

**36.21** 10,000cfm of atmospheric air is compressed adiabatically to 40psia by a 70% efficient compressor. What brake horsepower is required to drive the compressor?

- A. 370hp
- B. 530hp
- C. 760hp
- D. 1060hp

Look up **Adiabatic Compression** and use the formula provided.

$$\dot{W}_{comp} = \frac{\dot{m}P_i k}{(k-1)\rho_i \eta_c} \left[ \left( \frac{P_e}{P_i} \right)^{1-\frac{1}{k}} - 1 \right]$$

The the problem statement gives a volume flow rate rather than a mass flow rate, recall that mass flow rate is the product of density and volume flow rate.

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

Substituting into the equation, the density cancels out. All other inputs are known. Substitute, and solve for  $\dot{W}_{comp}$ . Convert units to hp.

$$\dot{W}_{comp} = \frac{QP_i k}{(k-1)\eta_c} \left[ \left( \frac{P_e}{P_i} \right)^{1-\frac{1}{k}} - 1 \right]$$

$$\dot{W}_{comp} = \frac{\left(10,000 \frac{ft^3}{min}\right) \left(14.7 \frac{lb_f}{in^2}\right) (1.4) \left(\frac{144in^2}{ft^2}\right)}{(1.4-1)(0.7)} \left[ \left( \frac{40psia}{14.7psia} \right)^{1-\frac{1}{1.4}} - 1 \right] = 3.5 \times 10^7 \frac{ft \cdot lb_f}{min}$$

$$\dot{W}_{comp} = 3.5 \times 10^7 \frac{ft \cdot lb_f}{min} \left( \frac{1min}{60s} \right) \left( \frac{1hp}{550 \frac{ft \cdot lb_f}{s}} \right) = 1062hp$$

**Answer D**