Water for Profit

PUMP EFFICIENCY CENTRIFUGAL SYSTEMS - ELECTRIC

WATERFORPROFIT

Pumping efficiency tests completed as part of system auditing within the Rural Water Use Efficiency Initiative found that many systems are operating inefficiently and costing growers more than is required.

Introduction

There are a number of reasons for inefficient operating:

- worn impellers
- poor pump selection
- improper motor size
- changes in application systems.

This Water for Profit sheet provides information enabling you to determine how efficiently your pump is currently operating.

What is pump efficiency?

Represented as a percentage, pump efficiency is a measurement of how well a pump converts power input into water delivery.

Pump efficiency = water power output ÷ power input

When the irrigation system was originally designed, a pump would have been chosen to provide sufficient head pressure, including friction losses, so that the sprinkler located at the highest point in the irrigation block operated at the correct pressure.

Pump curves

To obtain a pump curve from an irrigation supplier or the manufacturer, so that comparisons can be made against pump specifications, you will need the following information, which is located on the motor specification plate and the pump impeller bowl:

- Motor specifications (Hp/kW, RPM)
- Make, size and type of pump (e.g. Southern Cross, 100x60x250 centrifugal)

Also take note of how the pump is driven (e.g. v-belt, flat belt, direct).

Water power output

Total Dynamic Head (TDH)

The sum of suction line friction (m), static lift (m) and pump discharge operating pressure (m).

Suction line friction and static lift

For a centrifugal pump positioned above the water source, measure the vertical height between the water surface and the centre line of the pump (static lift) and determine friction loss from the screen to centre line of pump, OR alternatively use a vacuum pressure gauge on the suction side of the pump.

Example: 6 metres of 150 mm PVC with a hinged disc foot valve, pump is 2 metres above the water surface at a flow rate of 34 L/sec.

Suction line friction:

- 150 mm PVC pipe – 0.0256 m/m x 6 = 0.15 m
- Foot valve – 0.278 m

Static lift: 2 m

Suction Loss: 0.15 + 0.278 + 2 = 2.428 m

Pump discharge operating pressure

Measure using a suitably sized gauge, pressure range, installed on the discharge side of the pump. Example: 330 kPa (33.6 metres).

To convert psi to metres of head multiply by 0.70284

To convert kPa to metres of head multiply by 0.10194

Example: TDH equals 2.428 + 33.6 = 36.028 m.

The pressure (TDH) generated by the pump should provide sufficient pressure at the discharge point (sprinkler) in addition to the complete vertical lift and all friction losses.

Water discharge (Q)

Measure flow using a water meter. To obtain good readings the water meter needs to be positioned on the discharge side according to design specifications. If the closest that you are able to locate the meter is in the paddock at a hydrant point then check all mains and hydrants for leaks.

The majority of water meters are rotating units with black and red coloured numbers. The black numbers are whole megalitres or kilolitres and the red are part there of.

Example: 1 hour pumping duration

Start	Finish	Total
556900000	557022400	122400

122 400 litres/hour ÷ 3600 = 34 litres / second (Q).

Measuring flow rate without a water meter

If no water meter is available then measure discharge from individual sprinklers using a hose, bucket and stopwatch.

By timing the period it takes to fill a bucket you can determine discharge rate from individual sprinklers. The more sprinklers that you record the more accurate the discharge rate measurement will be.

Average the flow rates measured and then multiply by the number of sprinklers operating.

Power Input

Electricity (kW)

Systems measuring large amounts of electrical energy are geared to rotate slower and will have a multiplier number marked as 'M' on the face of the meters.

Multiple disc meters

Pumps operating on a three-phase power supply will use three individual disc meters.

The kilowatt load or demand of a pumping unit can be measured reasonably accurately by observing the time taken for the kWh meter discs to rotate a specific number of revolutions.

Using a stopwatch record the time taken for you to count a predetermined number of disc revolutions per meter.

(kW) = (R ÷ t) x (3600 ÷ c)

Example:

R – Sum of all revs counted (150 – 50 revs/meter)

t – Time taken in seconds (93 seconds)

c – Revs/kW marked on meter face (266.6)

(150 ÷ 93) x (3600 ÷ 266.6) = (1.612 x 13.5) = 21.7.

Digital meter

Digital meters are becoming more common as systems are upgraded or newly installed.

The meter scrolls continuously, displaying each screen for 9 seconds so don't panic if you miss a reading.

Record an initial reading from the total value and then after a predetermined amount of time record the new value.

Take note when watching the meter to make certain that the pump is operating on the correct rate.

Please select which is appropriate for the following.

Motor Efficiency (Me)

Depending on the size of the motor determine which decimal factor to use. Refer to Motor Specifications.

10 – 22 kW	0.88
22 – 55 kW	0.90
55 – 75 kW	0.92

Drive factor (Df)

How the motor drives the pump determines drive loss. Select the appropriate decimal factor:

Drive Type	Loss Factor
V-Belt	0.93
Direct	1.0
Flat belt	0.88

Pumping efficiency calculation

Once the relevant data has been collected a calculation can be completed to determine pumping efficiency.

Pump efficiency = water power output ÷ power input

Water power output: 0.98 x Q x TDH

Power input: kW x Me x Df

Example: The motor is rated at 22 kW so use Me of 0.9 and it is direct drive so Df is 1.0.

Pump Efficiency = 0.98 x 34 x 36.028 ÷ 21.7 x 0.9 x 1.0 = 1200.45 ÷ 19.53 = 61.46%.

To determine how efficiently the pump is operating refer to a manufacturer's pump performance curve to determine maximum efficiency available.

After following this process the pump efficiency is only 61.46% but according to the pump curve its maximum attainable efficiency is 68% meaning the pump is not too bad but was perhaps inefficient to start with.

- Benchmark recommendation pump efficiency is 70%
- Majority of pumps should achieve 75%.

Note: The test that you have completed is for a specific point in time and particular irrigation block. Pumping efficiency will change as a result of water level fluctuation and the topography of individual irrigation blocks being tested at the time.

Assistance from National Centre for Engineering in Agriculture / University of Southern Queensland staff and New South Wales Agriculture is gratefully acknowledged in compiling this information sheet.

For more details contact Growcom on 07 3620 3844.

A Growcom project conducted in collaboration with the Queensland Department of Agriculture, Fisheries and Forestry and the National Centre for Engineering in Agriculture with funding provided by the Queensland Government's Rural Water Use Efficiency Initiative.

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