

Answer on Question #73313-Physics-Classical Mechanics

The pump raises water to $0.75\text{m}^3/\text{min}$ 6.0m deep well and gives the water a speed of 10 m/s. How much power pump motor takes if the operating efficiency is 0.75?

Solution

$$\frac{dV}{dt} = 0.75 \frac{\text{m}^3}{\text{min}} = \frac{0.75 \text{m}^3}{60 \text{ s}} = 0.0125 \frac{\text{m}^3}{\text{s}}$$

$$P_{out} = \frac{dE_{out}}{dt} = \frac{d}{dt} \left(mgh + \frac{mv^2}{2} \right) = \frac{dm}{dt} \left(gh + \frac{v^2}{2} \right) = \rho \frac{dV}{dt} \left(gh + \frac{v^2}{2} \right)$$

$$P_{in} = \frac{P_{out}}{\eta} = \frac{\rho}{\eta} \frac{dV}{dt} \left(gh + \frac{v^2}{2} \right)$$

$$P_{in} = \frac{1000}{0.75} (0.0125) \left((6)(9.8) + \frac{10^2}{2} \right) = 1800\text{W} = 1.8 \text{ kW}.$$

Answer: 1.8 kW.

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