

Power for Water Pumping

The power required to pump water is proportional to the flow rate and to the pressure against which the pump is working. This pressure is usually expressed in terms of the "head," which has two contributions: (1) the height that the water must be pumped from groundwater level, and (2) an extra contribution, called the "friction head," due to friction in the pipes retarding the flow of water. A fairly accurate value for the power required can be calculated using the formula:

$$\text{Power} = 0.00025 \times \frac{G}{E_p} \times (WH + FH),$$

where

- G = water flow rate in gallons per minute;
- E_p = mechanical efficiency of the water pump;
- WH = water head—the vertical height in feet from groundwater level to tank inlet; and
- FH = friction head in feet.

This formula gives you the power in units of horsepower; to get the answer in watts, multiply by 746.

This equation is meant to work with the average flow rate and to give you the average power required by the pump. One simple way to establish an average flow rate is to estimate your need for water, expressed in gallons, and divide this need by the number of hours you expect the wind to produce usable power during the same time period. Do this on a daily, weekly or monthly basis—depending on the results of your wind survey. To get the flow rate in gallons per minute, then, use the formula:

$$G = \frac{\text{Gallons Needed}}{60 \times \text{hours of wind}}$$

Friction losses depend on the pipe length L (in feet), the pipe diameter D (in inches), the number N of pipe joints and corners, and the flow rate G . The formula for friction head FH is:

$$FH = \frac{L \times G^2}{1000 \times D^5} + 2.3 \times N.$$

The pipe length L includes all pipes down in the well, across the pasture, and up the hill or into the tank. If pipe diameter changes along the way, as it usually does, this formula must be used separately for each different length of pipe, and the results added together to get the total friction head.

Example: Suppose the depth of water in a well is 100 feet below the ground level. A 3-inch pipe brings this water to the surface. The water passes through one elbow joint and into a 1-inch diameter pipe running 200 feet along the ground, then through a second elbow joint and up 14 feet before passing through a third elbow and into the tank. Suppose the farmer needs 2700 gallons of water per day and there are an average of 6 hours of usable wind per day. How many watts of wind power must be supplied to a water pump with 75 percent efficiency?

Solution: The average flow rate needed is

$$G = \frac{2700}{60 \times 6} = 7.5 \text{ gallons/min.}$$

The friction head in the 3-inch pipe is

$$FH = \frac{100 \times 7.5^2}{1000 \times 3^5} + (2.3 \times 1) \\ = 2.3 \text{ feet.}$$

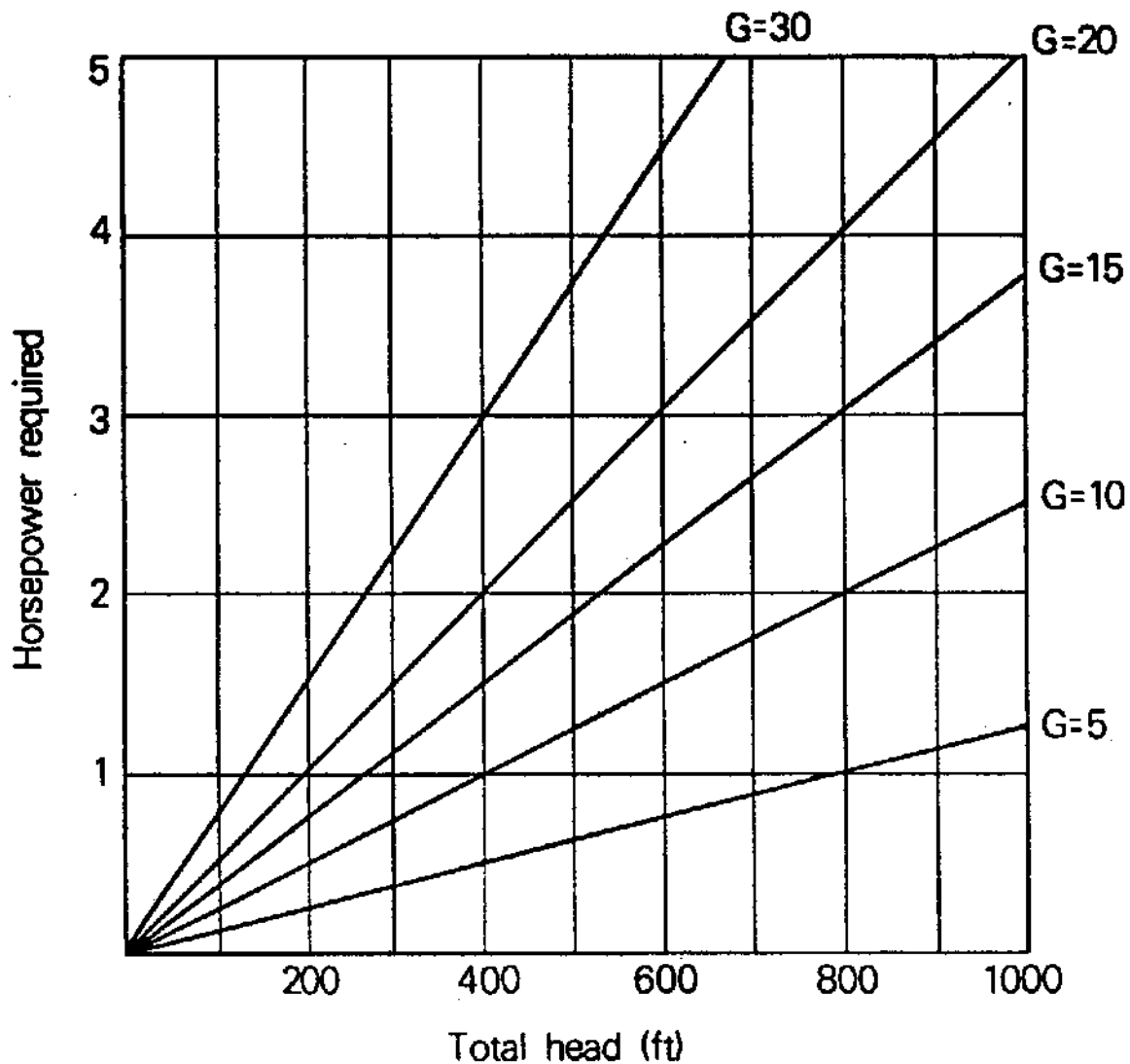
The friction head in the 1-inch pipe is

$$FH = \frac{214 \times 7.5^2}{1000 \times 1^5} + (2.3 \times 2) \\ = 16.6 \text{ feet.}$$

The total friction head is the sum of these two contributions or $FH = 18.9$ feet. Then the pump power required is

$$\text{Power} = 0.00025 \times \frac{7.5}{0.75} \times (114 + 18.9) \\ = 0.33 \text{ hp.}$$

To get the answer, you just multiply by 746, so the power requirement is 246 watts.



Pump power needed to lift water at a flow rate G , in gallons per minute. To get the wind power needed to drive the pump, divide by the pump efficiency—about 70 percent.