Find the maximum deflection.

$$y = \frac{5Wl^4}{384EI} = \frac{5\left(0.426\frac{lb_f}{in}\right)(216in)^4}{384\left(29\times10^6\frac{lb_f}{in^2}\right)(0.666in^4)} = 0.625in$$

Answer D

45.12 The displacement of a hydraulic press is $3in^3$ per revolution and the pump speed is $1800rpm$. The hydraulic pressure is $600psig$. The positive displacement pump is 80% efficient and is driven by a 3-phase, 208V AC motor that is 95% efficient. The power factor is 0.9. What size circuit breaker should be selected to protect the system?

A. $20A$

B. $30A$

C. $40A$

D. $50A$

By default, it is common practice to apply the formulas for hydraulic horsepower based on rules of thumb. However, fundamentally the power produced by a pump is the product of the pressure added by the pump, ΔP, and the volume flow rate, Q. The other details are unit conversions and efficiencies. It is possible and occassionally necessary to build up the formulation from this fundamental concept, as with this problem.

Suppose hydraulic horsepower may be expressed simply as below, provided we address units and efficiencies later on.

$$WHP = \Delta P \times Q$$

In this case, the hydraulic pressure is generated entirely by the pump and ΔP may be taken as $600psi$. The volume flow rate is not given, however the displacement of the hydraulic press, i.e. volume, is given as well as the rotational speed. This can be developed into volume per unit time, i.e. volume flow rate.

Determine the hydraulic horsepower delivered. Convert units to KW for convenience in the subsequent step.

$$WHP = \left(600\frac{lb_f}{in^2}\right)\left(3\frac{in^3}{rev}\right)\left(1800\frac{rev}{min}\right)\left(\frac{1min}{60s}\right)\left(\frac{1ft}{12in}\right)\left(\frac{1hp}{550\frac{ft\cdot lb_f}{s}}\right)\left(\frac{0.7457KW}{1hp}\right) = 6.1KW(delivered)$$

Apply the pump and motor efficiencies to determine the electrical power consumed by the motor in producing the power which was delivered.

$$\dot{W}_{elec} = P_{KW} = \frac{WHP}{\eta_p\eta_m} = \frac{6.1KW}{(0.8)(0.95)} = 8.03KW(consumed)$$

Search for Power for Different Motor Phases and select the formula for specifying the current for a 3-phase motor where the power consumed in KW is known.

$$I_{amps} = \frac{P_{KW}\left(1000\frac{W}{KW}\right)}{\sqrt{3}V\,(pf)} = \frac{(8.03KW)\left(1000\frac{W}{KW}\right)}{\sqrt{3}\,(208V)\left(0.9\frac{W}{VA}\right)} = 24.8A$$

Select the circuit breaker the next size up. An undersized breaker will trip anytime the motor draws its full load current, therefore it is not appropriate to round down.

Answer B

45.13 $90°F$, 20% relative humidity air is cooled using a 75% effective evaporative cooler. What is the temperature of the air after being cooled?

A. $55°F$

B. $63°F$

C. $70°F$

D. $76°F$

The effectiveness of an evaporative cooler is given by the formula below where t_1 represents the entering air dry bulb temperature, t_2 represents the leaving air dry bulb temperature, and t_s' is the wet bulb temperature of the entering air. The wet bulb temperature is the minimum temperature which could theoretically be achieved in a 100% efficient evaporative cooler.

$$\varepsilon_e = \frac{t_1 - t_2}{t_1 - t_s'}$$

Use the Psychrometric Chart to find the wet bulb temperature of the entering air.

$$t_1 = 90°F$$

$$\phi = 20\%$$

$$t_s' = 62.8°F$$

Substitute into the effectiveness formula and solve for t_2.

$$0.75 = \frac{90°F - t_2}{90°F - 62.8°F}$$

$$t_2 = 69.6°F$$

Answer C