46.62 A pump delivers $250gpm$ and produces $125ft$ of head. The fluid being distributed has a density of $71\frac{lb_m}{ft^3}$ and the pump is 80% efficient. What is the brake horsepower required to drive the pump?

A. $9.0hp$

B. $9.9hp$

C. $11.2hp$

D. $25.9hp$

Use the formula for Brake HP. The volume flow rate, head, and efficiency are given. Use the density of the fluid along with the standard density of water to determine the Specific Gravity, then solve for the bhp.

$$bhp = \frac{Q\Delta h \cdot SG}{3960\eta_p}$$

$$SG = \frac{\rho}{\rho_{water}} = \frac{71\frac{lb_m}{ft^3}}{62.4\frac{lb_m}{ft^3}} = 1.14$$

$$bhp = \frac{(250gpm)(125ft)(1.14)}{3960(0.8)} = 11.2hp$$

Answer C

46.63 A heat pump operated in cooling mode has a capacity of 2 refrigeration tons and uses a $1500W$ compressor. What is the coefficient of performance?

A. 4.7

B. 5.7

C. 8.1

D. 10.4

Since the heat pump is being operated in cooling mode, use the formula for refrigerators and air conditioners under Coefficient of Performance. Substitute the cooling capacity for Q_L and the compressor energy for W. Align the units in the numerator and denominator such that the final result is unitless.

$$COP = \frac{Q_L}{W}$$

$$COP = \frac{(2tons)\left(12,000\frac{Btu}{hr\cdot ton}\right)}{(1500W)\left(3.412\frac{Btu}{hr\cdot W}\right)} = 4.69$$

Answer A

46.64 A centrifugal pump consumes $200hp$ when operating at $1800rpm$. What is the electrical power demand when the pump speed is reduced to $1200rpm$? Assume 100% motor efficiency.

A. $44KW$

B. $59KW$

C. $66KW$

D. $89KW$

The motor output, typically expressed in *bhp*, is the input to the pump. Therefore, if the pump initially *consumes* $200hp$, this represents the motor output. Since the motor efficiency is assumed to be 100%, the motor's electrical power demand (input) is equal in magnitude to its *bhp* (output) and differs only in its units. Electrical power input is typically expressed in KW.

To account for the reduction in speed, the Pump Affinity Laws can be used to find the new power. Select the equation under the column "Speed Change" on the row "Horsepower." Let the subscript '1' denote the original operating conditions and '2' denote the new conditions. Substitute and solve for the new *bhp*.

$$bhp_2 = bhp_1 \left(\frac{N_2}{N_1}\right)^3 = (200hp)\left(\frac{1200rpm}{1800rpm}\right)^3 = 59.26hp$$

Since there are assumed to be no motor losses, simply convert the units of the output power from hp to KW to determine the electrical input power.

$$\dot{W} = 59.26hp\left(\frac{745.7W}{hp}\right)\left(\frac{1KW}{1000W}\right) = 44.2KW$$

Answer A