47.60 A single phase $240V$ motor drives a pump that supplies $100\frac{lb_m}{min}$ of $80°F$ water and adds $400ft$ of pressure head. The pump is 70% efficient and the motor is 90% efficient. What is the current drawn by the motor?

A. $3A$

B. $4A$

C. $5A$

D. $6A$

Use the Properties of Water table to look up the density of water at $80°F$. Use the density and the mass flow rate to find the volume flow rate. Convert units to gpm.

$$\rho = 62.2\frac{lb_m}{ft^3}$$

$$\dot{m} = \rho Q$$

$$Q = \frac{\dot{m}}{\rho} = \frac{100\frac{lb_m}{min}}{\left(62.4\frac{lb_m}{ft^3}\right)\left(\frac{1ft^3}{7.48gal}\right)} = 12gpm$$

Calculate the Water Horsepower delivered by the pump.

$$whp = \frac{Qh}{3960}$$

$$whp = \frac{(12)(400)}{3960} = 1.21hp$$

Use the pump and motor efficiencies to calculate the input power to the motor. Convert units to KW.

$$P_{[KW]} = \frac{whp}{\eta_m \eta_p} = \frac{(1.21hp)\left(0.7457\frac{KW}{hp}\right)}{(0.7)(0.9)} = 1.44KW$$

Select the equation in the table Power for Different Motor Phases for single-phase motors to determine the current. Assume the power factor is unity. Write and check all units.

$$P_{[KW]} = IV(pf)$$

$$I_{[amps]} = \frac{P_{[KW]}\left(\frac{1000W}{KW}\right)}{V(pf)} = \frac{(1.44KW)\left(\frac{1000W}{KW}\right)}{(240V)(1)} = 6A$$

Answer D

47.61 Olive oil has a dynamic viscosity of $40cP$ and a specific gravity of 0.92. What is the kinematic viscosity?

A. $4.3 \times 10^{-5} \frac{ft^2}{s}$

B. $4.7 \times 10^{-4} \frac{ft^2}{s}$

C. $2.0 \times 10^{-3} \frac{ft^2}{s}$

D. $1.7 \frac{ft^2}{s}$

Use the Specific Gravity to determine the density of the oil.

$$SG = \frac{\rho_{oil}}{\rho_{water}}$$

$$\rho_{oil} = SG \cdot \rho_{water} = (0.92)\left(62.4 \frac{lb_m}{ft^3}\right) = 57.4 \frac{lb_m}{ft^3}$$

Use the relation between Kinematic Viscosity and Absolute Viscosity i.e. 'Dynamic Viscosity'. Use Measurement Relationships for required unit conversioins to align with the answer choices.

$$\nu = \frac{\mu}{\rho}$$

$$\nu = \frac{(40cP)\left(2.412 \frac{lb_m}{hr \cdot ft \cdot cP}\right)\left(\frac{1hr}{3600s}\right)}{57.4 \frac{lb_m}{ft^3}} = 4.7 \times 10^{-4} \frac{ft^2}{s}$$

Answer B

47.62 $900gpm$ of a fluid flows through $500ft$ of a $8in$ pipe. The Reynolds number is $80,000$ and the relative roughness is 0.0003. What is the total pressure drop?

A. $2.5ft$

B. $3.5ft$

C. $5.8ft$

D. $8.2ft$

The pressure drop is calculated with the Darcy-Weisbach Equation.

$$h_f = \frac{fLv^2}{2Dg}$$

The Reynolds number and relative roughness are given. Use the Moody diagram to obtain the friction factor.

$$Re = 80,000$$