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Urban Water - Exercise 05

Pump dimensioning

Aim of the task is to practice graphical and computational procedures to characterise pump systems for various system layouts.

Repetition

What are the main parts of the Bernoulli equation?

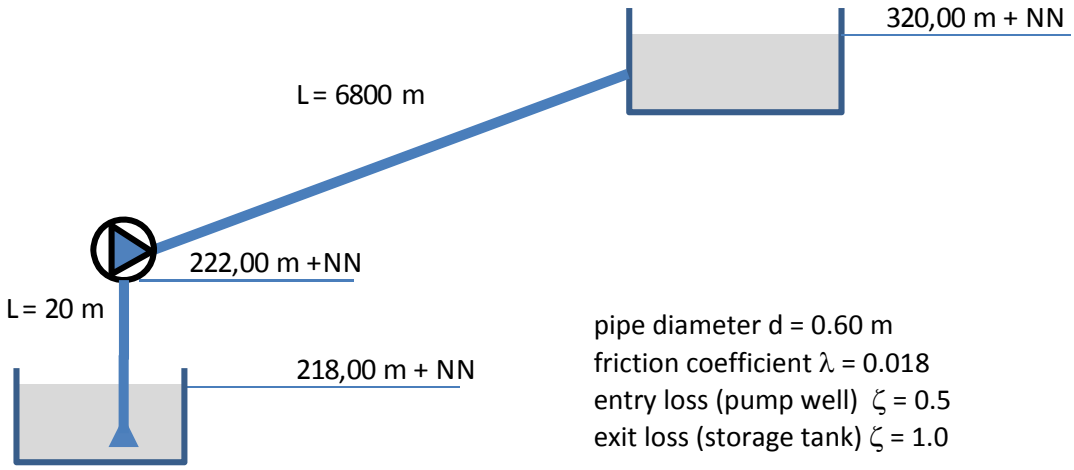
What kind of energy losses occur in a pipe system?

What is characterised by the pump curve and the system curve?

In a pump system, the net positive suction head (NPSH) of the system has to be at larger than the NPSH of the pump. Why?

Tasks

1. The drinking water supply of a city is to be covered. A pump system was installed to deliver a storage tank. Two identical pumps have been chosen which can be operated in single or parallel mode. Aim is to deliver 1440 m³/h in parallel mode.



a) Draw the head and energy line(s) in the system sketch and name them (not full-scale).

b) Determine the system curve H_A.

The difference of the velocity head between entrance and exit can be neglected as it is often done for practical applications. Determine the system curve for 3 to 4 points and draw it into the diagram below.

c) Determine the operation point for a single pump and for parallel operation and the static and dynamic proportion of the lifting height. Can Q = 1 440 m³/h be delivered with the configuration?

d) Calculate the power of one pump and of the engine in single mode.

e) Calculate whether the NPSH of the system is sufficient.
(vapour pressure p_V = 0.01 bar, atmospheric pressure p_A = 1.013 bar)

