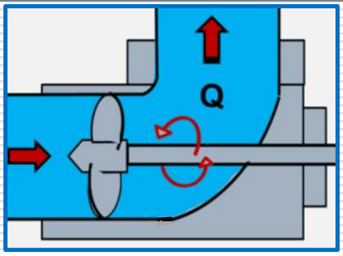
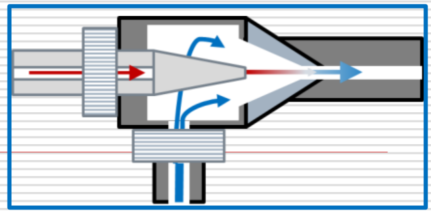
Description of Pumps and Pump Types
(Definitions and Visualization)

Pump:

Propeller (axial flow) Pump: pressure energy is imparted to the fluid by the mechanical rotation of blades.



Jet (mixed flow) Pump: nozzle spray is released into the throat of the main pipe and suction induces flow



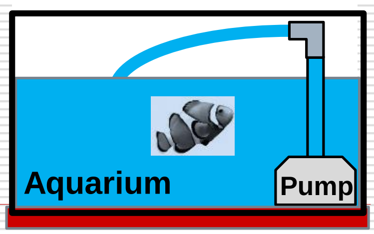
Centrifugal Pump Characteristic Curves
(Visualization and Flow vs. Head Principles)

Consider the aquarium pump flow in the figure.
Every pump delivers a certain power: $P_o = \gamma Q H_p$

Q: Based on the equation, what happens to the flow if the delivery tube is raised?

A:

Q: What happens if the delivery tube is raised even higher?



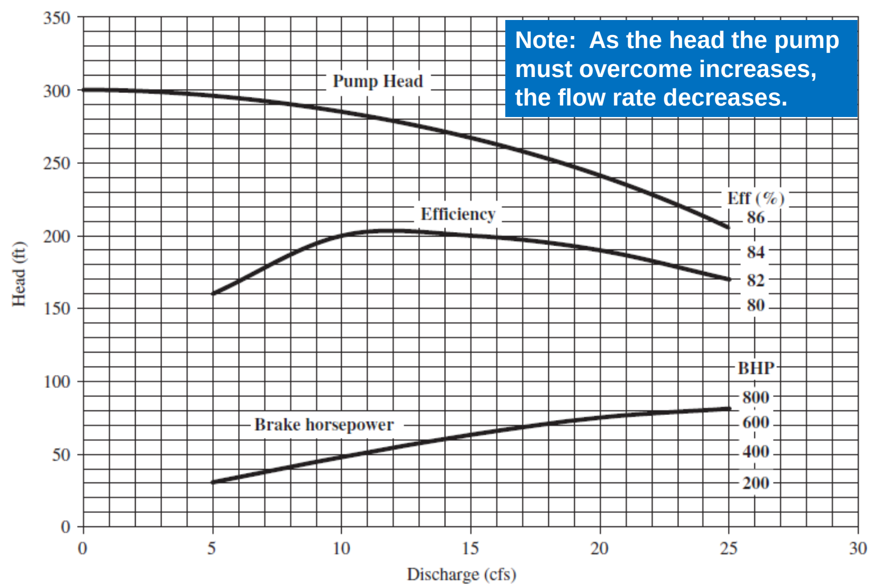


Figure 5.8 Typical pump characteristic curves

Description of Characteristic Curves

(Definitions and Pump Rating Concepts)

Characteristic (Performance) Curves: produced and made available by pump manufacturers based on lab and field tests.

Pump Head:

Brake Horsepower: power input required by the pump (P_i).

Efficiency (e): **Rated Capacity:**

Q: For the pump on the previous slide, determine the rated capacity (max. "e" and BHP), shutoff head, and H at Q = 20.

Affinity Laws: Once the characteristics of a pump are known for one speed, they can be determined for any speed.

$Q_2/Q_1 = N_{r2}/N_{r1}$; $H_{p2}/H_{p1} = (N_{r2}/N_{r1})^2$; $BHP_2/BHP_1 = (N_{r2}/N_{r1})^3$

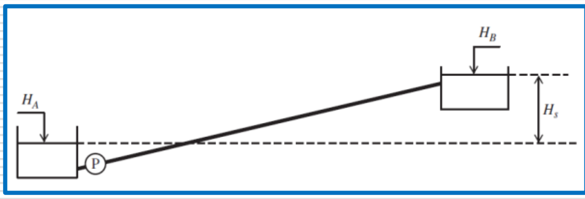
Single Pump and Pipeline Analysis
(Example Problem – Active Learning)

For the pump-pipeline system shown; H_A = 100 ft, H_B = 220, D = 2.0 ft., L = 12,800 ft., C_{HW} = 100, pump characteristics are known (columns 1 & 2; table on next slide). Find the Q.

Solution: From an energy balance: [ ]

or, H_p = [ ] ; where $H_s = H_B - H_A$ = 120 ft

Note: The pump adds energy to overcome static lift or head (H_s) and friction loss. For Hazen-Williams method **(Table 3.4)**



$h_f = KQ^{1.85}$, where

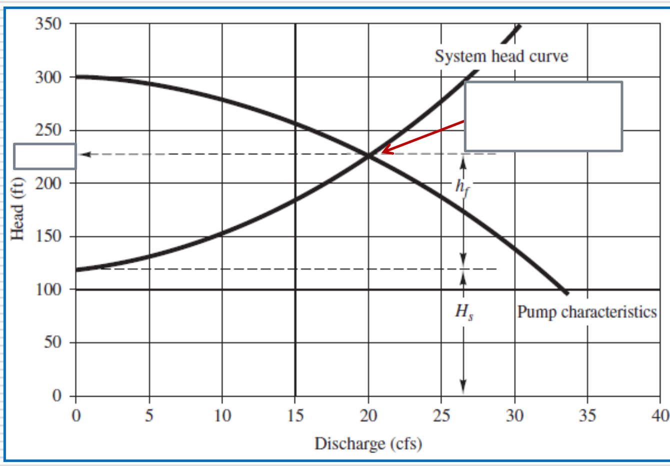
$K = 4.73 \cdot L/(D^{4.87}C^{1.85})$

Thus, K = 0.413

Single Pump and Pipeline Analysis
(Example Problem – cont.)

Fill in the solution table ➔

Q (cfs)	H_p (ft)	h_f (ft)	H_s (ft)	H_{SH} (ft)
0	300.0			120.0
5	295.5			128.1
10	282.0			149.2
15	259.5			181.9
20	225.5			225.4
25	187.5			279.3



Plot two curves. What is the **system head** curve? What is the Q for **this pump in this pipeline system**?

Homework Problems: