Clean Energy Technology Open-Ended Project

REPORT 2019

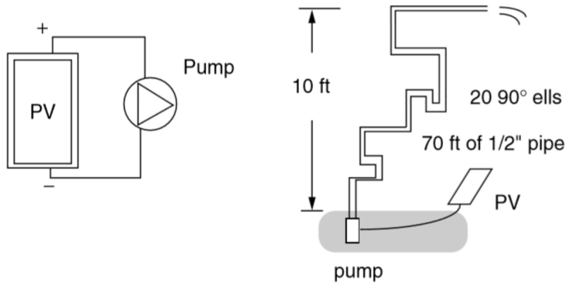
Meraj Ali Shah

Department of Mechanical Engineering, NEDUET, Karachi.

Sumaika Khan

Department of Mechanical Engineering, NEDUET, Karachi

A PV module is directly connected to a water pump that needs to raise water 10-ft high through 70 ft of 0.5” plastic tubing with twenty 90◦ ells



The pump curves of head H versus flow Q as a function of input voltage are shown in Figure P9.15b & hour-by-hour I –V curves for the PV module are shown in Figure P9.19c along with the pump I –V curve.

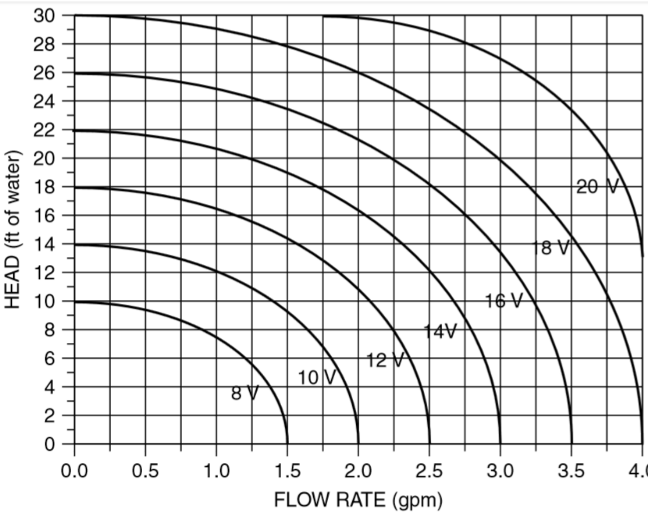


Figure P9.15b Pump curves.

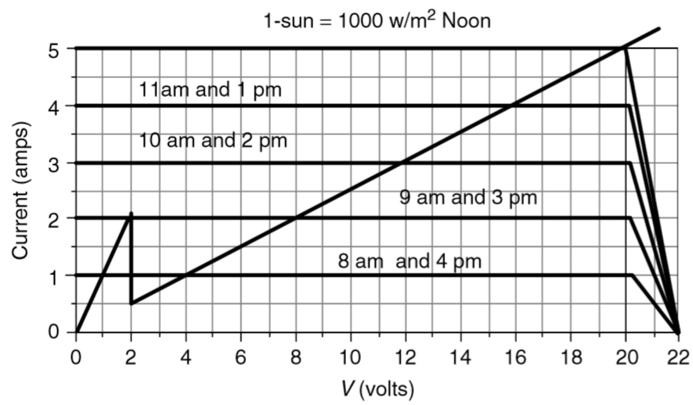


Figure P9.15c

Using Table 9.19, find the equivalent length of the pipe and ells to create a hydraulic system curve similar to that in Figure 9.56. Remember to include the 10 feet of static head. Plot that system curve on top of the pump curves in Figure P9.15b. Now find the hour-by-hour pumping rate Q (gpm) that will result.

Q (gpm)	$\Delta h_f/L$ (ft of water/ft of pipe)
1	$1.4(10^{-2})$
2	$4.8(10^{-2})$
3	$10.0(10^{-2})$
4	$17.1(10^{-2})$
5	$25.8(10^{-2})$
6	$36.3(10^{-2})$
8	$63.7(10^{-2})$
10	$97.5(10^{-2})$

Table 9.17

(OR) $\frac{\Delta h_f}{L} = 5.74(10^{-3})Q + 9.19(10^{-3})Q^2$

Curve fit of the table data

Q is in gpm & $\Delta h_f/L$ in ft of water/ft of pipe

Solution:

Equivalent Length of pipe:

Using table 9.19, for 90◦ ells, equivalent length for 1/2” diameter plastic pipe is **1.5ft.**

L_{eq}=70 + 20x1.5 ft

L_{eq}=100 ft Ans.

Hydraulic system resistance curve:

