CE 3372 – Water Systems Design
Exercise Set 5

Purpose:	Application of energy and pumping concepts; System curve; Operating point
Task(s):	Compute head loss as function of discharge in a pipe (system curve). Determine pump operation point from a pump curve.

Exercise

1. A water supply system draws from a river at an elevation of 800-feet and delivers the water to a storage reservoir at elevation 820-feet. The supply pipeline is a 1000-foot long, 10-inch diameter, cast iron pipe. A single pump with the pump characteristic curve in Figure 1 is used to fill the reservoir.

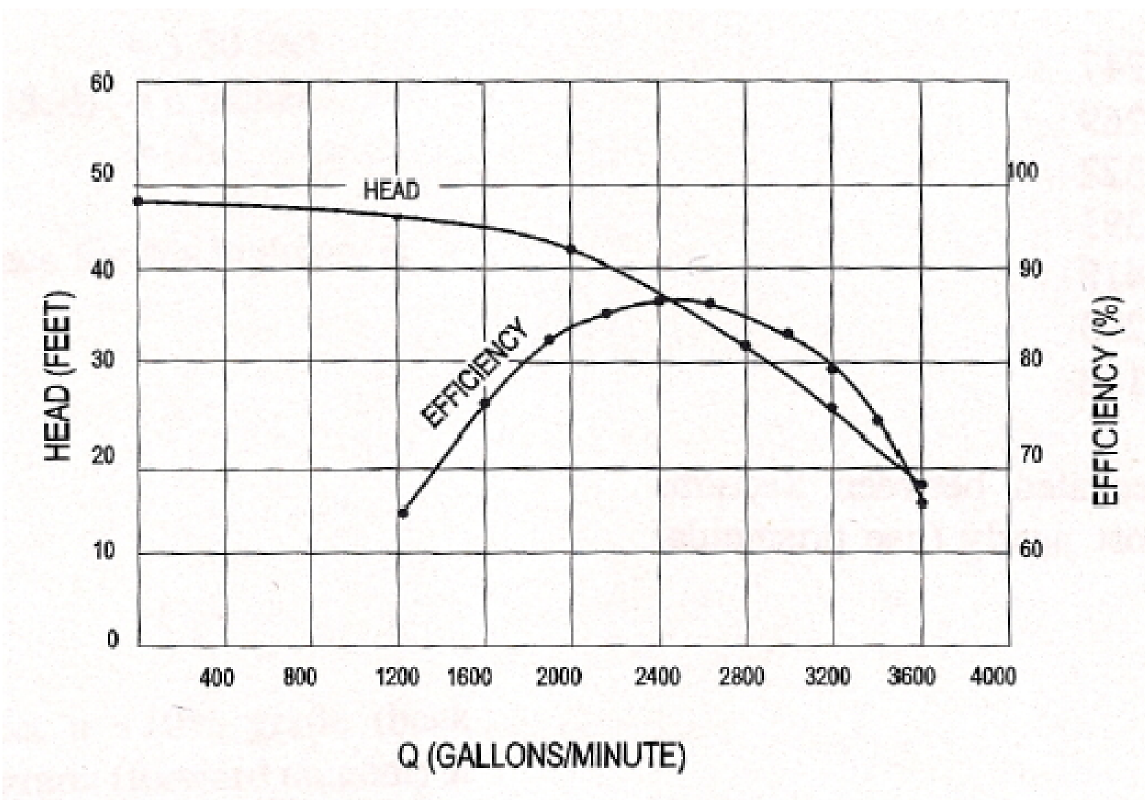

Figure 1: Lift station performance curve

Determine:

(a) Sketch the system described in the problem statement.

(b) Inlet and outlet minor loss coefficients, cite your source of minor loss coefficients.

(c) The roughness height for use in head loss calculations, cite your source of roughness height.

(d) The energy equation for the system (system curve).

(e) The system loss for a discharge of 1200, 1600, 2000, 2400, and 2800 gallons-per-minute.

- Show the calculation of Reynolds number for the different flow rates.
- Show the determination of the friction factors.

(f) The operating discharge for the system using the supplied pump curve.

(g) The electric power supplied to the pump to lift the water at the operating point.

2. Water is to be pumped at a rate of 70 liters per second in a 1-kilometer meter long, 200 millimeter diameter pipeline between two reservoirs with an elevation difference of 26 meters. A schematic of the system is shown on Figure 2. The kinematic viscosity of water in the system is $\nu = 1 \times 10^6 m^2/s$ The roughness height of the steel pipe is $\epsilon = 0.045mm$.

