Pump Efficiency Worksheet

IRRIG8Quick

What is the Irrigation Quick Test about?

The purpose of this Irrigation Quick Test is to determine the energy efficiency of the motor and pump combination feeding the irrigation system.

IRRIG8Quick is designed so irrigation managers can do testing and calculations themselves. As well as this worksheet, a guideline is available to assist.

Determining Performance

The effective efficiency of your pump and motor combination can be estimated from power readings, flow rates and pressures. The information should be easy to obtain, and calculations needed are included in the tables and explained in the Guidelines.

What needs to be done?

1 Gather information about the system
2 Record the data on the worksheet
3 Calculate answers using the worksheet & guide

When should testing be done?

Complete the efficiency test when commissioning a new system and after any major changes to the pump or irrigation system.

Testing should be repeated as part of system checks at the start of every season. Compare with past results to identify slippage or failures.

Equipment you will need

- This worksheet and the guidelines
- Stop watch
- Measuring jug (for fuel tank topping)
- Pressure gauge
- Tape measure
- Pen or pencil

Field measurements

- Test duration
- Power meter readings
- Fuel used
- Water meter readings
- Pressure generated
- Height from water level to pump outlet

Step 1: Energy Use

For each pump, calculate energy use rate in kW. Add energy use rates of multiple pumps to get the total.

A Electricity meters show energy consumption in kilowatt hours (kWh). Include any 'multiplier value'.

Divide kilowatt hours consumed by hours taken to calculate the kilowatts. (kWh / h = kW).

B Diesel and petrol engine fuel use must be converted to kWh equivalent values.

Step 2: Water Consumption

Follow Step 2 to record and calculate water use.

If no meter: Determine flow rate by doing an IRRIG8Quick irrigation calibration.

Step 3: Rate of Work Done

The rate of work done by a pump is calculated from the water flow rate, lift (change in elevation x specific gravity) and increase in Pressure Head.

Elevation Head (lift)
Elevation head is the lift from drawn down water level to centre of pump outlet. Usually positive, but negative if water level is higher than the pump.

Specific Gravity (SG) accounts for the force of gravity. Divide by 3600 to convert flow/hour to flow/second.

Pressure Head Increase
If there is positive head on the intake from a primary pump, subtract it to get pressure generated by pump.

If possible, add the intake pipe friction determined using the IRRIG8 Delivery System Efficiency test.

Outlet Pressure
Read directly from a pressure gauge at pump outlet. Ensure gauge is in good condition. Replace it if not.

Step 4: Pump Efficiency

Shows how much of the energy consumed does useful work. It is usually given as a percentage.

Relative Performance
Select a reasonable value for your situation from Guidelines Table 1 and compare it with the calculated efficiency for your actual pumping plant. The relative performance is usually given as a percentage.

Efficiency Cost
The potential savings are calculated from the annual cost and the relative performance value determined.

Worksheet for IRRIG8Quick Pump Efficiency Test

Enter times, meter readings, elevation and pressure data. Complete the calculations as directed. Enter information using the measurement units (e.g. kWh or metres) specified to ensure calculated answers have the correct units.

Step 1 A: Electricity

		Pump 1	Pump 2
a	Test Duration (hours)		
b	Meter kWh Start		
c	Meter kWh End		
d	Meter kWh Used [c – b]		
e	Meter Multiplier		
f	Energy Used / Hour (kW) [d x e / a]		
g	Energy Cost ($ / kWh)		
h	Annual Run Time (h)		
i	Annual Energy Use (kWh) [f x h]		
k	Annual Energy Cost ($ pa) [g x j]		

Step 1 B: Fossil Fuel

		Pump 1	Pump 2
a	Test Duration (hours)		
b	Fuel Used (L)		
c	Energy Conversion (kWh/L) [from Table 1]		
e	Fuel Cost ($/L)		
f	Energy Used / Hour (kW) [b x c / a]		
g	Energy Cost ($ / kWh) [e / f]		
h	Annual Run Time (h)		
j	Annual Energy Use (kWh pa) [f x h]		
k	Annual Energy Cost ($ pa) [g x j]		

Step 2: Water Use

a	Test Duration (hours)	
b	Meter m³ Start	
c	Meter m³ End	
d	Meter m³ Used [c – b]	
e	Meter Multiplier	
f	Water Used (m)³ [d x e]	
g	Water Flow Rate (m³/h) [f / a]	
h	Annual Run Time (h)	
j	Annual Water Use (m³ pa) [g x h]	

Step 3: Work Done

a	Elevation Change (m)	
b	Elevation Head (kPa) [a x SG]	
c	System Intake Pressure (kPa)	
d	Pump Outlet Pressure (kPa)	
e	Pressure Head (kPa) [d – c]	
f	Inlet-side Friction (kPa) [from Delivery Efficiency Worksheet]	
g	Total Dynamic Head (kPa) [b + e + f]	
h	Water Flow Rate (m³/h) [g from Step 2]	
j	Work Done (kW) [g x h / 3600]	
k	Design Outlet Pressure (kPa) [from Design Details]	
m	Outlet Pressure Deviation (kPa) [d – k]	
n	Outlet Pressure Deviation % [m / k x 100]	

Step 4: Pump Efficiency

a	Electric Power(kW) [from Step 1 A: f]	
b	Fossil Fuel Power (kW) [from Step 1 B: d]	
c	Total Power (kW) [a + b]	
d	Work Done (kW) [from Step 3: j]	
e	Overall Pump Efficiency % [d / c) x 100]	
f	Typical Efficiency [from Table 1]	
g	Relative Performance % [e / f x 100]	

Efficiency Cost

h	Electricity Cost ($ pa) [from Step 1 A: j]	
j	Fossil Fuel Cost ($ pa) [from Step 1 B: h]	
k	Total Energy Cost ($ pa) [h + j]	
m	Typical Efficiency Cost ($ pa) [k x g / 100]	
n	Annual Cost Saving ($ pa) [k – m]	
p	Annual Water Use (m³ pa) [from Step 2: j]	
q	Pumping Energy Cost ($/m³) [k / p]	
r	Power Demand (kW/m³) [Step 1: f / Step 2: g]	

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