# Water for Profit

## PUMP EFFICIENCY CENTRIFUGAL SYSTEMS - DIESEL

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 efficient 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 surface pump positioned above the water source visually measure the vertical height between the water surface and the centre of the pump (static lift) and determine friction loss between the screen and 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 50L/sec.

Suction line friction:

- 150mm PVC pipe – 0.049 m/m x 6 = 0.294 m
- Foot valve – 0.568 m

Static lift – 2 m

Suction Loss – 0.294 + 0.568 + 2 = 2.862 m.

***Pump discharge operating pressure***

Measure using a suitably sized gauge, pressure range, installed on the discharge side of the pump. Example: 550 kPa (56 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 2.862 + 56 = 58.862 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)***

Measuring 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 | 557080000 | 180000 |

180 000 litres ÷ 3600 = 50 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 multiply by the number of sprinklers operating.

## Power input

*Diesel consumption- l/hour*

There are three ways to determine fuel consumption.

- ideally a flow meter is in the delivery line and is accurately measuring fuel consumption
- you could take before and after dip stick readings to gauge an approximate consumption
- as long as the diesel is not used for any other purpose then a long term reading could be established against pump operating times.

Example: 1 hour pumping duration

| Start | Finish | Total |
|---|---|---|
| 450 litres | 435 litres | 15 litres / hour |

*Specific Fuel Consumption - kWh/l*

From exhaustive study and research of diesel motor curves and manufacturers' specification we will use an average figure of 3.33 kWh / litre for this calculation.

Please select which is appropriate for the following

*Derating factor (ASL)*

| Metres above sea level | Derating factor |
|---|---|
| 0 -200 | 0.99 |
| 200 - 400 | 0.98 |
| 400 - 600 | 0.97 |
| 600 - 800 | 0.96 |
| 800 - 1000 | 0.95 |

*Drive factor (Df)*

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

| Drive Type | Loss Factor |
|---|---|
| Flat belt | 0.88 |
| V-belt | 0.93 |
| Right angle gear drive | 0.95 |
| Direct | 1.0 |

*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: 1/hour x kWh/1 x Df x ASL

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 50 x 58.862 ÷ 15 x 3.3 x 0.95 x 0.97 = 2884.23 ÷ 46.1 = 62.5%

For the example we used a right angle gear drive at 0.95 and we were 560 metres above sea level 0.97.

To determine how efficient 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% 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%.

*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.*

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For more details contact Growcom on 07 3620 3844.



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