Question 9.

An industry operates a cooling water pump for process cooling and refrigeration applications. During the performance testing the following operating parameters were obtained:

(a) Pump water flow (Q) = 0.40 m^3/s

(b) Power consumption (P) = 325 kW

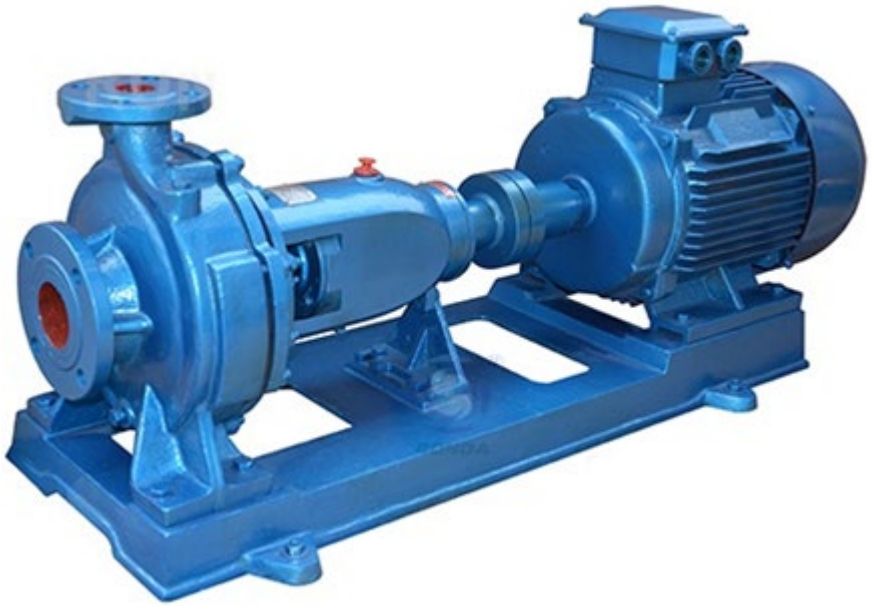
(c) Suction head, tower basin level (h1) = +1 m

(d) Delivery head (h2) = +55 m

(e) Motor efficiency = 88 %

(f) Density of water = 996 kg/m3

Determine the pump efficiency.



$$\eta_{pump} = \frac{Hydraulic\ Power\ \mathbf{or}\ Pump\ Power\ Output}{Power\ Input\ to\ the\ Pump\ Shaft}$$

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$$P_h(kW) = \frac{\rho(\frac{kg}{m^3}) \times g(\frac{m}{s^2}) \times Q(\frac{m^3}{s}) \times H(m)}{1000}$$

Hydraulic Power

$$\eta_{pump} = \frac{Hydraulic\ Power\ \mathbf{or}\ Pump\ Power\ Output}{Power\ Input\ to\ the\ Pump\ Shaft}$$

✓ ✓ ✓ ?

$$P_h(kW) = \frac{\rho(\frac{kg}{m^3}) \times g(\frac{m}{s^2}) \times Q(\frac{m^3}{s}) \times H(m)}{1000}$$

