33.40 A pump transports $3\,million\,gallons\,per\,day$ of oil with specific gravity 0.88 and generates $700ft$ of head. The pump turns at $1750rpm$ and is driven by $1000ft \cdot lb_f$ of torque. What is the efficiency of the pump?

A. 90%

B. 93%

C. 97%

D. 99%

Convert the flow rate into gpm.

$$Q = 3 \times 10^6 \frac{gal}{day}\left(\frac{1day}{24hrs}\right)\left(\frac{1hr}{60min}\right) = 2083gpm$$

Determine the hydraulic horsepower using the Water Horsepower that includes the specific gravity to account for the fluid being oil rather than water. The flow rate must be in gpm and the head must be in ft.

$$whp = \frac{Q\Delta h \cdot SG}{3960}$$

$$whp = \frac{(2083)\,(700)\,(0.88)}{3960} = 324hp$$

The Torque of a Motor is a related to the horsepower and speed in rpm according to the equation shown, which takes into account all unit conversions for convenience, provided torque is in $ft \cdot lb_f$. Rearrange to solve for bhp.

$$T_{[ft \cdot lb_f]} = 5250 \times \frac{bhp}{rpm}$$

$$bhp = \frac{T_{[ft \cdot lb_f]} \times rpm}{5250} = \frac{(1000)\,(1750)}{5250} = 333hp$$

Calculate the pump efficiency.

$$\eta_{pump} = \frac{whp}{bhp}$$

$$\eta_{pump} = \frac{324hp}{333hp} = 97.2\%$$

Answer C