CE 3372 WATER SYSTEMS DESIGN

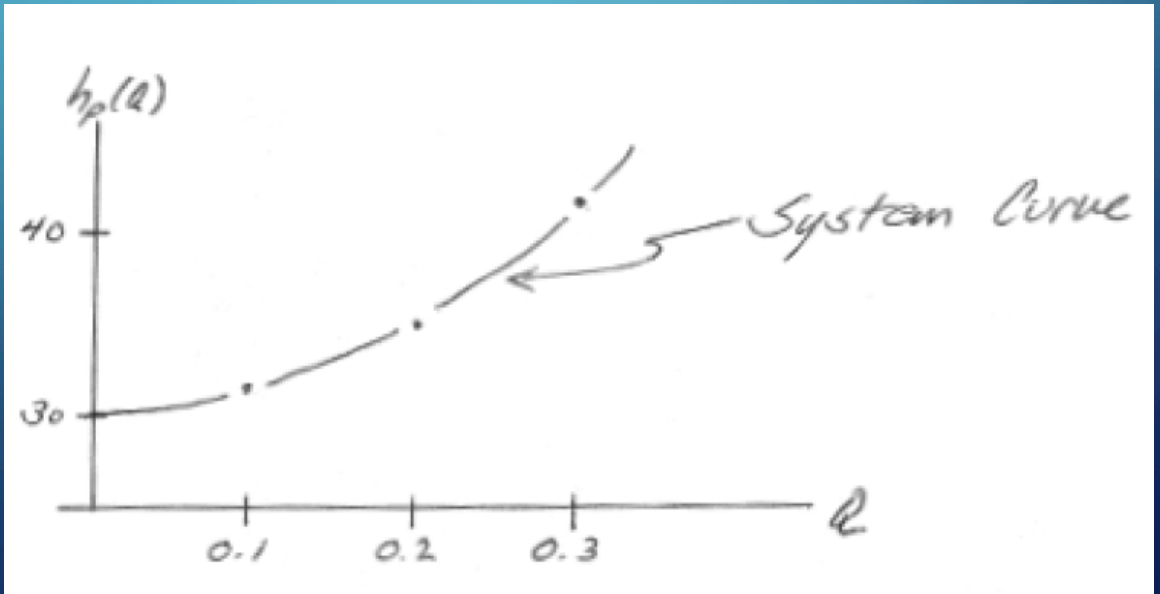
PUMPS AND LIFT STATIONS PART 2 (FALL 2020)

