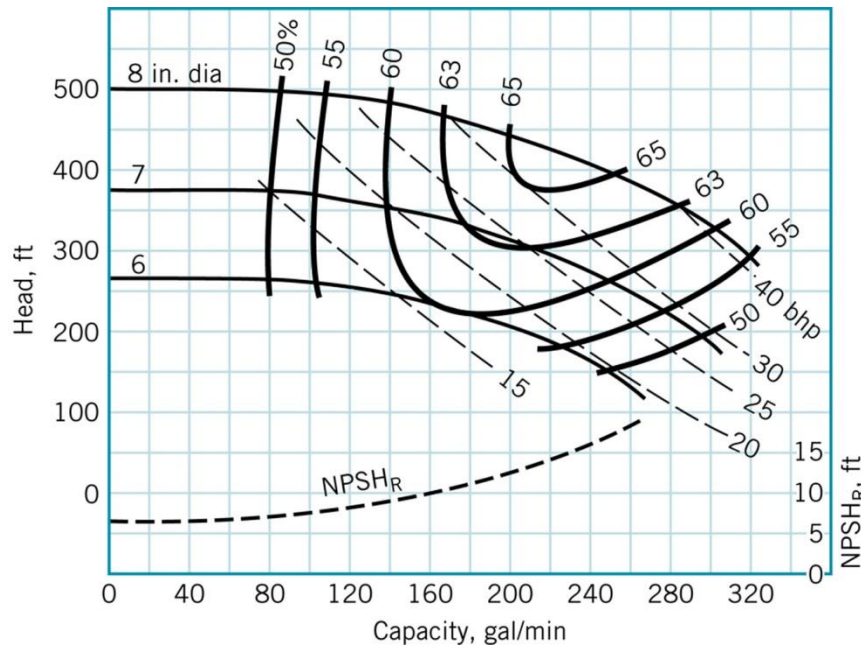


Centrifugal pump

Net positive suction head: NPSH



- Suction side of pump:
- low *absolute* pressure
 - needs to avoid cavitation
 - cavitation causes loss in efficiency and could damage the pump

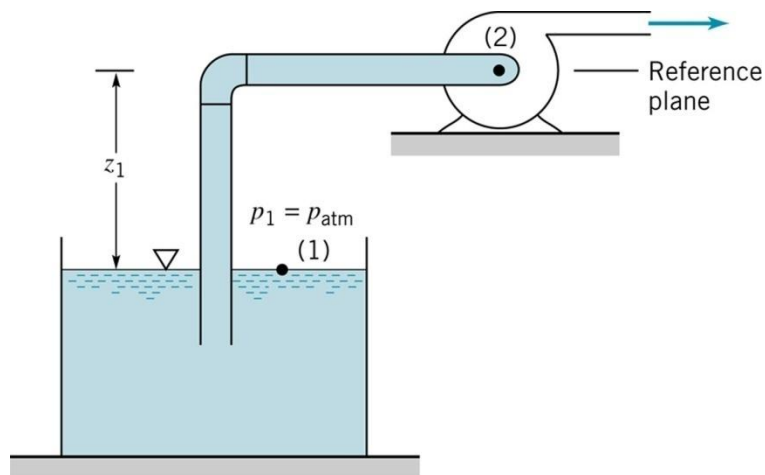
$$\text{NPSH} = \frac{p_s}{\gamma} + \frac{v_s^2}{2g} - \frac{p_v}{\gamma}$$

Eq (12.24)

NPSH_R is the required NPSH to avoid the cavitation, usually determined experimentally.

Centrifugal pump

Net positive suction head: NPSH



$NPSH_A$ is the available NPSH in actual flow system, can be calculated.

For a system in the figure:

$$\frac{p_s}{\gamma} + \frac{v_s^2}{2g} = \frac{p_{atm}}{\gamma} - z_1 - h_L$$

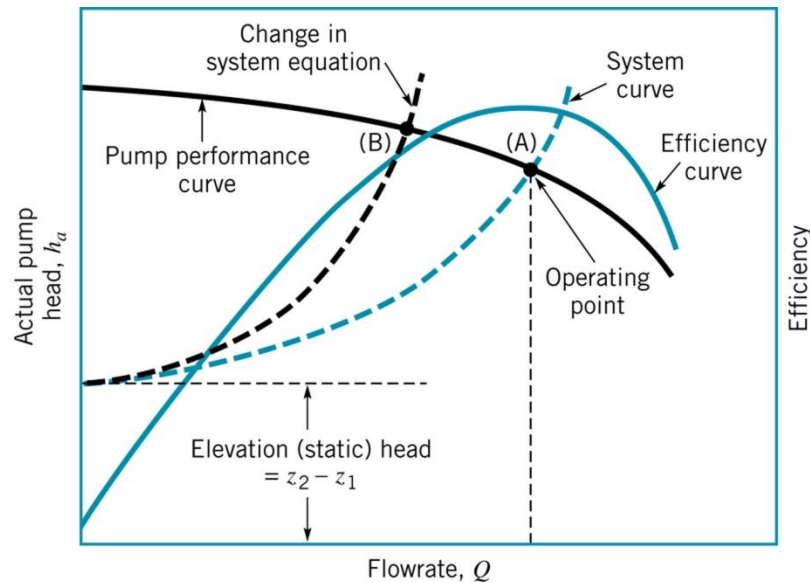
Condition must be met:

$$NPSH_A \geq NPSH_R$$

$$NPSH_R + z_1 + h_L + \frac{p_v}{\gamma} \leq \frac{p_{atm}}{\gamma}$$

Centrifugal pump

Pump selection



Operating point satisfies both the system equation and the pump equation.

The system equation:

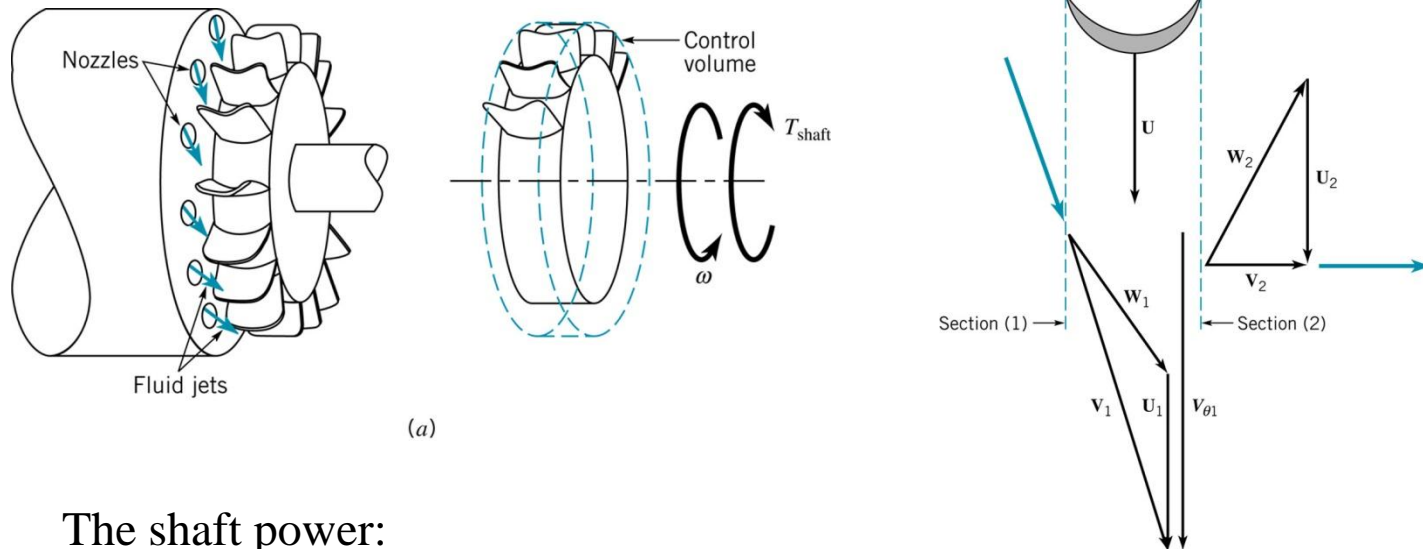
$$h_a = \frac{\Delta p}{\gamma} + \frac{\Delta v^2}{2g} + \Delta z + h_L$$

$\Delta = \text{out} - \text{in}$

The pump equation:

$$h_s = f(Q)$$

Impulse turbine



The shaft power:

$$\dot{W}_{shaft} = \dot{m}(\pm U_{out} v_{\theta out}) - \dot{m}(\pm U_{in} v_{\theta in}) \quad \text{Eq (12.4)}$$

The turbine efficiency:

$$\eta = \frac{\dot{W}_{shaft}}{P_f} = \frac{\dot{W}_{shaft}}{\gamma h_a Q}$$