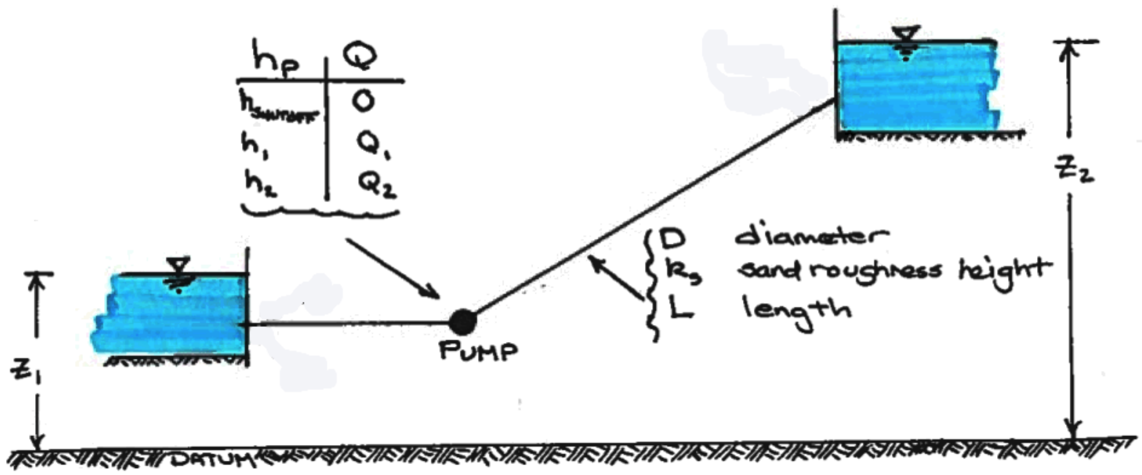

Figure 2: Pipeline and pump schematic

Determine:

(a) A pump type (from the four curves below) that can supply the required head at the required flow rate.

(b) Write the impeller speed for the pump in your selection.

(c) Indicate (label on the appropriate pump curve) the operating point of the pump you selected.

(d) Estimate the required NPSH for the pump you choose.

(e) Demonstrate that $NPSH_a > NPSH_r$ for your pump choice.

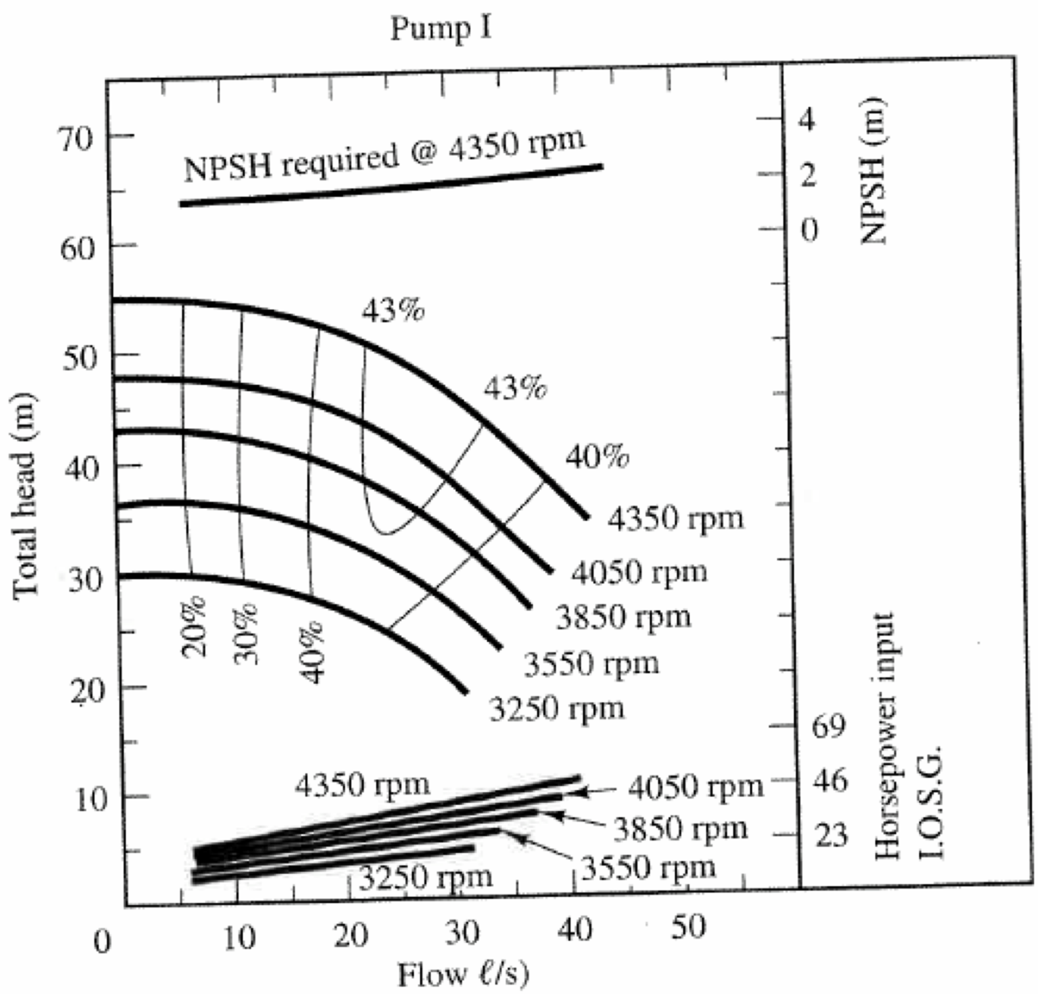

Figure 3: Pump Type I

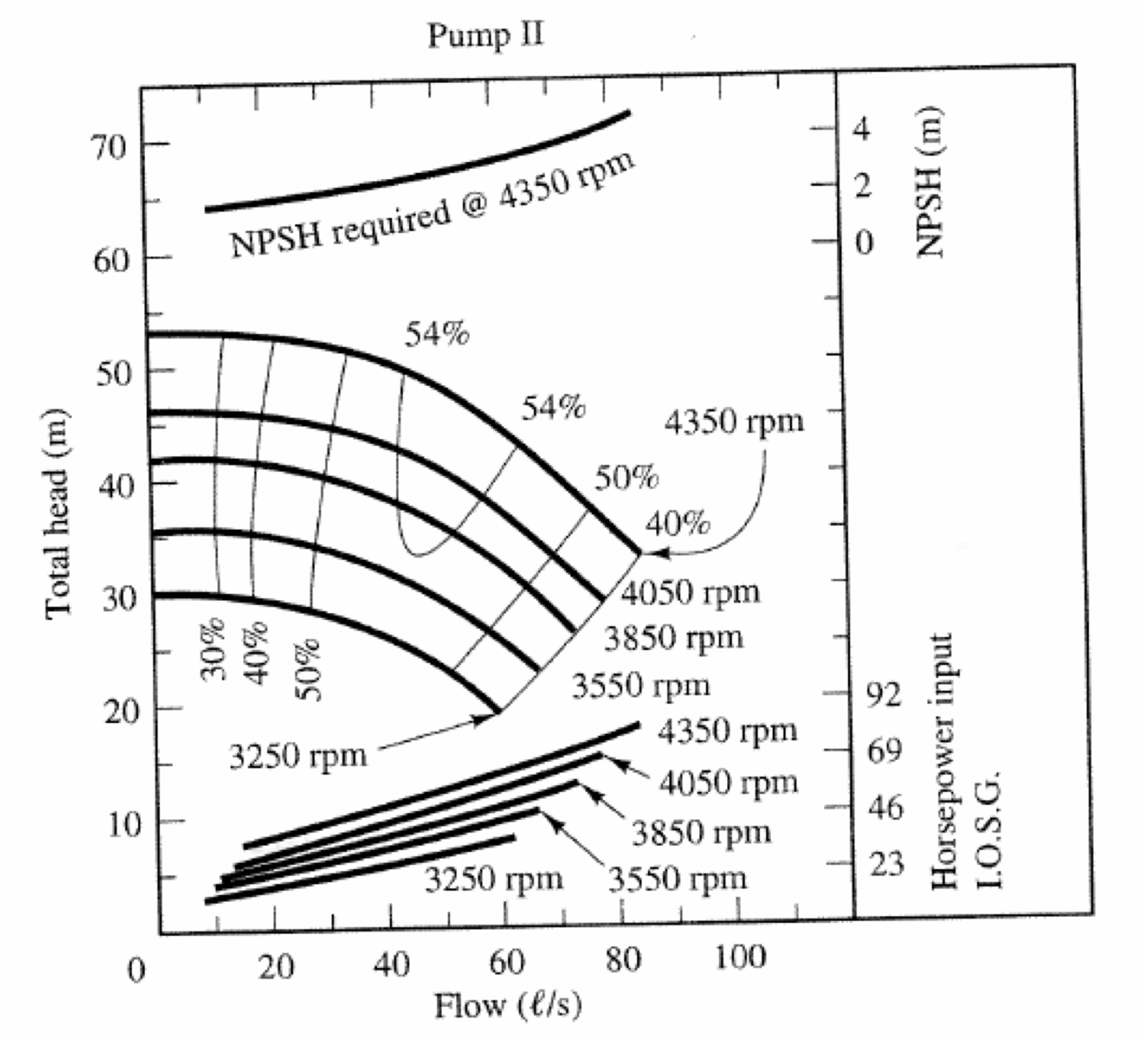