SELECTING PUMPS

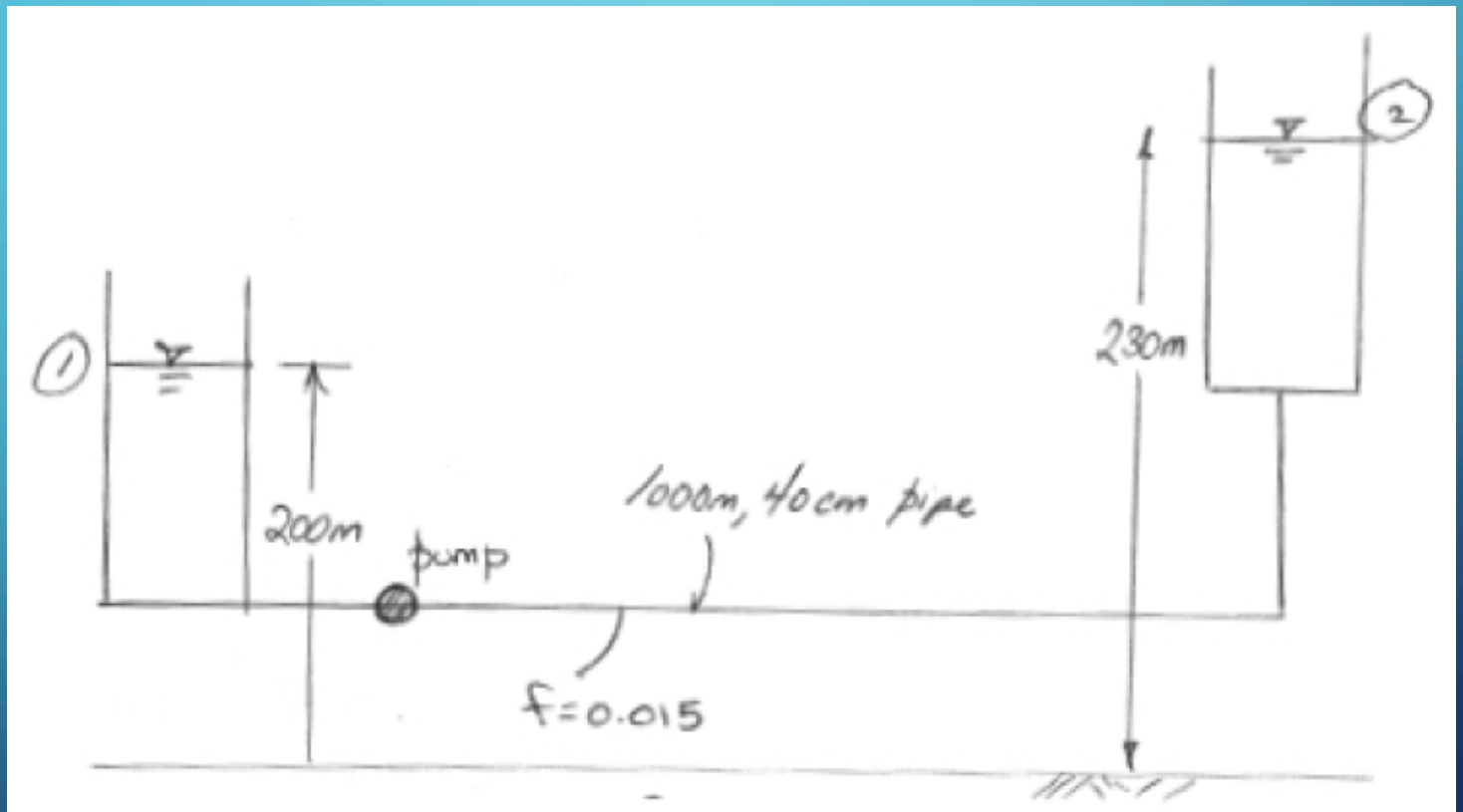
- Design conditions are specified
- Pump is selected for the range of applications
- A System Curve (H vs. Q) is prepared
- System Curve is matched to Pump Curve
- Matching point (Operating point) indicates the actual working conditions

SYSTEM CURVES

- A system (characteristic) curve is a plot of required head versus flow rate in a hydraulic system (H vs. Q)
  - The curve depicts how much energy is necessary to maintain a steady flow under the supplied conditions
  - Total head, H_p = **elevation head + head losses**



SYSTEM CURVES



$$H_p = (30) + H_{\text{Loss}} = 30 + (f\frac{L}{D} + K_{\text{entrance}} + K_{\text{bend}} + K_{\text{exit}})\frac{Q^2}{A^2\ 2g} = 127Q^2 + 30$$

SYSTEM CURVES

- This relationship tells us that the added head has to be at least 30 meters just to keep the reservoirs at the two levels shown, if any flow is to occur the pump must supply more than 30 meters of head.

$$H_p = (30) + H_{\text{Loss}} = 30 + (f\frac{L}{D} + K_{\text{entrance}} + K_{\text{bend}} + K_{\text{exit}})\frac{Q^2}{A^2\ 2g} = 127Q^2 + 30$$

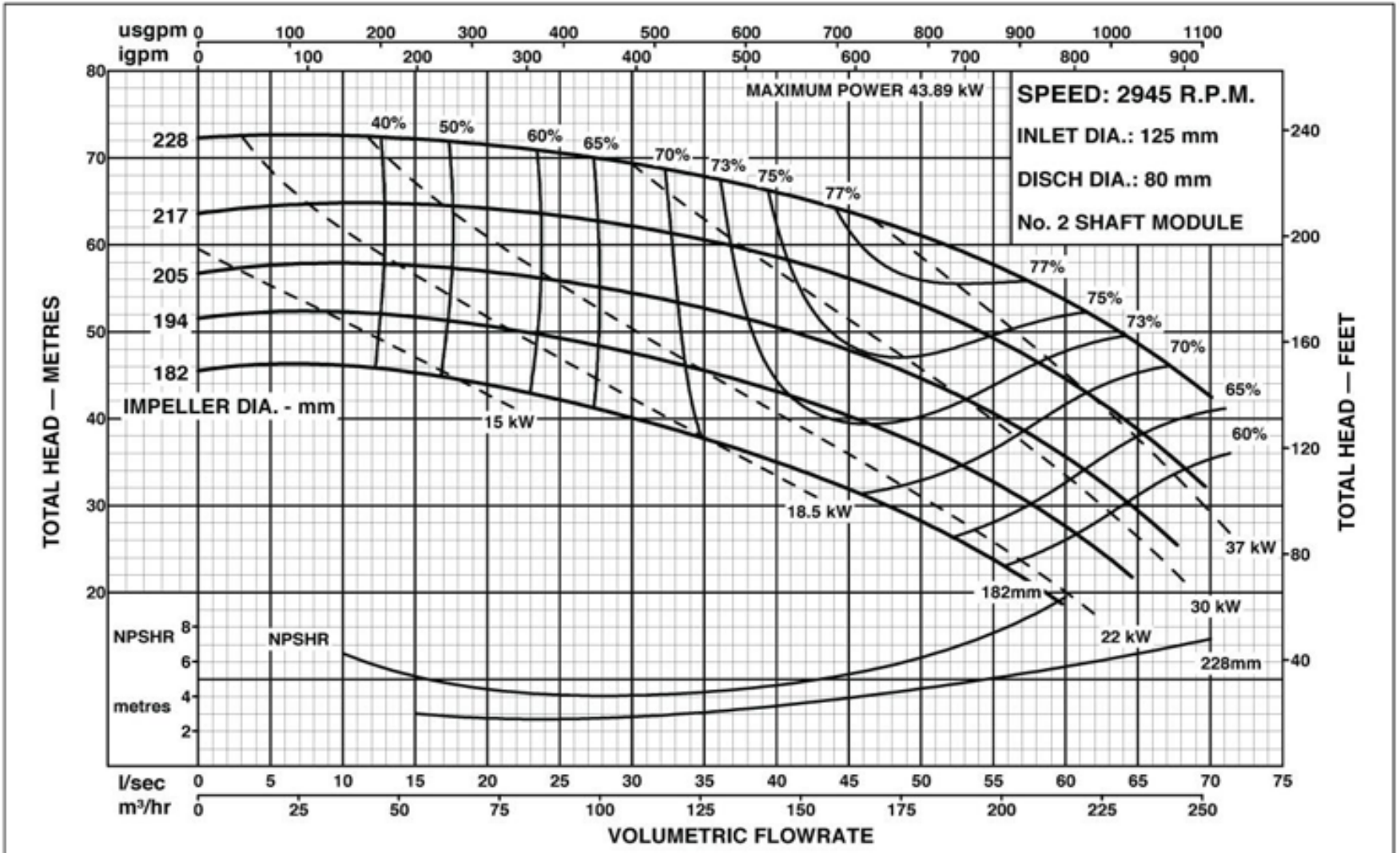
PUMP CURVES

- Provided information from the manufacturer on the performance of pumps in the form of curves.
- Information may include:
  - discharge on the x-axis
  - head on the left y-axis
  - pump power input on the right y-axis
  - pump efficiency as a percentage
  - speed of the pump (rpm)
  - NPSH of the pump

Southern Cross

ISO Sovereign 125 x 80-200

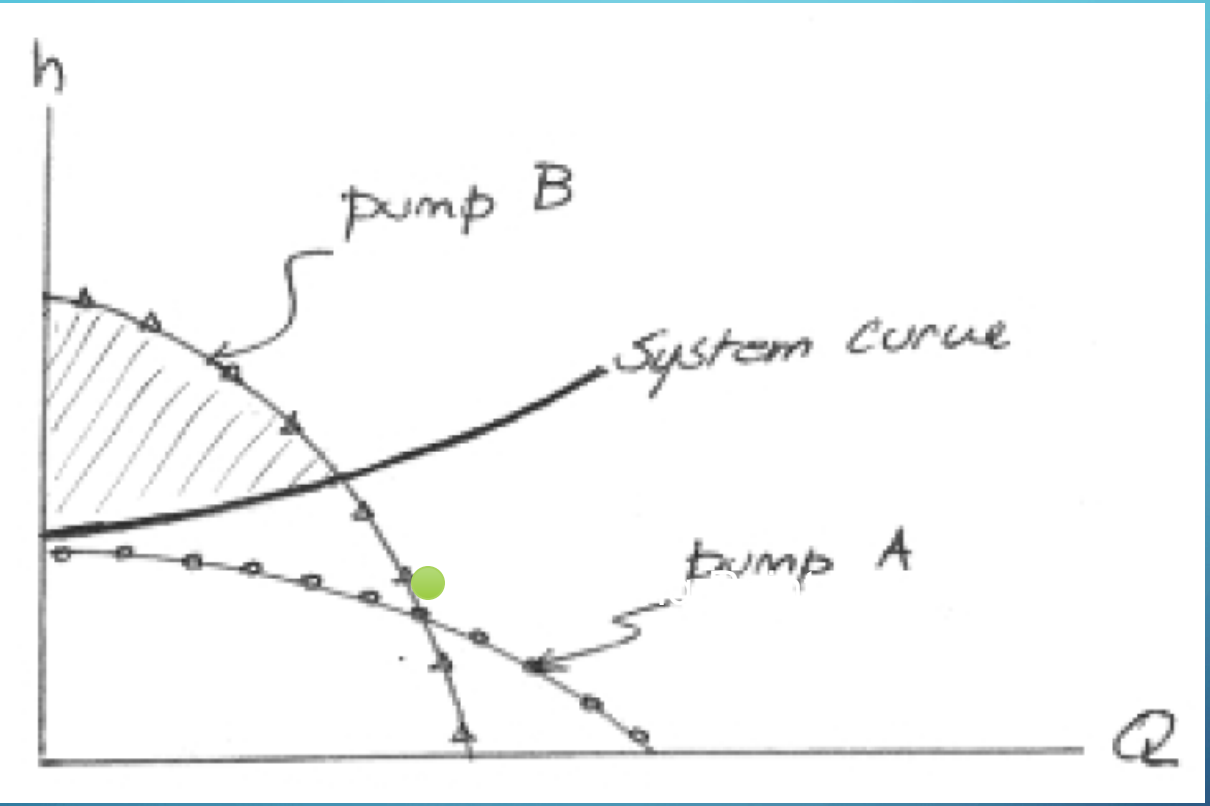
CENTRIFUGAL PUMP PERFORMANCE DATA



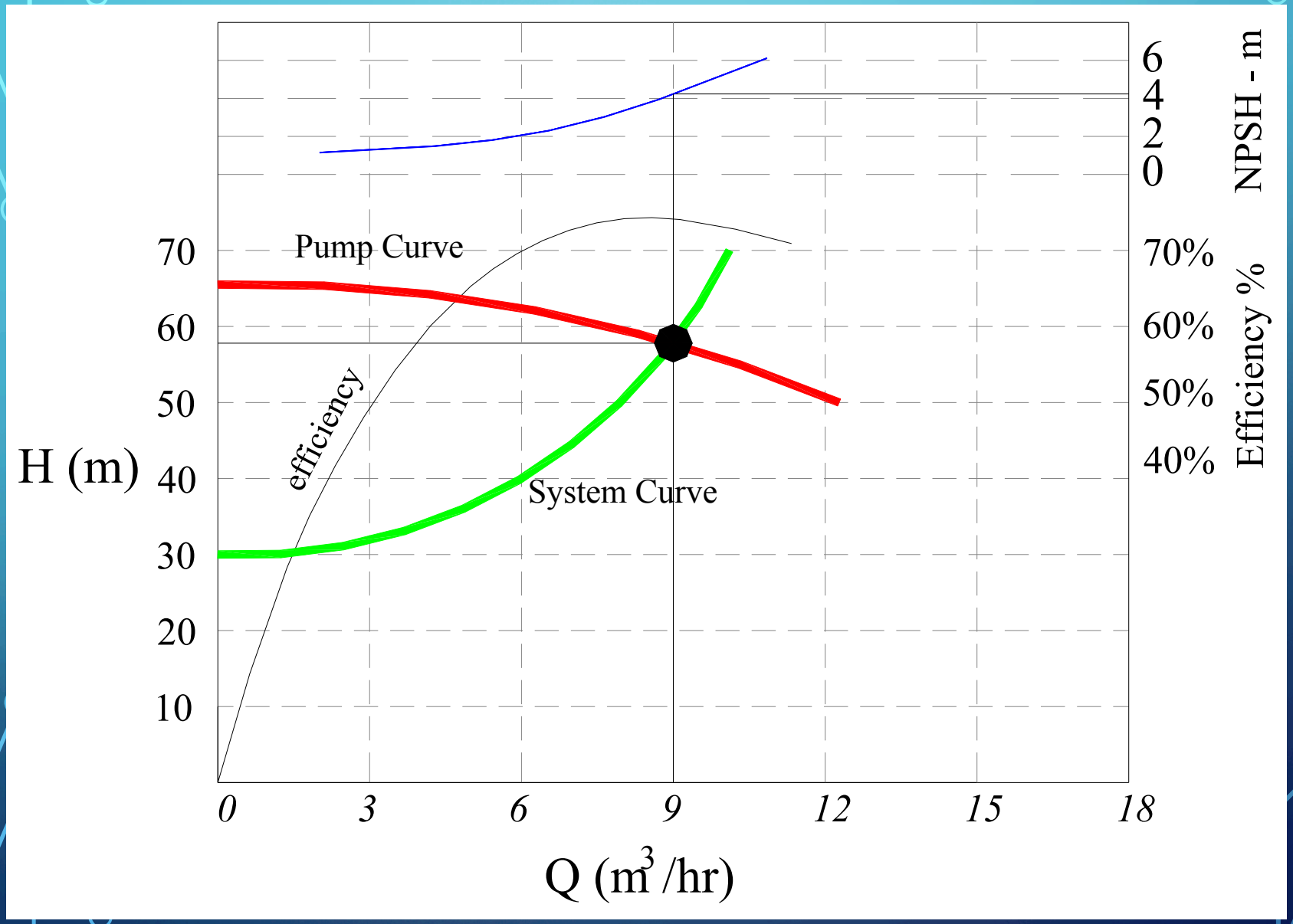
Performance to AS2417 Grade 2 for clean, cold water only.

May 2005

PUMP CURVES

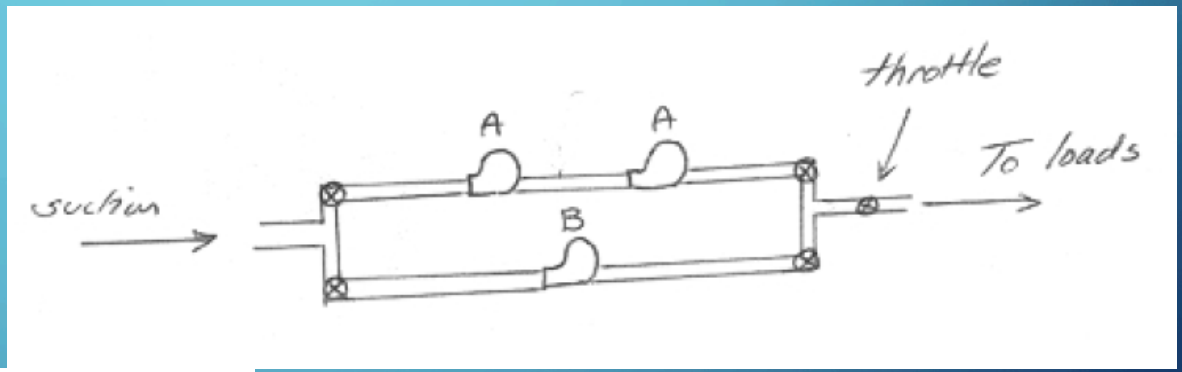


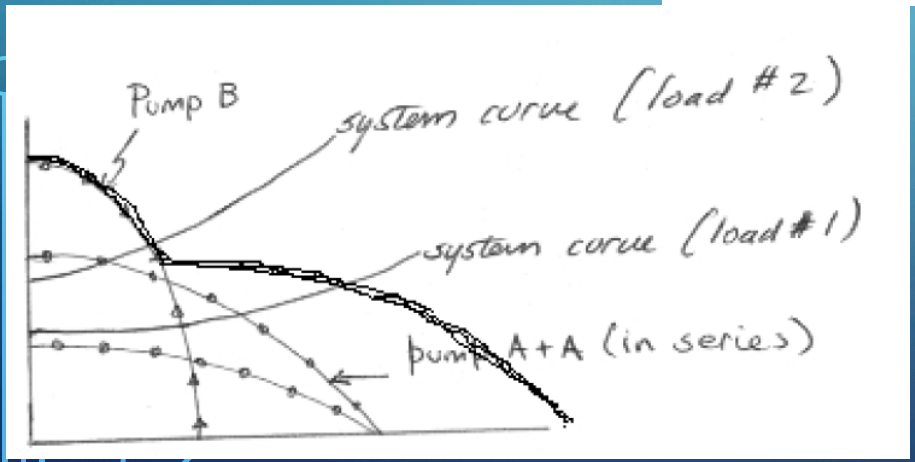
- Pump A cannot meet the needs of the system at any flow rate
- Pump B supplies enough head over part of the system curve
- The shaded area is the area where the pump supplies excess head


Pump Curve
efficiency
System Curve
H (m)
70
60
50
40
30
20
10
0
3
6
9
12
15
18
Q (m3/hr)
6
4
2
0
NPSH - m
70%
60%
50%
40%
Efficiency %

MULTIPLE PUMPS

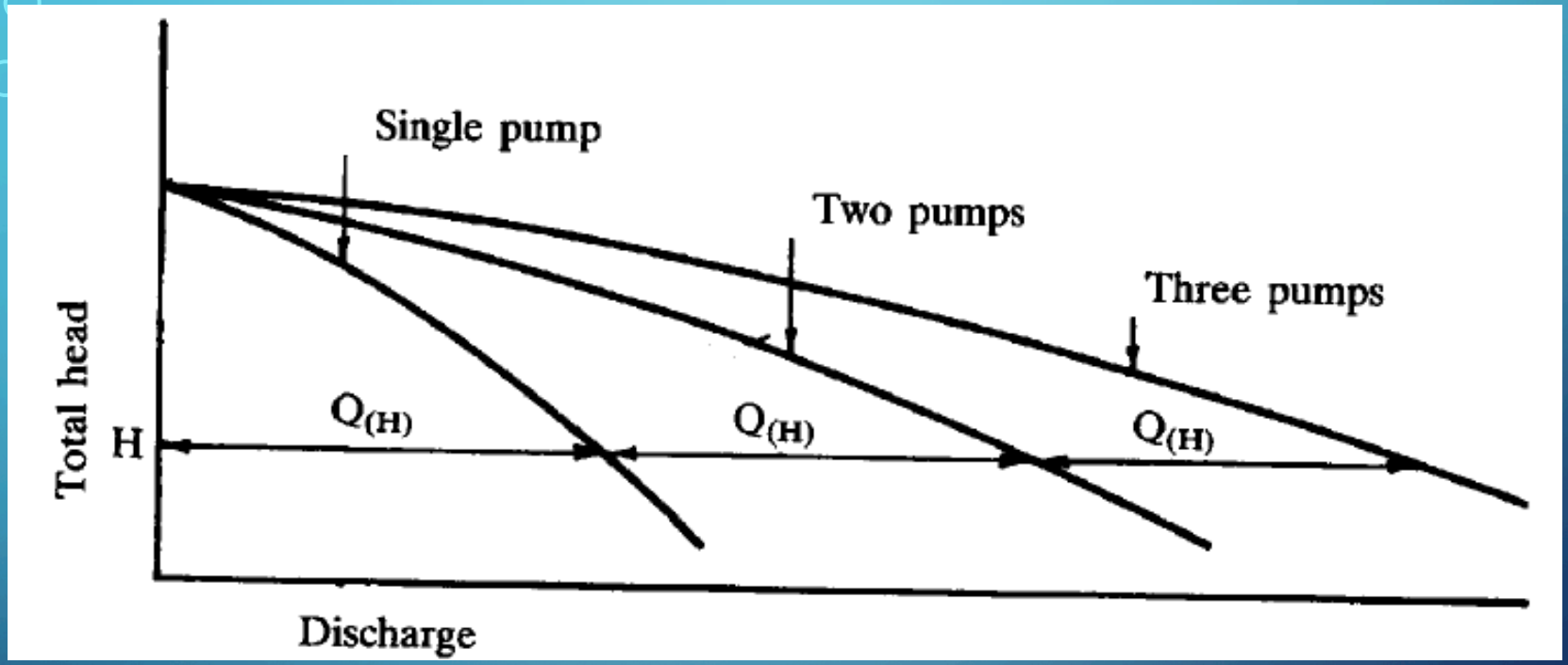
- Series and parallel combinations can be used to adjust “pump curves” to fit system requirements.

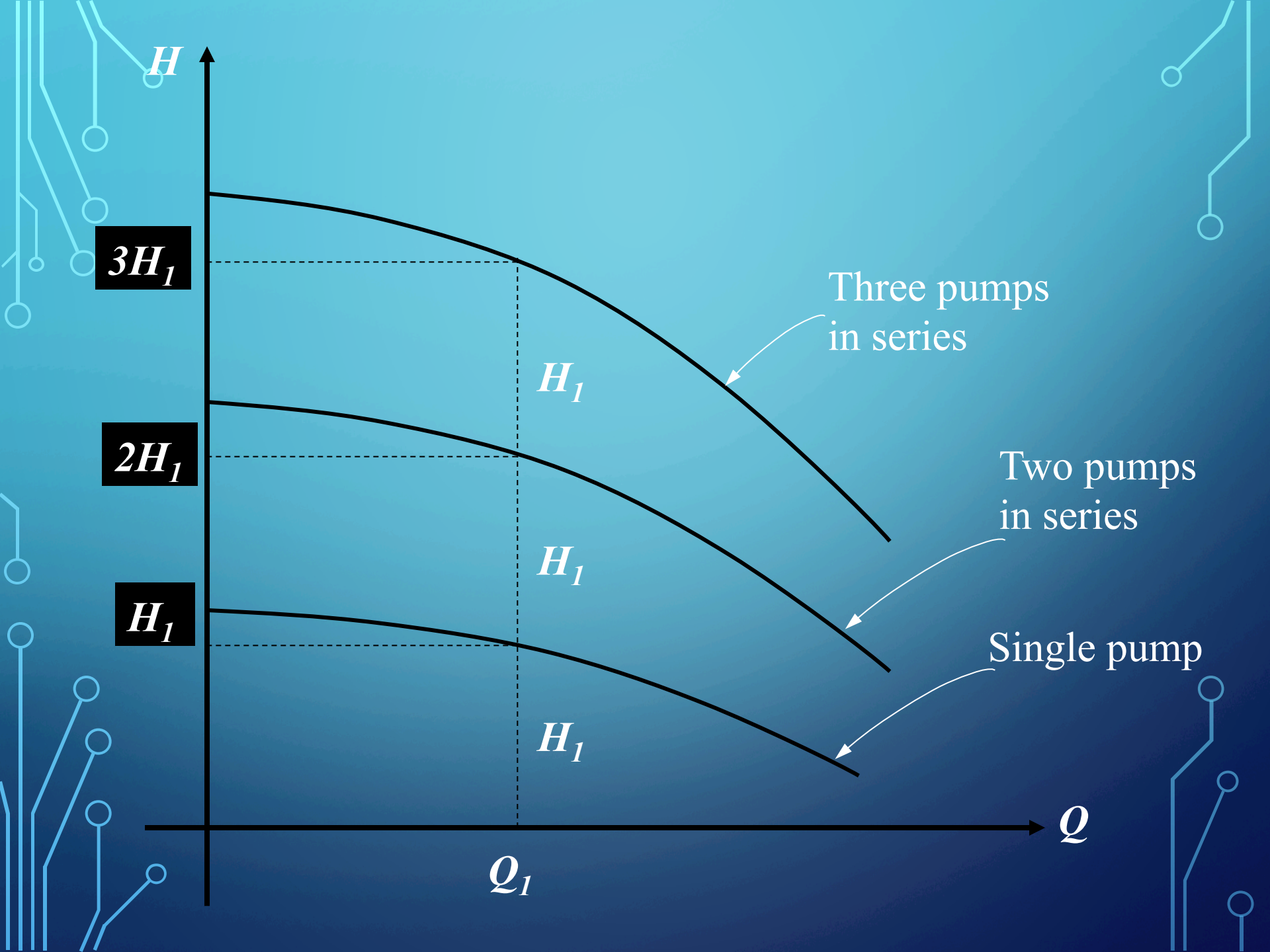




Parallel pumps add flow for given head

Series pumps add head for given flow


Single pump
Two pumps
Three pumps
Total head
H
$Q_{(H)}$
$Q_{(H)}$
$Q_{(H)}$
Discharge


H
3H1
2H1
H1
H1
H1
H1
Three pumps
in series
Two pumps
in series
Single pump
Q
Q1