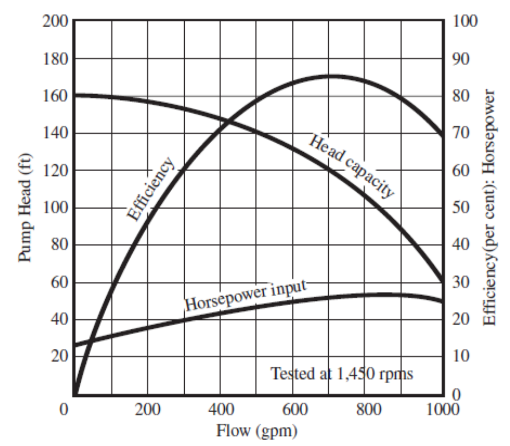
Pump Combinations – Large Flow Range
(Concepts and Visualization)

Design Objective: Operate pumps at their peak efficiency.

Q: What is the flow range for operating this pump at an 80% or better efficiency?

Q: A project requires a pump head of 60 ft but Q varies (250-1000 gpm). Will this pump work? ➔



Using Pumps in Parallel
(Concepts and Visualization)

Pumps in Parallel: Flows are additive for a given pump head.

Q: A project requires a pump head of 60 ft, but Q varies (250 to 1000 gpm). Design an efficient pump system.

A: Use two pumps in parallel: Pump 1 ➔ high efficiency for Q = 250 to 500 gpm & Pump 2 ➔high "e" for Q = 300 to 550 gpm. Use both pumps for high flows.

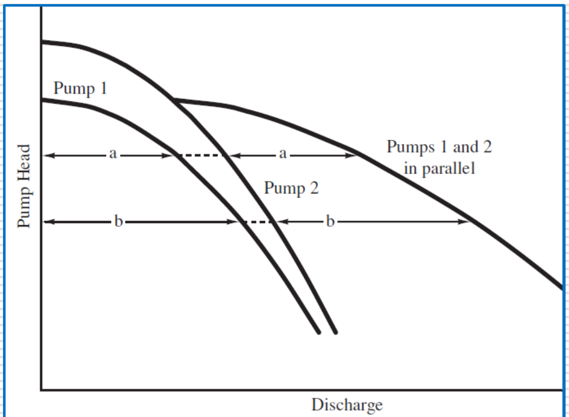


Figure 5.11 Pump characteristics for two pumps in parallel

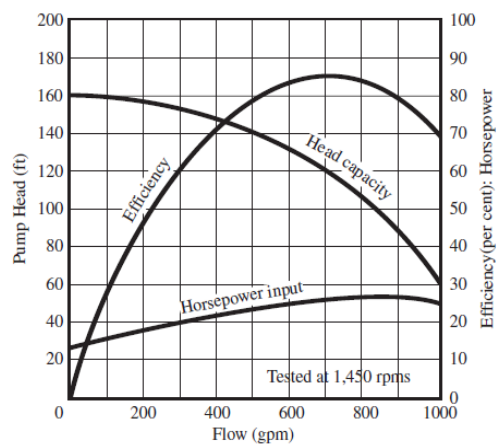
Pump Combinations – Large Head Range

(Concepts and Visualization)

Design Objective: Operate pumps at their peak efficiency.

Q: What is the pump head range for operating this pump at efficiencies greater than 80%.

Q: A project requires a flow of 200 gpm, but H_p varies (60 to 155 feet). Will this pump work? ➔



Using Pumps in Series

(Concepts and Visualization)

Pumps in Series: Heads are additive for a given pump flow.

Q: A project requires a flow of 200 gpm, but H_p varies (60 to 155 feet). Design an efficient pump system.

A: Use two pumps in series: Pump 1 ➔ high efficiency for H_p = 40 to 80 ft & Pump 2 ➔ high "e" for H_p = 45 to 90 ft. Use both pumps for high heads.

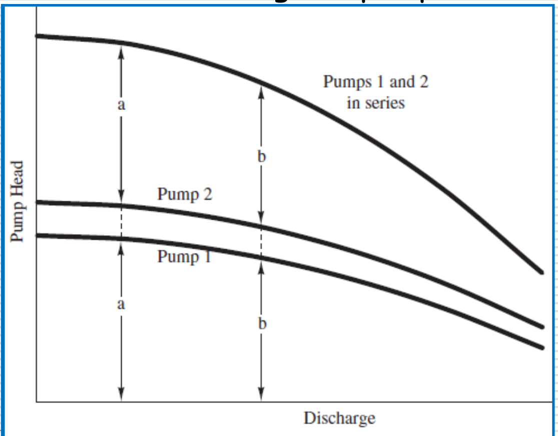


Figure 5.12 Pump characteristics for two pumps in series

Analysis of Pumps in Series and Parallel

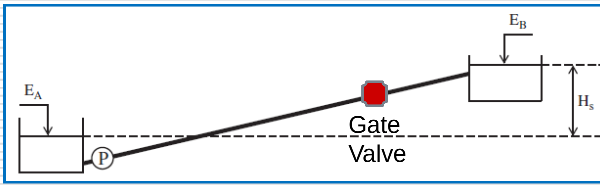
(Example Problem)

For a pump-pipeline system; E_B = 90m, E_A = 80m, L = 300m, D = 40cm, e = 0.12mm, ν = 1.31x10^{-6} m^2/sec. Find the Q, e, and H_p for 1 pump, 2 pumps in series, & 2 pumps in parallel.

