Answer Key

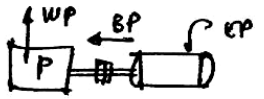
Pumps and Pipings

Total volume of the pool = 572 m3

$\eta_o = 60\% = \frac{WP}{BP}$

cost = ₱0.40/kw-hr

TDH = 55 m



$\eta_o = \frac{WP}{EP} * 100\%$

$WP = Q\gamma_w TDH = (572\ m^3)\left(\frac{1\ hr}{3600\ s}\right)\left(9.81\ \frac{kN}{m^3}\right)(55\ m)$

$WP = 85.7285\ kW$

Then;

$0.60 = \frac{85.7285\ kW}{EP}$

$EP = 142.8808\ kW$

Therefore;

$Total\ cost = \left(₱0.40/kw\text{-}hr\right)\left(142.8808\ kW\right)(1\ hr)$

Total cost = ₱57.1523

$N_s = 45$

$N = 610\ rpm$

$$Q = \left(0.015\ m^3/s\right)\left(\frac{1000L}{1m^3}\right)\left(\frac{1gal}{3.78L}\right)\left(\frac{60s}{1min}\right) = 238.0952\ gpm$$

from;

$$N_s = \frac{N\sqrt{Q}}{h^{3/4}}$$

$$45 = \frac{610\ rpm\sqrt{238.0952\ gpm}}{h^{3/4}}$$

$$\boxed{h = 1241.6243\ m}$$

$$\frac{BP_1}{BP_2} = \left(\frac{N_1}{N_2}\right)^3$$

$$N_2 = N_1 - 0.45N_1$$

$$N_2 = 0.55N_1$$

$$\frac{30\,kW}{BP_2} = \left(\frac{N_1}{0.55N_1}\right)^3$$

$$BP_2 = 4.99125\,kW$$

$$\%\,Decrease = \frac{BP_1 - BP_2}{BP_2} = \frac{(30 - 4.99125)\,kW}{30\,kW}$$

$$\%\,Decrease = 83.36\,\%$$

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$$

$$\frac{25\,m}{H_2} = \left(\frac{400\,rpm}{1100\,rpm}\right)^2$$

$$H_2 = 189.0625\,m$$

$$\text{increase in head} = \Delta H = (189.0625 - 25)\,m$$

$$\boxed{\Delta H = 164.0625\,m}$$

$$Q = A v$$

$$Q = \frac{\pi d^2}{4} v = \frac{\pi (0.070\ m)^2}{4} (20\ m/s) = 0.07697\ m^3/s$$

$$WP_{jet} = Q \gamma h_v$$

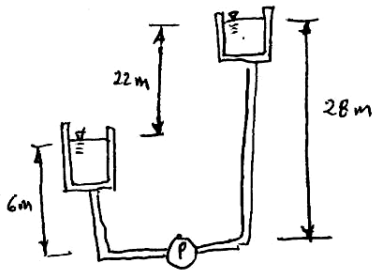
$$h_v = \frac{1}{2} \frac{v^2}{g_0} = \frac{1}{2} \frac{(20\ m/s)^2}{9.81\ m/s^2} = 20.3874\ m$$

$$WP_{jet} = (0.07697\ m^3/s)(9.81\ kN/m^3)(20.3874\ m)$$

$$WP_{jet} = (15.394\ kw)\left(\frac{1\ hp}{0.746\ kw}\right)$$

$$\boxed{WP_{jet} = 20.6354\ hp}$$

11



$$\eta_p = \frac{WP}{BP}$$

$$TDH = (z_2 - z_1) + \frac{1}{2}\left(\frac{v_2^2 - v_1^2}{g_o}\right) + \left(\frac{P_2 - P_1}{\gamma_w}\right) + h_L$$

$$P_1 = \left(-2.3\ psi\right)\left(\frac{101.325\ kPa}{14.7\ psi}\right) = -15.8536\ m$$

$$Q = A_1 v_1 \qquad Q = A_2 v_2$$

$$0.02\ m^3/s = \frac{\pi (0.065\ m)^2}{4} v_1 \qquad 0.02\ m^3/s = \frac{\pi (0.053\ m)^2}{4} v_2$$

$$v_1 = 6.0272\ m/s \qquad v_2 = 9.0654\ m/s$$

$$TDH = (22m) + \frac{1}{2}\left(\frac{9.0654^2 - 6.0272^2}{9.81\ m/s^2}\right)m^2/s^2 + \left(\frac{260 + 15.8536)m}{9.81\ kN/m^3}\right) + 2.3m$$

$$TDH = 54.7568\ m$$

then;

$$WP = Q\gamma TDH = \left(0.02\ m^3/s\right)\left(9.81\ kN/m^3\right)\left(54.7568\ m\right)$$

$$WP = 10.7433\ kw$$

subst;

$$0.78 = \frac{10.7433\ kw}{BP}$$

$$BP = \left(13.7734\ kw\right)\left(\frac{1\ hp}{0.746\ kw}\right)$$

$$BP = 18.4630\ hp$$

$$\eta_p = \frac{WP}{EP} * 100\%$$

$$WP = Q \gamma TDH = \left(0.4 \frac{m^3}{s}\right)\left(9.81 \frac{kN}{m^3}\right)(110\,m)$$

$$WP = 431.64\,m$$

subst;

$$0.75 = \frac{431.64\,m}{EP}$$

$$EP = 575.52\,kW$$

$$WP = 6\gamma\ TDH$$

$$= \left(1200\ \frac{gal}{min}\right)\left(\frac{1\ min}{60s}\right)\left(\frac{3.78\ L}{1\ gal}\right)\left(\frac{1\ m^3}{1000\ L}\right)\left(9.81\ \frac{kN}{m^2}\right)(120\ ft)\left(\frac{1\ hp}{3.28\ ft}\right)$$

$$WP = (27.1330\ kw)\left(\frac{1\ hp}{0.746\ kw}\right)$$

$$WP = 36.3713\ hp$$

$Q = 4800\ gal/min$

$SG = 0.80$

$TDH = 120\ ft = 36.5854\ m$

$\eta_c = 65\%$

$\eta_M = 80\%$

$$WP = Q\gamma TDH$$

$$= \left(4800\frac{gal}{min}\right)\left(\frac{3.78\ L}{1\ gal}\right)\left(\frac{1\ m^3}{1000\ L}\right)\left(\frac{1\ min}{60\ s}\right)(0.80)\left(9.81\ kN/m^3\right)(36.5854\ m)$$

$$WP = (86.8258\ kW)\left(\frac{1\ hp}{0.746\ kW}\right) = 116.3884\ hp$$

Then,

$$\eta_c = \frac{WP}{EP}$$

$$0.65 = \frac{116.3884\ hp}{EP}$$

$$EP = 179.0591\ hp$$

Hence,

$$\eta_M = \frac{BP}{EP}$$

$$0.85 = \frac{BP}{179.0591\ hp}$$

$$\boxed{BP = 152.2002\ hp}$$