Assignment 3

(Due: 30 October, 2017 by 17:00)

Q1. A pump delivers water from a supply reservoir to an elevated tank at a rate of 120 litres per second. The elevation difference between the reservoirs is 45 m, and the discharge line is 140 m long ductile-iron pipe (k_s = 0.12 mm) and 35 cm in diameter. The suction line is 10 m long of the same diameter and material as the discharge line. Minor losses on the suction line amount to 3.7 $v^2/2g$, and the only minor loss coefficient on the discharge line is a bellmouth exit of 0.5. The critical cavitation parameter for the pump is 0.13. If the pump is installed 1 m to 3 m above the supply reservoir, will the installation be susceptible to cavitation?

Assume: P_{atm} = 101.4 kN/m^2, P_{vap} = 2.37 kN/m^2, ν = 1 x 10^{-6} m^2/s

Q2. Two identical pumps having the tabulated characteristics are to be installed in a pumping station to deliver sewage to a settling tank through a 200 mm in diameter pipeline that is 2.5 km long. The elevation difference between the reservoirs is 15 m. Allowing for minor head losses of 10 $v^2/2g$ and assuming an effective roughness of 0.15 mm calculate the discharge and power consumption if:

a) a single pump is used;

b) the two identical pumps are used is series;

c) the two identical pumps are used in parallel.

Assume ν = 1.13 x 10^{-6} m^2/s.

Q (L/s)	H_p (m)	η (%)
0	30.0	-
10	27.5	44
20	23.5	58
30	17.0	50
40	7.5	18

Q3. A pump is required to deliver water to an elevated storage tank. The water must be raised 44 m, and a 150 m-long ductile-iron pipe (k_s = 0.12 mm), 35 cm in diameter is to be used. Determine the appropriate pump speed (based on the highest efficiency obtainable) and the operating conditions if **Pump III** in Figure 5.24 is used. The suction line is 10 m of the 150 m length, minor loss coefficients on the suction line total 3.7, and the discharge line contains only an exit loss (k_L = 1.0).

Assume $\nu = 1 \times 10^{-6}$ m^2/s.

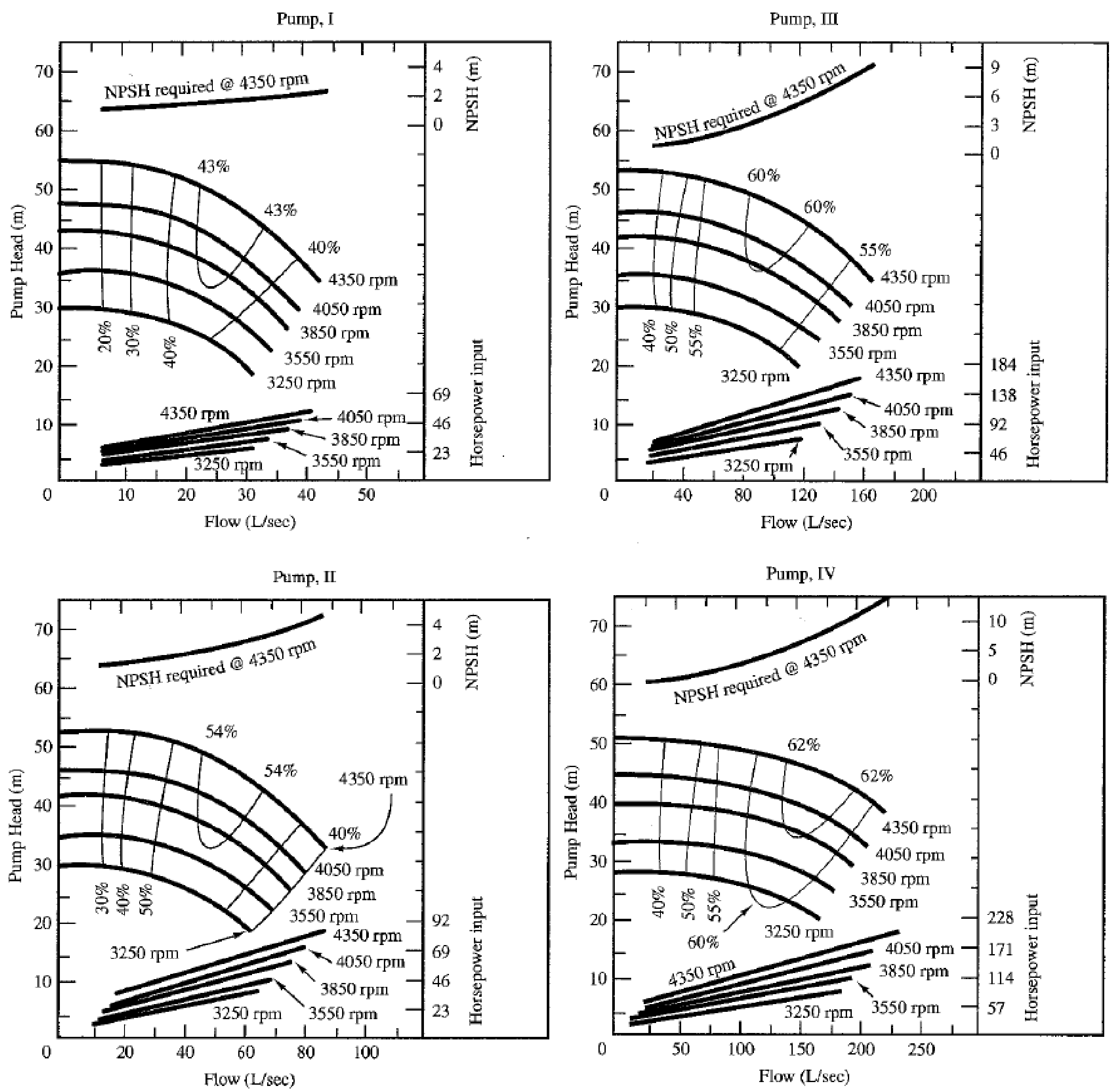

Figure 5.24 Characteristic curves for several pump models

Q4. A 0.5 m–diameter concrete (k_s = 0.36 mm) pipe has 5 cm-thick **rigid** walls and carries water 600 m before discharging it into another reservoir. The surface elevation of the downstream reservoir is 55 m lower than the supply reservoir. A gate valve (k_L = 0.15) just upstream of the lower reservoir controls flow rate. Minor losses on the pipe also include a simple entrance (k_L = 0.5). Calculate the maximum water hammer pressure that can be expected on the valve if it closes in 0.65 sec. Also determine the total pressure the pipeline will be exposed to during the water hammer phenomenon.

Assume: $K = 2.2 \times 10^9$ N/m^2 and $\nu = 1 \times 10^{-6}$ m^2/s