12.46

12.46 A centrifugal pump provides a flowrate of 500 gpm when operating at 1750 rpm against a 200-ft head. Determine the pump's flowrate and developed head if the pump speed is increased to 3500 rpm.

For a given pump the effect of a change in speed on Q and h_a is given by Eqs. 12.36 and 12.37. Thus,

$$\frac{Q_1}{Q_2} = \frac{\omega_1}{\omega_2} \qquad \text{(Eq. 12.36)}$$

and with $Q_1 = 500\ gpm$, $\omega_1 = 1750\ rpm$, and $\omega_2 = 3500\ rpm$, then

$$Q_2 = \frac{\omega_2}{\omega_1} Q_1 = \frac{(3500\ rpm)}{(1750\ rpm)}(500\ gpm)$$

$$= \underline{\underline{1000\ gpm}}$$

Similarly,

$$\frac{h_{a_1}}{h_{a_2}} = \frac{\omega_1^2}{\omega_2^2} \qquad \text{(Eq. 12.37)}$$

so that with $h_{a_1} = 200\ ft$

$$h_{a_2} = \left(\frac{\omega_2}{\omega_1}\right)^2 h_{a_1} = \left(\frac{3500\ rpm}{1750\ rpm}\right)^2 (200\ ft)$$

$$= \underline{\underline{800\ ft}}$$

12.53

12.53 A certain axial-flow pump has a specific speed of $N_S = 5.0$. If the pump is expected to deliver 3000 gpm when operating against a 15-ft head, at what speed (rpm) should the pump be run?

Since

$$N_s = \frac{\omega\,(rad/s)\sqrt{Q\,(ft^3/s)}}{\left[g\,(ft/s^2)\ h_a\,(ft)\right]^{3/4}}$$

for $N_s = 5.0$, $g = 32.2\ ft/s^2$, $h_a = 15\ ft$, and with

$$Q = \frac{3000\ \frac{gal}{min}}{\left(7.48\ \frac{gal}{ft^3}\right)\left(60\ \frac{s}{min}\right)} = 6.68\ \frac{ft^3}{s}$$

it follows that

$$\omega\,(rad/s) = \frac{(5.0)\left[\left(32.2\ \frac{ft}{s^2}\right)(15\ ft)\right]^{3/4}}{\sqrt{6.68\ \frac{ft^3}{s}}}$$

$$= 199\ \frac{rad}{s}$$

Hence

$$\omega\,(rpm) = \frac{\left(199\ \frac{rad}{s}\right)\left(60\ \frac{s}{min}\right)}{2\pi\ \frac{rad}{rev}}$$

$$= \underline{\underline{1900\ rpm}}$$