Irrigating Smart
Conserves Water
Saves Money
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Irrigation Pumping Plant Efficiency Testing

Pump Efficiency

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This publication includes a definition of pump horsepower, an explanation of pump efficiency and information about how to calculate those values.

Efficiency Significance

Selecting a proper pumping system will conserve fuel or electricity and decrease the annual pumping costs. Inefficient and poorly chosen pumping systems can increase annual costs dramatically. There also is a possibility excessive wear will occur on the pumping plant, and water may be wasted.

Pump Efficiency

Pump efficiency is defined as the ratio of water horsepower output from the pump to the shaft horsepower input for the pump. Water horsepower is determined by the flow rate and pressure delivered from the pump. The shaft horsepower is delivered to the pump from the power unit, which usually is an electric motor or internal combustion engine.

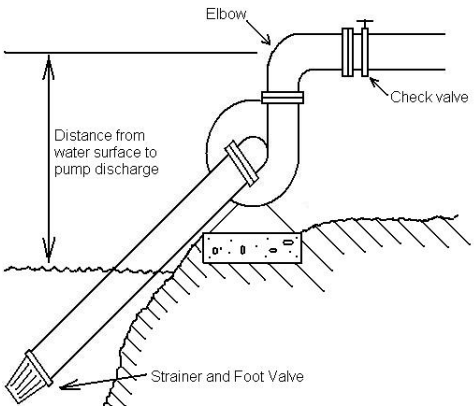
If a pump was 100 percent efficient, the mechanical horsepower input would be equal to the water horsepower output by the pump. No pump is 100 percent efficient, so the mechanical horsepower input will be greater than the water horsepower output. Lower efficiencies are due to energy losses caused by friction, leakages originating from pressure differentials within the pump case and losses due to a more complex nature.

The efficiency of a particular pump is estimated by determining two values. These values are pump flow rate and total head.

Total Head

Total head is determined by measuring the distance from the source water surface to the output of the pump, as well as the pressure the pump is producing at the pump outlet. If this value is measured for a centrifugal pump, the distance from the water surface to the pump outlet needs to be measured as indicated in the following diagram.

Centrifugal pump



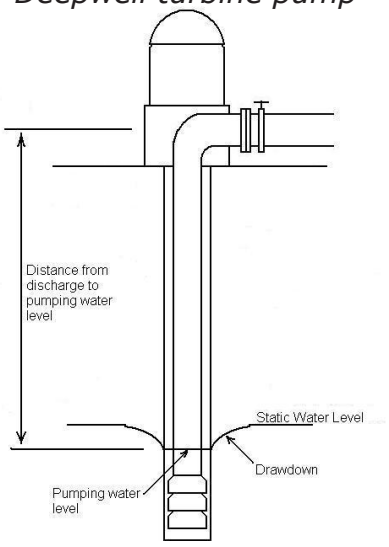
In addition, the pressure at the pump outlet also needs to be measured. The total head can then be determined by knowing that 2.306 feet of water is equal to 1 pound per square inch of pressure (psi). For example, if the distance from the water surface to the pump outlet was 8 feet and the pressure measured at the pump outlet was 60 psi, the total pressure head would be:

$H = 8 + 60 \bullet 2.306 = 146.4$ feet

Total head can be determined for a deep well turbine pump, as well. Again, the distance from the pumped water surface to the pump outlet must be measured (See the following diagram.). There will always

be a drop from the static water surface to the pumped water surface. The pressure that is delivered at the pump outlet also is measured.

Deepwell turbine pump



For example, if the distance from the pumped water surface to the pump outlet was 134 feet and the pressure measured at the pump outlet was 60 psi, the total pressure head would be:

$$H = 134 + 60 \bullet 2.306 = 272.4 \text{ feet}$$

Flow Rate

Flow rate is the total water volume that passes through a fixed point over time. Flow rate can be measured using a flow meter. Numerous flow meters are available, but an ultrasonic flow meter usually is the most convenient flow meter to use.

This flow meter can be programmed to read flow rate in whatever units are required, but gallons per minute usually is the measurement used.

Ultrasonic flow meter

Determining Pump Efficiency

Water horsepower can be calculated by using this formula:

$$WHP = \frac{HQ}{3960}$$

Where H is the total head of the water in feet and Q is the flow rate in gallons per minute. For example, if the flow rate for the previous centrifugal pump was 654 gpm, the water horsepower for the pump would be:

$$WHP = \frac{146.4 \text{ x } 654}{3960} = 24.2\ WHP$$

If the same flow rate was used for the previous turbine pump example, the water horsepower would be 44.98 WHP.

Pump input horsepower is determined by measuring the speed and torque of the motor shaft input to the pump.

Once these two values have been determined, pump efficiency is a simple calculation that can be determined by this formula:

$$\eta = \frac{hp_{water}}{hp_{of\ pump}}$$

If the horsepower input to the previous centrifugal pump example was 33 horsepower, the pump efficiency would be:

$$\eta = \frac{24.2}{33} = 0.73 \text{ or } 73\%$$

It should be noted that this document outlines the procedures for determining pump efficiency only. Operators may want their pumping unit efficiency to be evaluated for the complete unit. If so, the efficiency of the motor or engine will be included, and the overall efficiency will be lower than pump efficiency.

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