. P11.20

Solution:
Follow class note