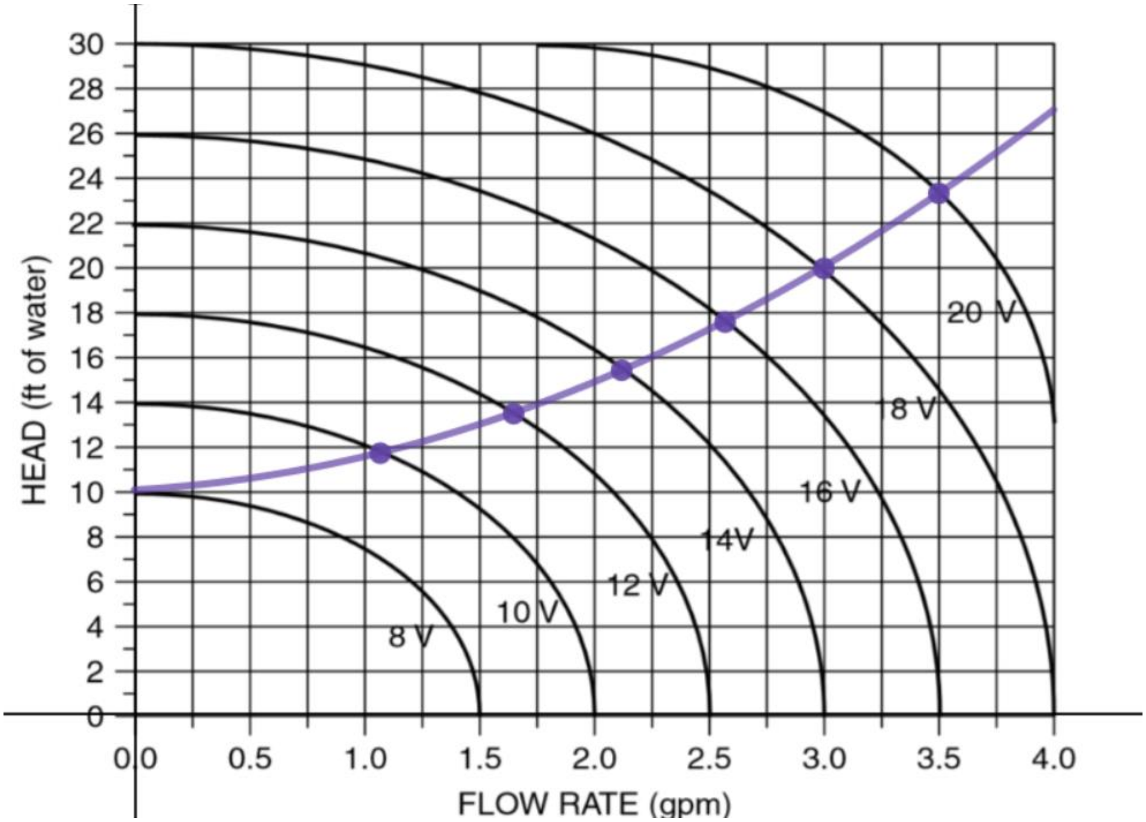
$h_{sys} = \Delta z + h_{loss}$

$h_{sys} = \Delta z + L_{eq} \times (\frac{\Delta h_f}{L})$

$h_{sys} = 10 + 100 \times \{5.74(10^{-3})Q + 9.19(10^{-3})Q^2\}$

$h_{sys} = 10 + 0.574Q + 0.919Q^2 ----------(1)$ Ans.

Now, eq (1) can be plotted on top of pump performance curve,



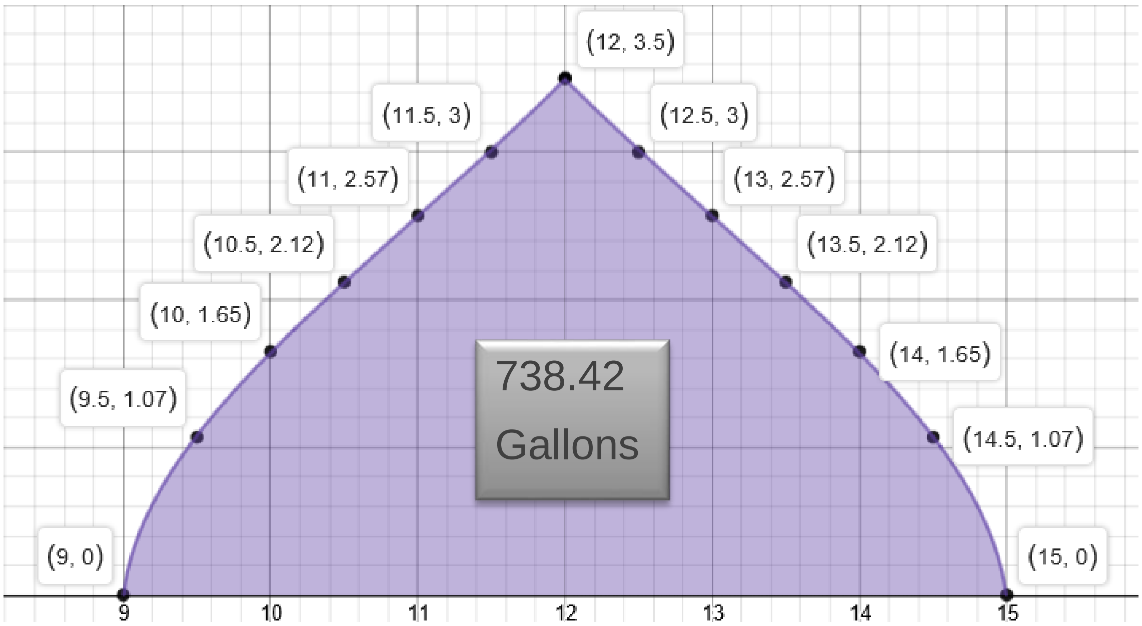
The above graph can be seen on **https://goo.gl/T3P7T4**

By looking at the PV I–V curves and pump/system H–Q curves we can say that the pump will start at 9 am (8volts). We can extract the following details

Time	Voltage	Flowrate,Q (gpm)
9:00 am	08	0
9:30 am	10	1.07
10:00 am	12	1.65
10:30 am	14	2.12
11:00 am	16	2.57
11:30 am	18	3
12:00 am	20	3.50
12:30 pm	18	3
1:00 pm	16	2.57
1:30 pm	14	2.12

2:00 pm	12	1.65
2:30 pm	10	1.07
3:00 pm	08	0

Plotting these flowrates against time



Using curve fitting and numerical integration(https://goo.gl/ZExAad) the area is approximated to be **738.42 Gallons** each day.