Figure 4: Pump Type II

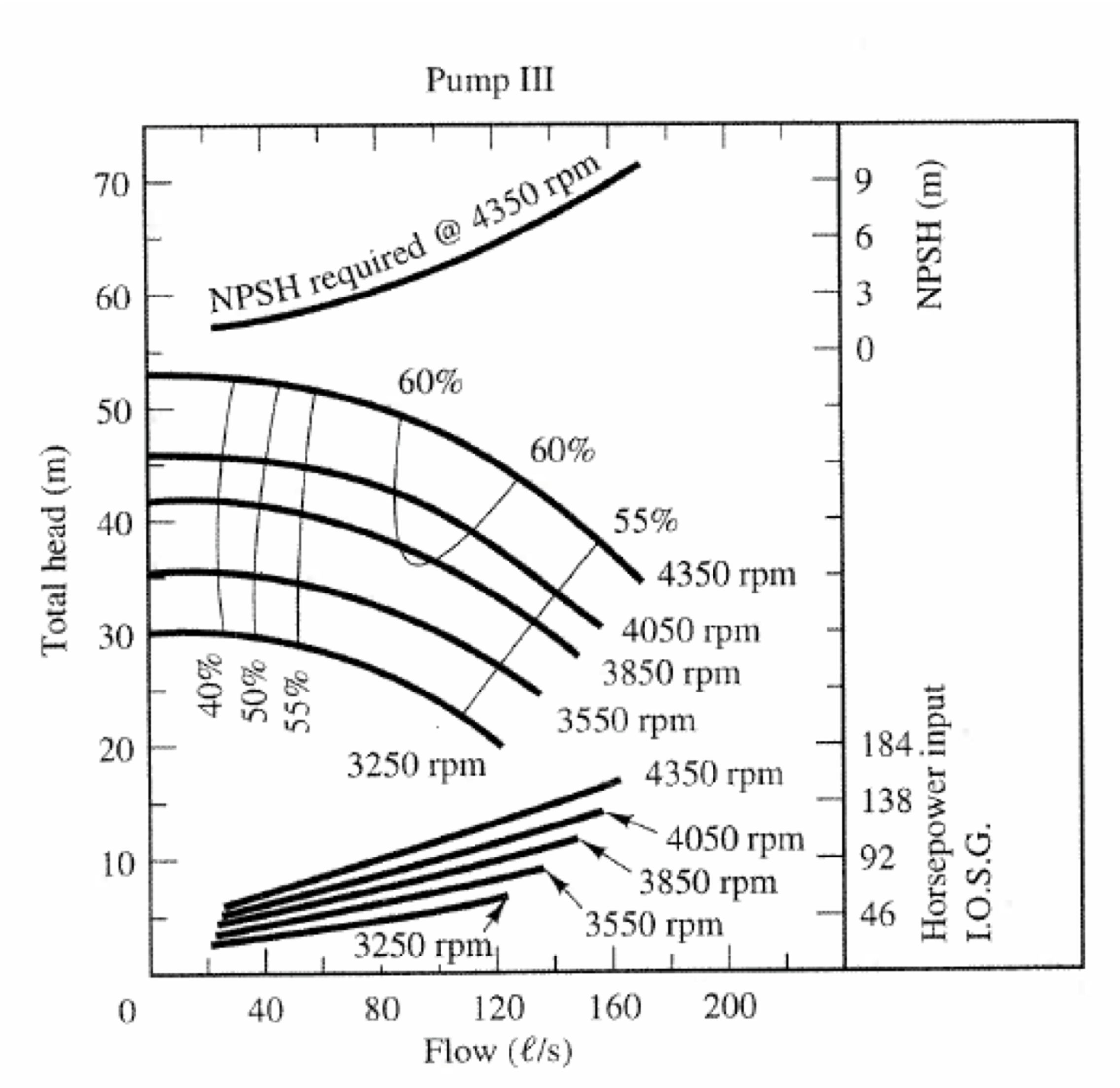

