A small centrifugal pump, when tested at 2875 rpm with water, delivered a flowrate of 252 gpm and a head of 138 ft at its best efficiency point (efficiency is 76%). Determine the specific speed of the pump at this test condition. Sketch the impeller shape you expect. Compute the required power input to the pump.

SOLUTION:

The dimensional specific speed is given by:

$$N_{sd} = \frac{\omega\ (\text{rpm})\sqrt{Q\ (\text{gpm})}}{\left[H\ (\text{ft})\right]^{3/4}}$$

Using the given data:

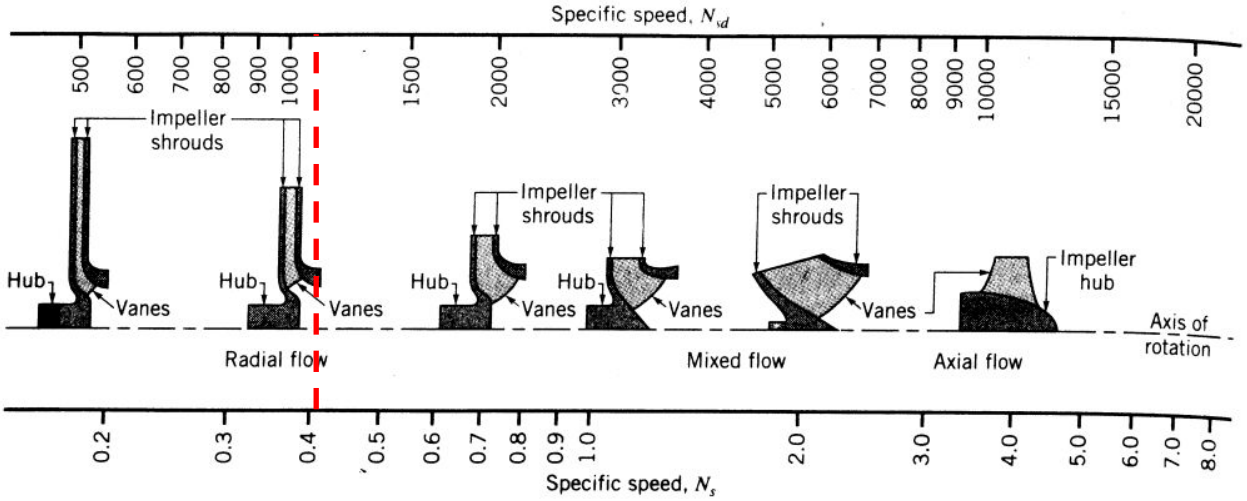
$$\boxed{N_{sd} = 1130\ \text{rpm}\cdot\text{gpm}^{1/2}/\text{ft}^{3/4}}$$

The dimensionless specific speed is:

$$N_s = \frac{N_{sd}}{2733\ \dfrac{\text{rpm}\cdot\text{gpm}^{1/2}}{\text{ft}^{3/4}}}$$

$$\boxed{N_s = 0.414}$$

The expected impeller shape is radial as shown in the figure below.



(Figure from Munson, B.R., Young, D.F., and Okiishi, T.H., *Fundamentals of Fluid Mechanics*, 3rd ed., Wiley.)

The power input to the pump is given by:

$$\dot{W}_{\text{shaft}} = \dot{W}_{\text{fluid}} / \eta_P$$

where

$\dot{W}_{\text{fluid}} = \dot{m}gH = \rho QgH$ (Note: 1 ft^3 = 7.48 gal, 1 hp = 550 lb$_f$·ft/s, and 1 lb$_f$ = 1 slug·ft/s^2.)

$\dot{W}_{\text{fluid}} = 8.80$ hp

$$\boxed{\dot{W}_{\text{shaft}} = 11.6\ \text{hp}}$$