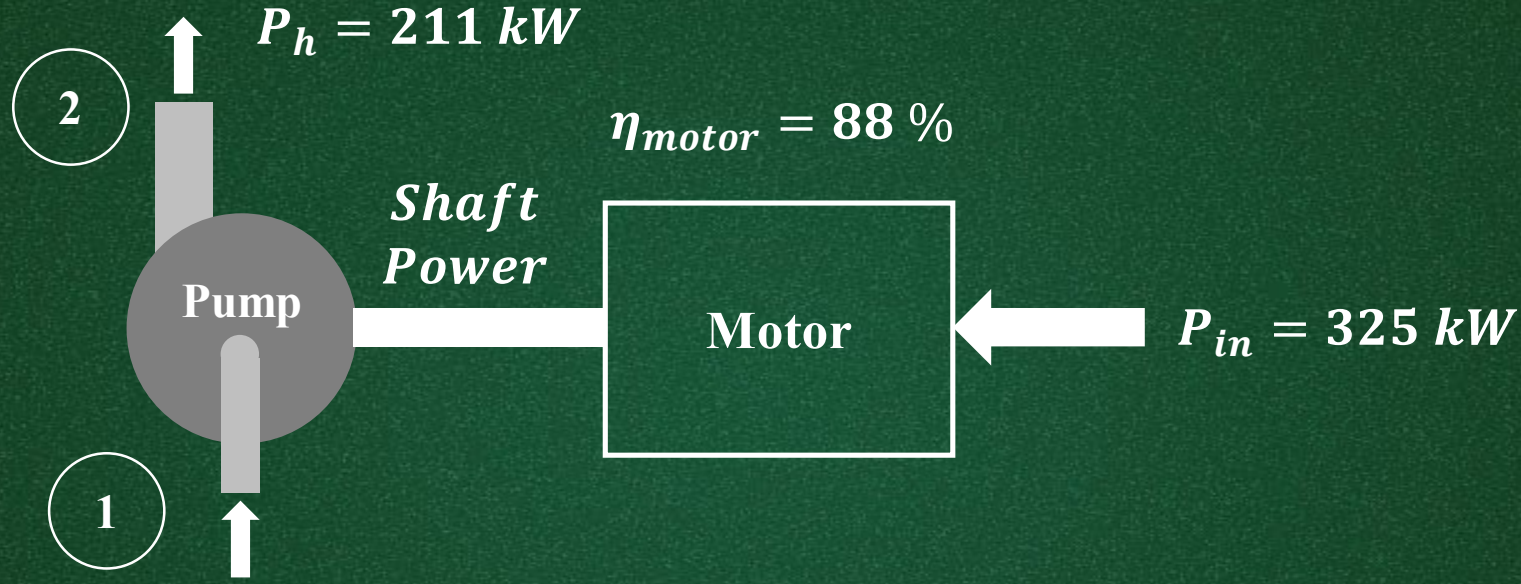
$$\eta_{pump} = \frac{Hydraulic\ Power\ \mathbf{or}\ Pump\ Power\ Output}{Power\ Input\ to\ the\ Pump\ Shaft}$$

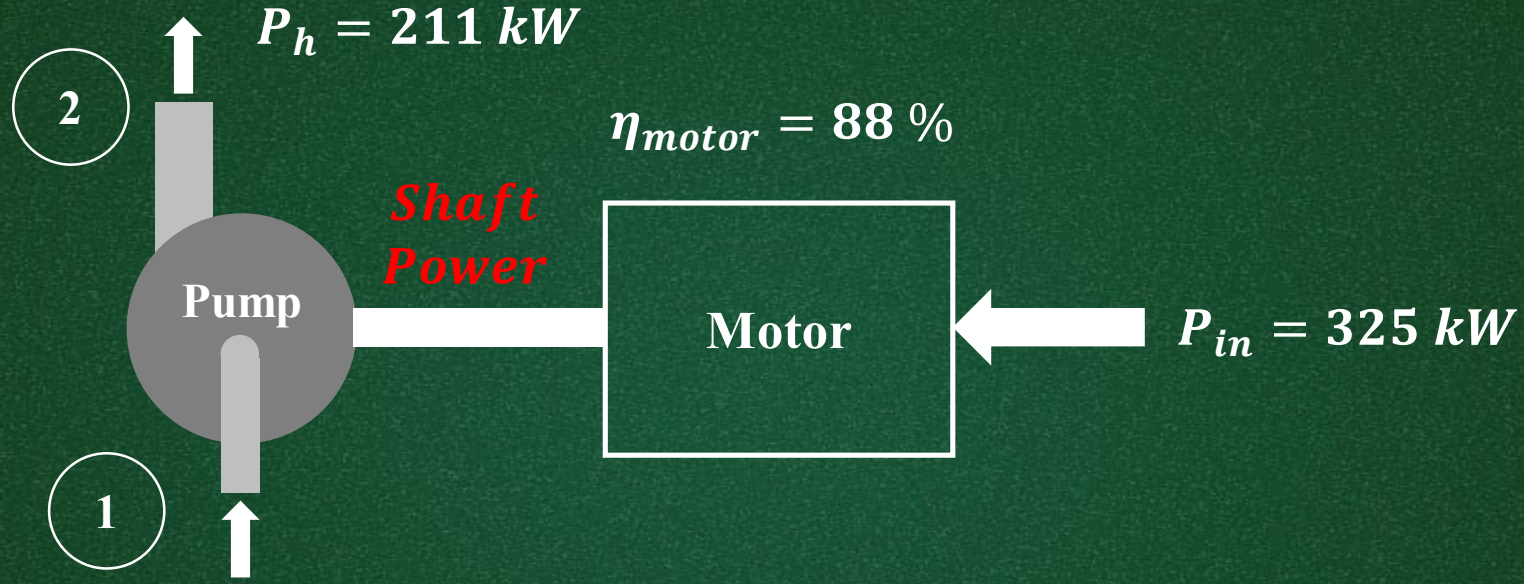
✓ ✓ ✓ ?