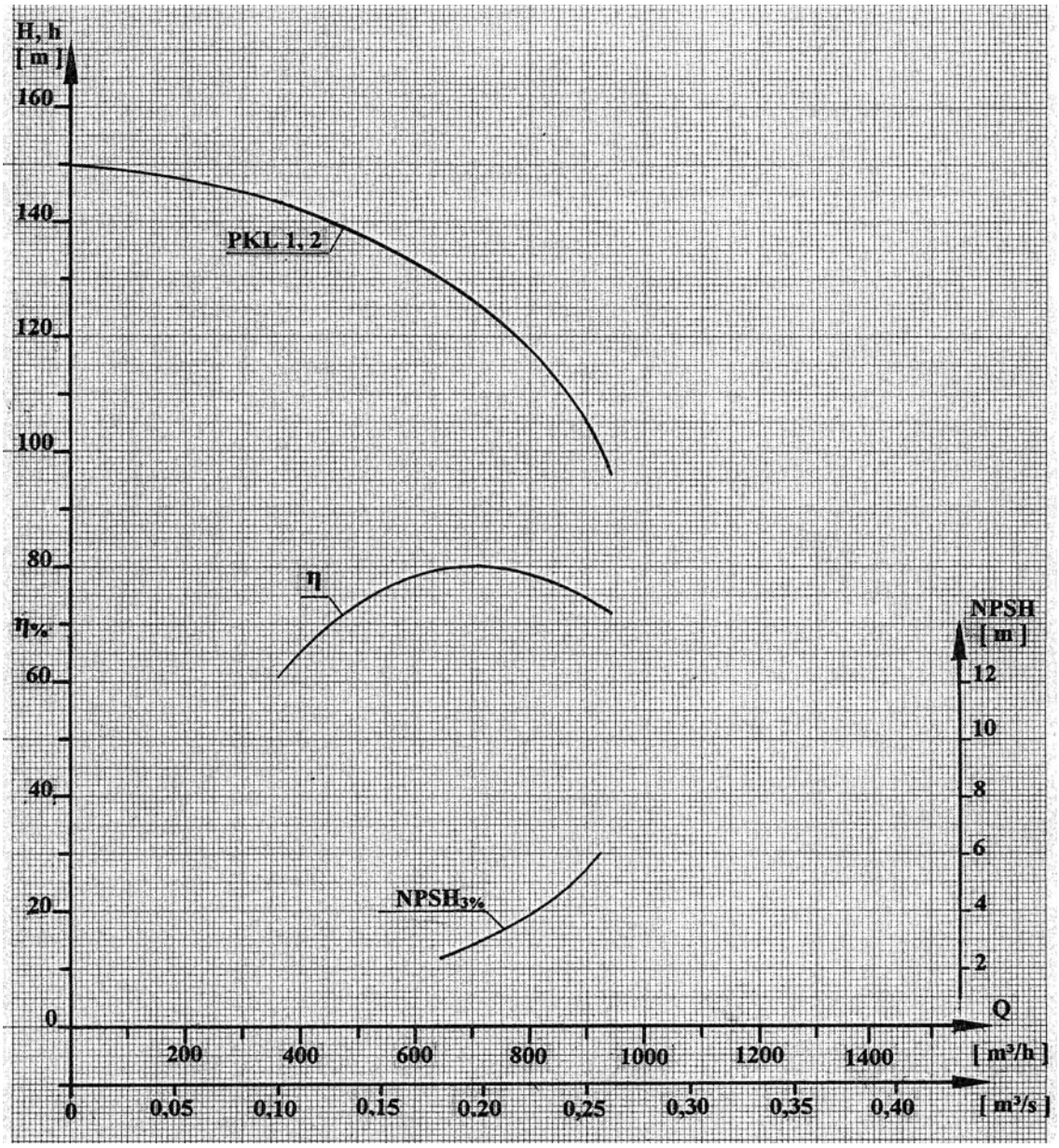


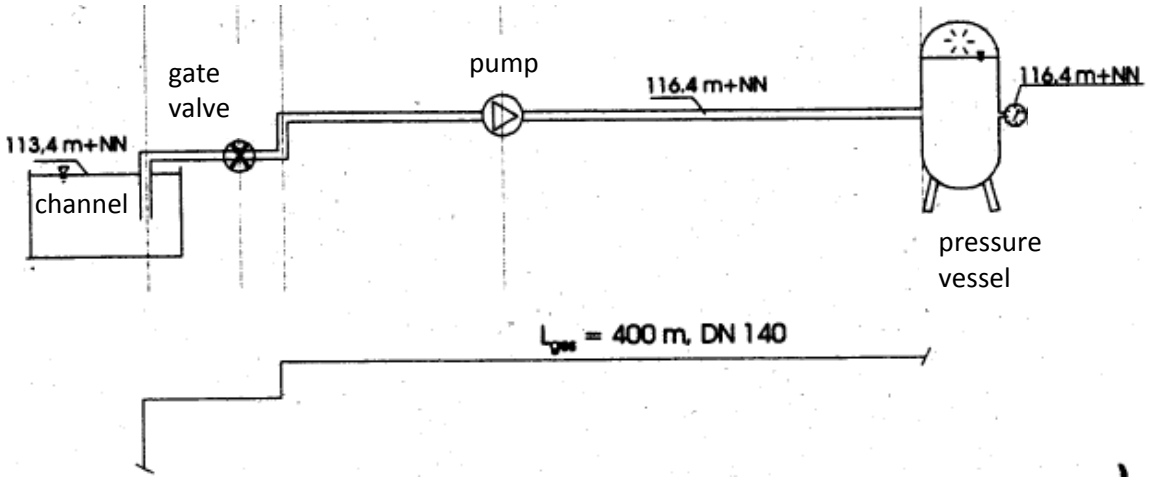
Figure 1: Pump and system characteristics

2. A pump delivers water from an open channel into a pressure vessel.

   a) Draw the energy line into the figure below and name the losses.

