$$M \approx 2.6$$

Alternatively, use the equation from Isentropic Flow Relationships. Solve for M. Assume the ratio of specific heats $k = 1.4$.

$$\frac{P_0}{P} = \left(1 + \frac{k-1}{2}M^2\right)^{\frac{k}{k-1}}$$

$$M = \sqrt{\left(\frac{2}{k-1}\right)\left[\left(\frac{P_0}{P}\right)^{\frac{k-1}{k}} - 1\right]}$$

$$M = \sqrt{\left(\frac{2}{1.4-1}\right)\left[\left(\frac{300psia}{14.7psia}\right)^{\frac{1.4-1}{1.4}} - 1\right]} = 2.61$$

Answer B

47.55 A pump requires $120hp$ to transport $1400gpm$. What percent reduction in power will be realized when the flow rate is reduced to $800gpm$?

A. 19%

B. 33%

C. 67%

D. 81%

Reference the Pump Affinity Laws and use the equation for horsepower as a function of speed. Speed and volume flow rate are linearly proportional, therefore the ratio of the volume flow rates may be substituted for the ratio of the speeds.

$$\frac{Q_2}{Q_1} = \frac{N_2}{N_1}$$

$$bhp_2 = bhp_1\left(\frac{N_2}{N_1}\right)^3$$

$$bhp_2 = bhp_1\left(\frac{Q_2}{Q_1}\right)^3$$

Consider the original operating conditions as State 1, and the new conditions as State 2. Substitute and solve for the new power.

$$bhp_2 = (120hp)\left(\frac{800gpm}{1400gpm}\right)^3 = 22.4hp$$

Calculate the percent reduction relative to the original power.

$$\frac{(120hp - 22.4hp)}{120hp} = 81\%$$

Answer D

47.56 A fluid with a specific gravity of 1.1 is pumped by a $150hp$ pump which generates $300ft$ of head. What is the increase in pressure observed at the pump outlet?

A. $130psi$

B. $143psi$

C. $3300psi$

D. $20,600psi$

Refer to the section under the Bernoulli Equation. The change in pressure is essentially the head added by the pump converted from ft to psi, and after adjusting for the specific weight of fluids other than water, as is the case in this problem.

$$\Delta p = \gamma h$$

Head added by the pump, h, is given. The specific weight is a function of the Specific Gravity. Solve for γ and substitute into the original equation.

$$SG = \frac{\gamma}{\gamma_w}$$

$$\gamma = SG \cdot \gamma_w$$

$$\Delta p = SG \cdot \gamma_w h$$

Evaluate the increase in pressure, Δp, and convert units to psi.

$$\Delta p = (1.1)\left(62.4\frac{lb_f}{ft^3}\right)(300ft)\left(\frac{1ft^2}{144in^2}\right) = 143psi$$

Answer B