Solution: From an energy balance:

or, H_p = where $H_s = E_B - E_A$ = 10 m

Note: The pump adds energy to overcome static lift (H_s), friction loss, and minor losses. Note that ∑K = 1.65



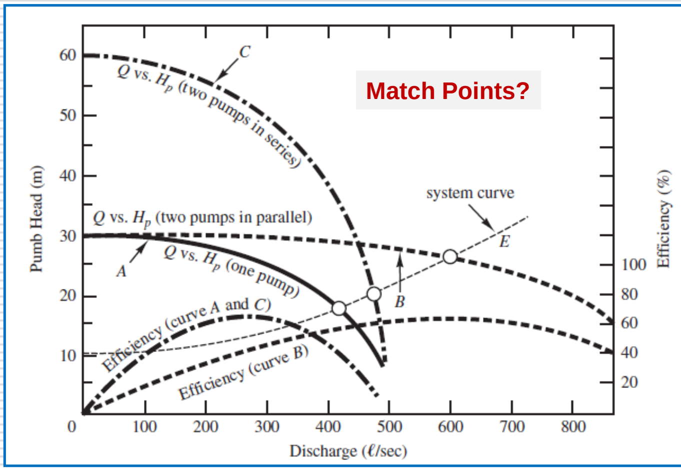
Determine the system head curve for this pipeline.

Pumps in Series and Parallel

(Example Problem – cont.)

Fill in the solution table ➔

Q (L/sec)	V (m/sec)	N_R	f	H_{SH} (m)
0	0	—	—	10.0
100	0.80	2.44 × 10^5	0.0175	10.5
300	2.39	7.30 × 10^5	0.0160	14.0
500	3.98	1.22 × 10^6	0.0155	20.7
700				



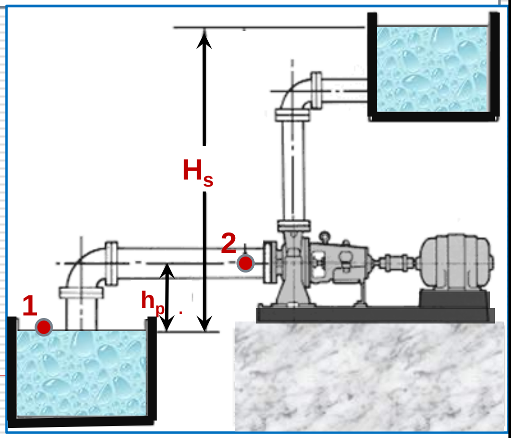
Plot the system head curve on the pump's characteristic curves. Find the Q, e, and H_p for 1 pump, 2 pumps in series, & 2 in parallel.

Cavitation in Water Pumps

(Visualization and Energy Conservation Principles)

Q: Balance energy between points 1 and 2 (figure below).

A:



Q: Solve for P_2/γ:

A:

High negative pressure may cause water to vaporize & cavitation is to be avoided.

Q: How does a designer avoid cavitation problems?

A:

Selection of a Pump

(Visualization and Design Concepts)

Q: What is the best type of pump for high heads and low flows? …for low heads and high flows? What is the best type for a broad range of flow and head conditions?

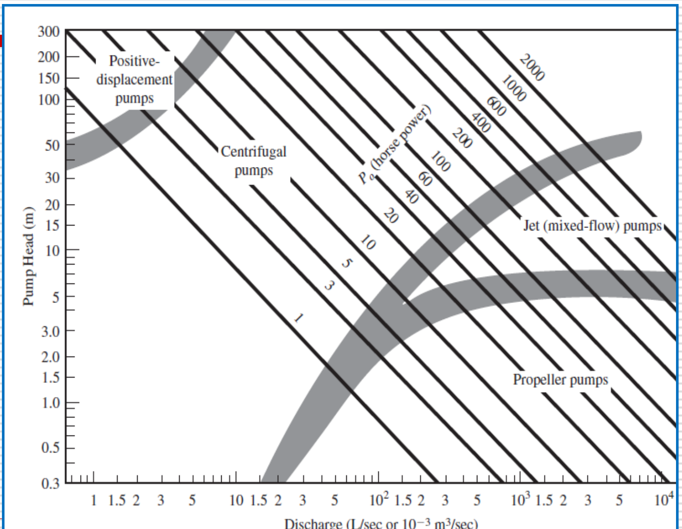


Figure 5.22 Discharge, head, and power requirements of different types of pumps

Selection of a Pump

(Design Concepts and Example Problem)

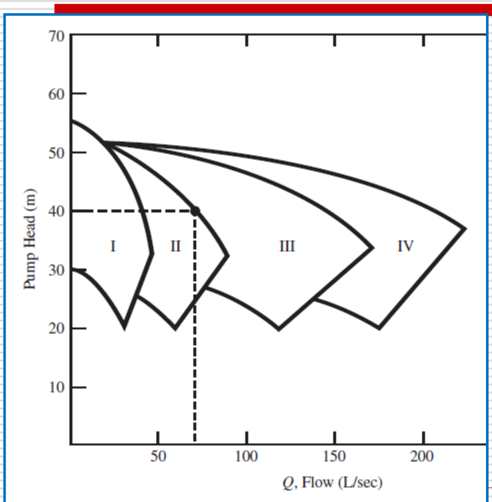


Figure 5.23 Pump model selection chart

The required flow for a pipeline is 70 L/sec. Based on the energy equation, the required pump head is 40 m. Based on the manufacture's pump selection chart, either Pump I or Pump II will work. The characteristic curves for each pump are shown on the next slide.

Selection of a Pump

(Design Concepts and Example Problem)

Q: Choose the best pump and state its operating conditions.