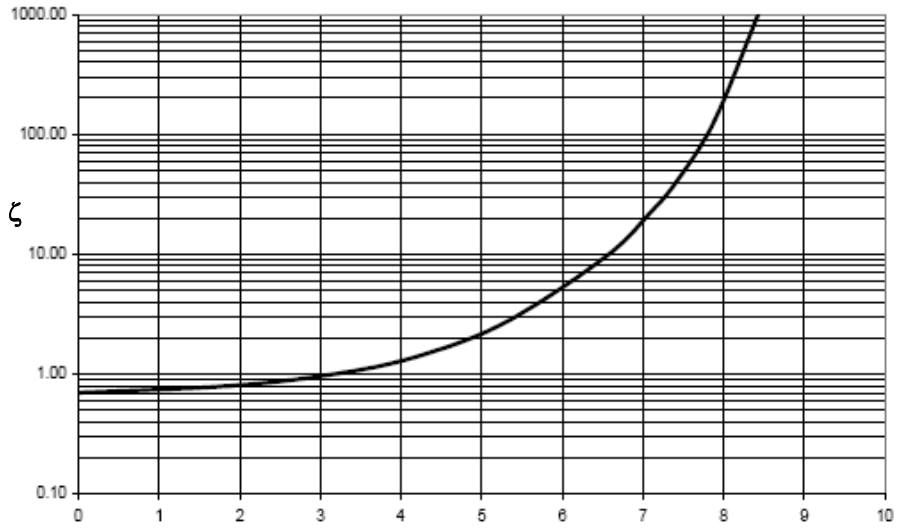
   b) Calculate the hydraulic head that has to be provided by the pump for a discharge of 87 m³/h.

   c) After several start and shut down operations using the gate valve the pump is damaged by cavitation. What is the constructive problem? How would you solve it?



Pressure in the vessel = 3.70 bar
Single elbow loss $\zeta = 0.15$
Friction loss $\lambda = 0.021$

Entrance loss $\zeta = 0.3$
Gate valve loss $\zeta \rightarrow$ figure 2



gate open number of revolutions gate closed

Figure 2: Loss coefficient for the gate valve

Homework (5 points)

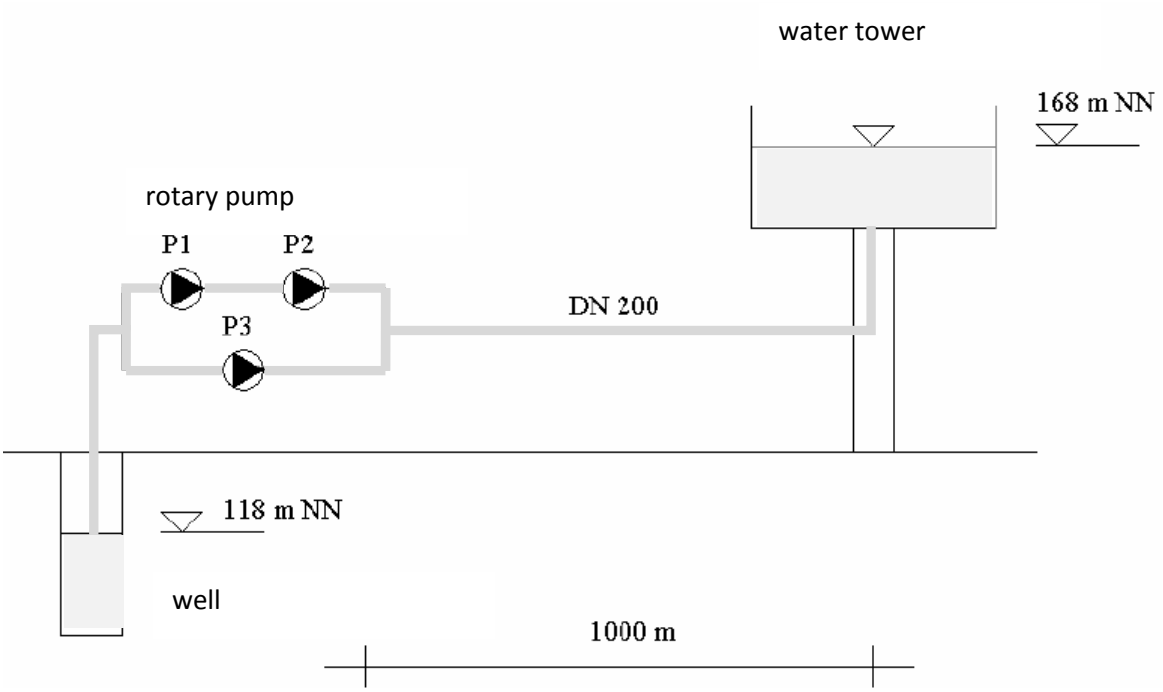
3. From a well, water is delivered to a water tower with various centrifugal pumps. The pump curves and the system curves have already been calculated and are given in Figure 3 (Pump Curve of pump 2 = pump 1).