Figure 5: Pump Type III

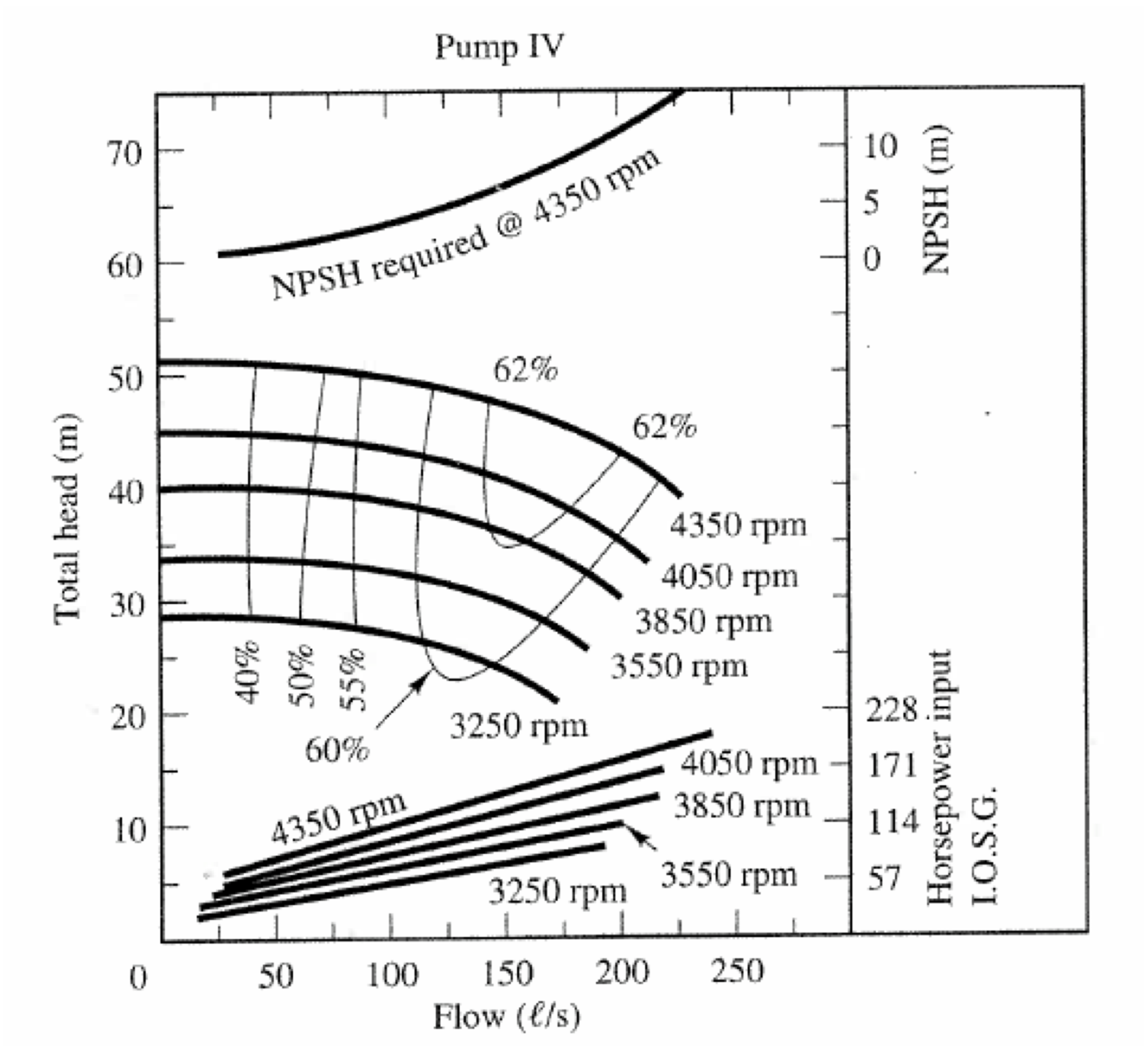

Figure 6: Pump Type IV