47.57 A pump running at $1750rpm$ delivers $250gpm$ and generates $150ft$ of head. What is the head generated by the pump after the impeller is trimmed by 25%, assuming the speed remains the same?

A. $84ft$

B. $113ft$

C. $150ft$

D. $267ft$

Use the Pump Affinity Laws for Impeller Diameter Change. Consider the original pump conditions as State 1 and pump attributes after modification as State 2. A 25% reduction in diameter retains 75% of the original diameter such that $\frac{D_2}{D_1} = 0.75$. The speed is unchanged and the volume flow rate is extra information. Selet the formula below and determine the head for the new conditions.

$$h_2 = h_1 \left(\frac{D_2}{D_1}\right)^2$$

$$h_2 = (150ft)\,(0.75)^2 = 84.4ft$$

Answer A

47.58 A pump is used to distribute $90°F$ water from an open tank at $5gpm$. The centerline of the pump is located $8ft$ above the surface of the water. The manufacturer's specifications state the inlet pressure for this arrangement must be at least $30psi$. What is the net positive suction head required?

A. $35ft$

B. $61ft$

C. $69ft$

D. $103ft$

Net Positive Suction Head Required, or $NPSH_R$, is always provided by the pump manufacturer. In this case, the manufacturer has provided the required inlet pressure, which is the same information given in psi rather than ft of head. The additional information in the problem statement will impact the net positive suction head *available*, but the net positive suction head *required* is purely a specification from the manufacturer. Simply convert the units from psi to ft. There is no need to add atmospheric pressure. The atmosphere may help contribute to the required head / pressure.

$$NPSH_R = (30psi)\left(2.31\frac{ft}{psi}\right) = 69ft$$

Answer C

47.59 A water-cooled chiller produces $500gpm$ of $45°F$ supply chilled water from $56°F$ return chilled water. The chiller has a coefficient of performance of 4.8. What is the load on the condenser?

A. $181tons$

B. $229tons$

C. $277tons$

D. $325tons$

Use the sensible cooling rule of thumb for water to determine the refrigeration effect, $\dot{Q}_{in}$.

$$\dot{Q}_{in} = 500gpm\Delta T_{CHW}$$

$$\dot{Q}_{in} = 500\,(500)\,(56-45) = 2,750,000\frac{Btu}{hr}$$

Use the Coefficient of Performance for a refrigeration cycle to determine the work done by the compressor.

$$COP_R = \frac{\dot{Q}_{in}}{\dot{W}_{in}}$$

$$\dot{W}_{in} = \frac{\dot{Q}_{in}}{COP} = \frac{2,750,000\frac{Btu}{hr}}{4.8} = 572,917\frac{Btu}{hr}$$

The condenser load is the total heat rejected by the condenser which is the sum of the heat absorbed by the evaporator and the compressor input energy. Calculate $\dot{Q}_{out}$. Convert units from $\frac{Btu}{hr}$ to $tons$.

$$\dot{Q}_{out} = \dot{Q}_{in} + \dot{W}_{in}$$

$$\dot{Q}_{out} = 2,750,000\frac{Btu}{hr} + 572,917\frac{Btu}{hr} = 3,322,917\frac{Btu}{hr}$$

$$\dot{Q}_{out} = 3,322,917\frac{Btu}{hr}\left(\frac{1ton}{12,000\frac{Btu}{hr}}\right) = 277tons$$

Answer C