$$P_h(kW) = \frac{\rho(\frac{kg}{m^3}) \times g(\frac{m}{s^2}) \times Q(\frac{m^3}{s}) \times H(m)}{1000}$$

$$Total\ Head = h_2 - h_1 = 55 - 1 = 54\ m$$

$$P_h(kW) = \frac{996\left(\frac{kg}{m^3}\right) \times 9.81\left(\frac{m}{s^2}\right) \times 0.4\left(\frac{m^3}{s}\right) \times 54(m)}{1000} = 211$$


$P_h = 211\ kW$
2
$\eta_{motor} = 88\ \%$
Shaft Power
Pump
Motor
$P_{in} = 325\ kW$
1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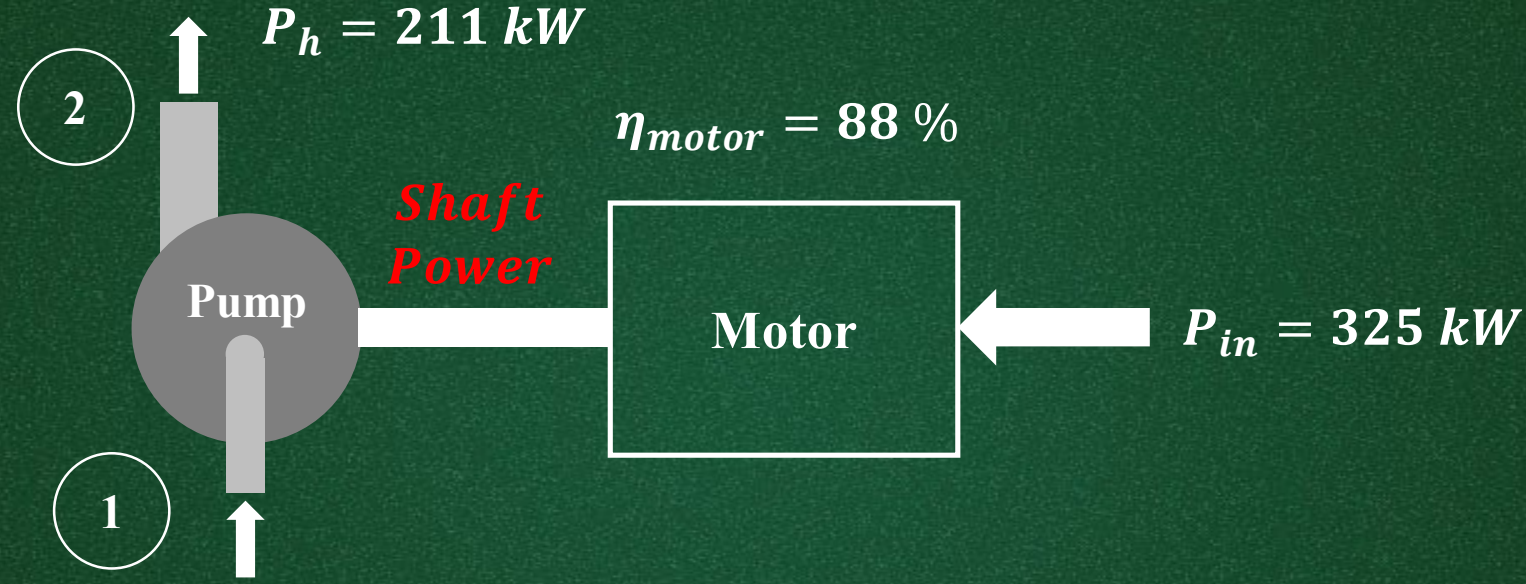

$$\eta_m = \frac{P_{out}}{P_{in}} \longrightarrow Shaft\ Power = P_{out} = \eta_m \times P_{in}$$

$$= 0.88 \times 325 = 286\ kW$$

$$\eta_{pump} = \frac{P_h}{P_{shaft}} \longrightarrow \eta_{pump} = \frac{211}{286} = 73.77\ \%$$

Thank you for your attention


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