Find whp. Note the formula is already arranged to produce horsepower units provided the input units are as shown. Therefore, it is not necessary to write the units as long they are known to be correct.

$$whp = \frac{Q_{[gpm]}\Delta P_{[psi]}}{1714} = \frac{(166.66)\,(34.7)}{1714} = 3.37hp$$

Apply the pump efficiency to solve for the bhp:

$$bhp = \frac{whp}{\eta} = \frac{3.37hp}{.9} = 3.74hp$$

Answer D

40.15 $20,000gpm$ **of water flows through a turbine in a hydroelectric power application. The inlet pressure is** $50psig$ **and the exit pressure is** $1atm$**. The turbines have an overall efficiency of 80%. What is the electrical capacity of the hydroelectric plant?**

A. $350KW$

B. $435KW$

C. $470KW$

D. $540KW$

A hydroelectric turbine performs the opposite function of a pump. Pumps consume mechanical *brake* horsepower and produce *hydraulic* horsepower; hydroelectric turbines consume *hydraulic* horsepower and produce *brake* horsepower — the power of a rotating shaft. Therefore, we can start by writing the formula for whp, then express the electrical power as a fraction of the whp. Any losses are accounted for by the efficiency of the turbine (and since it is an *overall* efficiency can be assumed to include any generators that may be part of the electricity producing system downstream.)

$$whp = \frac{Q_{[gpm]}\Delta P_{[psi]}}{1714}$$

$$P_{elec} = \eta_t \cdot whp$$

Since the inlet pressure was given as $50psig$ and the outlet pressure is atmospheric pressure, $\Delta P = 50psi$. The volume flow rate was given in gpm. Combine the two formulas above, substitute, solve, and convert to KW:

$$P_{elec} = \frac{\eta_t Q_{[gpm]}\Delta P_{[psi]}}{1714} = \frac{(.8)\,(20,000)\,(50)}{1714} = 466.7hp\left(\frac{.7457KW}{1hp}\right)$$

$$P_{elec} = 348KW$$

Answer A

40.16 A 1600rpm centrifugal pump with an 8in impeller requires 7.5bhp when delivering 250gpm of water at a head of 75ft. What is the new capacity when the impeller diameter is increased to 12in?

A. 250gpm

B. 305gpm

C. 375gpm

D. 560gpm

Make a table to organize the given information. Distinguish the two operational states as Case 1 and Case 2. There is more information about Case 1 than required to solve the problem. There's also more that could be specified about Case 2 than is necessary.

Case 1	Case 2
$n_1 = 1600rpm$	$n_2 = n_1$
$D_1 = 8in$	$D_2 = 12in$
$bhp_1 = 7.5hp$	
$Q_1 = 250gpm$	$Q_2 = ?$
$\Delta h_1 = 75ft\, H_2O$	

Look up pump affinity laws in the reference handbook and select the equation which relates volume flow rate and diameter. The relationship is linear; i.e. a 50% increase in the diameter of the impeller drives a 50% increase in the volume flow rate, provided all other parameters remain unchanged. Substitute and solve for Q_2:

$$\frac{Q_2}{Q_1} = \frac{D_2}{D_1} \rightarrow Q_2 = Q_1 \left(\frac{D_2}{D_1}\right)$$

$$Q_2 = (250gpm)\left(\frac{12in}{8in}\right) = 375gpm$$

Answer C