   Determine graphically the

   a) operation point if only pump 1 and 2 are in operation

   b) operation point if all pumps are in operation

   c) the proportionate flow of every pump (case b) at the operation point (**Solution**: Pump 1 = Pump 2: 16 m³/h each, pump 3: 48 m³/h)



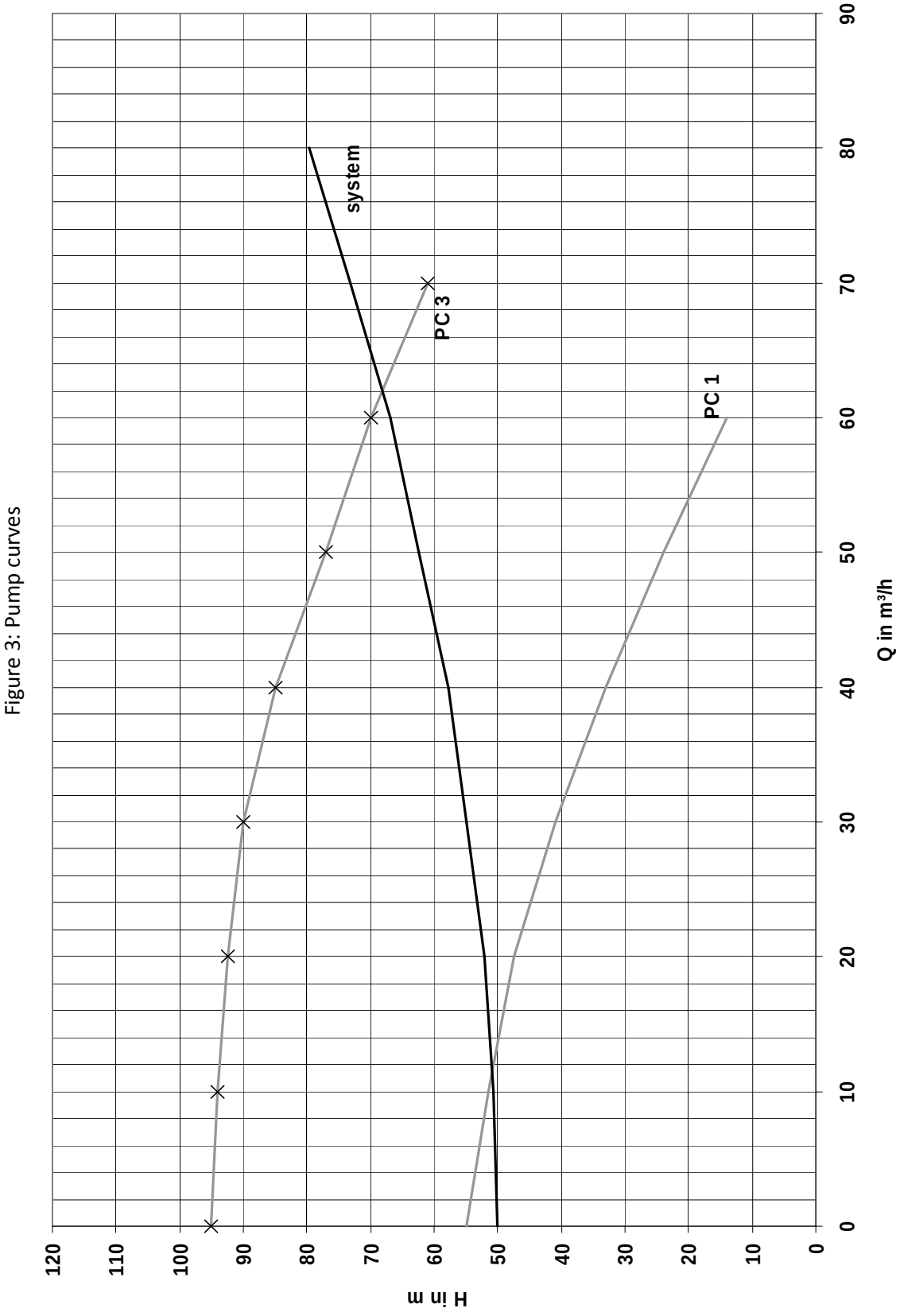


Figure 3: Pump curves