Pump Assessment
Ensuring maximised return on upgrades

High energy costs are a concern for irrigators in the sugar industry. Cost savings can often be found through an assessment of the irrigation infrastructure.

This case study outlines an assessment of one aspect of the system, the pumping infrastructure, at a site near Maryborough in Southern Queensland.

Background Information

Observations and measurements were taken on a pump used to deliver water from a scheme channel to a furrow irrigated field through underground mains.

A basic pump assessment involves the following steps:

1. **Record the details of the site** and your observations (including the farm location, owner's details, type of irrigation system etc).
2. **Record the motor and pump specifications** from compliance plates.
3. **Install a flowmeter** on a suitable section of pipe.
4. **Install pressure gauges** on pump inlet and outlet.
5. **Start and run system** at typical operating conditions.
6. **Record pressures and elevations** from pump centreline.
7. **Record water volume** (using the flowmeter) **and kWh** (using the meter box) at the start and end of a specified period of time (several hours or whole irrigation event).
8. **If possible, verify the flow rate** with secondary measurements.

What We Measured

Flowrate	=	73 L/s
Outlet Pressure	=	14.4 psi (at 1.1 m height above pump)
	=	17.15 + 1.1 = 18.25 m
Inlet Pressure	=	0m (estimated)
Calculated TDH	=	18.5 m (using pressures and velocity heads)
Power Usage	=	21.34 kWh per hour (from meter box)

Simple calculations based on this data

Flow in 1 hour	=	73 L/s x 60 x 60/1,000,000 = 0.2628 ML/h
Energy per ML	=	21.34 / 0.2628 = 81.22 kWh/ML
kW.h per ML/metre lift	=	81.22 / 18.5 = 4.39 kWh/ML/m

As a general rule of thumb, a value less than 5.0 kWh/ML/m indicates that the pump and motor are working efficiency to deliver the flow and pump head.

A value of 4.39 indicates the pump infrastructure is working efficiently in this case.

The outcome of this assessment is that there is likely to be little benefit in upgrading the motor or replacing the pump with a new model that delivers the same flow and head.

Verifying Flow Measurements

It is always a good idea to check flowrates when taking measurements of a pump or irrigation system.

Bucket and stopwatch at flume cups:				
Average flow across 21 cups	=	0.691 L/s		
Estimated total flow	=	0.691 x 96 cups	=	66.3 L/s
Mechanical flow meter:	71.1 L/s			

Bucket measurements were lower than 73 L/s, which can be explained by the difficultly in using the bucket at this site. The mechanical flowmeter was within 2.5% of the value measured by the portable ultrasonic, which helps to validate the measurement of 73 L/s.

This pump is working effectively to deliver 73 L/s at 18.5 metres of head.

However, an assessment of the site suggests that the pump head required is only 3.5 m, with the excess 15 m (approximately 80% of the energy cost) being burnt off through a partially closed butterfly valve.

> **The pumping cost based on Tariff 20 (26.875 c/kW.h) is:**
>
> Cost per ML   =   Energy per ML x Tariff
>
>   =   81.22 x 0.26875   = $21.83/ML
>
> **Assuming that this pump delivers 320ML per annum:**
>
> Energy Cost   =   21.83 x 320   = $6,985

Operating an irrigation system with a valve always partially open is like driving a car with the handbrake on. Usually there is a good reason why irrigators use these valves, like preventing cavitation or maintaining correct pressures, but in these cases we should seriously consider if the pump is fit for purpose.

While the pumping cost of $21.83/ML appears comparatively low, this pump is only supplying a furrow irrigated field with minimal vertical lift and so this cost can be reduced.

Options for this site

Four possibilities were proposed in order to reduce the pump head through better matching the pump to the irrigation system:

1. **Trim the impeller.** A careful reduction of the diameter of the impeller will drop the head for a given flow.
2. **Install a variable frequency drive (VFD).** This will allow the pump to run at a lower speed, which will reduce head and/or flow.
3. **Replace the pump** with a model better suited to the required flow and head.
4. **Combination of VFD and new pump.**

A quick analysis was also completed to assess the likely benefits of installing an alternative energy source (10 kW and 20 kW solar systems) on this site.

	Capital cost ($)	Pumping cost $/ML	Energy cost to pump 320 ML ($)	Annual export @ 7.8c kWh ($)	Net potential saving ($)	ROI (%)	Payback (Years)
Existing pump		$21.83	$6,985				
Existing pump + solar (20 kW)	$33,000	$17.91	$5,730	$2,253	$3,508	10.6%	9.41
Trim Impeller	$350	$11.64	$3,726		$3,259	931.1%	0.11
VFD on existing pump	$9,000	$10.77	$3,446		$3,538	39.3%	2.54
VFD on existing pump + Solar (10 kW)	$25,500	$8.81	$2,819	$1,127	$5,292	20.8%	4.82
New pump	$3,000	$5.98	$1,912		$5,072	169.1%	0.59
VFD on new pump	$6,500	$3.29	$1,054		$5,931	91.2%	1.10
VFD on new pump + Solar (10 kW)	$23,000	$2.66	$852	$1,251	$7,384	32.1%	3.11

Assessment of options to reduce energy cost at this site

The most cost-effective choice at this site is trimming the impeller. This will reduce the energy cost by 46 per cent and has a rapid payback. The second-best option is to install a new pump. This option also has a short payback time (less than 1 year).

Installation of an alternative power source (solar) has the potential to decrease net power costs, but the payback period is 4 to 10 years.

Addressing the hydraulic issues before installing a solar power system means that a smaller solar system is suitable and comes at a lower cost with more rapid payback on the investment.

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