Pump Performance Case Study

Peter Smith (Sapphire Irrigation Consulting)

This case study was developed for the Tamworth, NSW, Optmised Dairy Farm for the Smarter Irrigation for Profit Project – Round 1.

A dairy farm on the Peel River near Tamworth has about 23 ha of irrigated pastures. For many years, the fields were supplied by big-gun travelling irrigators. In 2013, two centre pivots and a lateral move irrigator were installed. The pivots irrigate 18 ha of pasture.

One centre pivot was located on a flat area alongside the river. The second centre pivot was located on a hill adjacent to the flat area. The difference in elevation is about 20 metres. Both pivots have three spans with an overhang and end-gun.

The 'Flats' pivot applies 40.5 ML per season on average and the 'Hills' pivot applies 47.5 ML. Both pivots are supplied from the same centrifugal pump which extracts water from the river.

When the irrigation systems were upgraded, the owner anticipated that the pump would not perform at the best efficiency. He did not know the actual figures until pump performance tests were undertaken in 2016. The results are in the table below.

2016	'Flats' centre pivot	'Hill' centre pivot
Flow rate – specified	18.3 L/s	20.0 L/s
Flow rate – measured	13.6 L/s	19.4 L/s
Pressure at centre – specified	110 kPa	228 kPa
Pressure at centre – measured	155 kPa	214 kPa
Pressure at pump – measured	165 kPa	505 kPa
Total Dynamic Head – measured	22.3 m	57.2 m
Electric motor	TECO 22 kW, 415 V	
Pump	Grundfos 80 x 50 – 250	
Measured pump efficiency	12%	46%
kWh/ML	573	383
kWh/ML/m	25.7	6.7

This pumping installation was delivering the required duty (flow rate and pressure) adequately for both centre pivots. But the efficiency was poor when supplying the 'Hill' pivot and alarming when supplying the 'Flats' pivot. Efficiency measurements such as 12% are rare but unfortunately pump efficiency around 50% is all too common.

To improve the performance, the pump was replaced with a new Goulds 80x50-20 and the motor replaced with a new Monarch 18.5 kW at an overall cost of $8,195.00.

The performance was tested again in 2017 with the following results:

2017	'Flats' centre pivot	'Hill' centre pivot
Flow rate – specified	18.3 L/s	20.0 L/s
Flow rate – measured	16.9 L/s	19.5 L/s
Pressure at centre – specified	110 kPa	228 kPa
Pressure at centre – measured	155 kPa	128 kPa ?
Pressure at pump – measured	179 kPa	469 kPa
Total Dynamic Head – measured	24.3 m	54 m
Electric motor	Monarch 18.5 kW, 415 V	
Pump	Goulds 80 x 50 – 200	
Measured pump efficiency	75%	63%
kWh/ML	99	256
kWh/ML/m	4.1	4.7

With the new pumping unit installed, the efficiency at both duties showed a marked improvement. When supplying the 'Hill' pivot, the efficiency improved a lot from 46% to 63%. When supplying the 'Flats' pivot, it improved enormously from 12% to 75%.

The energy used per ML pumped per metre of Total Dynamic Head is used to compare the performance of pumps with different duties. In 2016, when supplying the 'Hill' pivot, this measure was 6.7 kWh/ML/m and when supplying the 'Flats' pivot it was a whopping 25.7 kWh/ML/m, both in excess of the accepted benchmark of 4 kWh/ML/m.

In 2017, when supplying either pivot, this measure was much lower for both duties, 4.7 for the 'Hill' pivot and 4.1 for the 'Flats' pivot. This means the new pumping unit is well suited to both duties and the result is a substantial reduction in energy used and much lower operating costs.

The cost savings and payback period based on two power charges, 14 and 25 cents per kWh, are shown below.

Running costs saving per season		**Cost of new unit**	**Seasons to pay back**	
@ 0.14 $/kWh	@ 0.25 $/kWh		@ 0.14 $/kWh	@ 0.25 $/kWh
$3,536.54	$6,315.26	$8,195	2.3	1.3

Cost savings and payback periods such as these are fairly common. Measuring pump performance is relatively simple and replacement pumps and motors are relatively cheap.

Do you know how your pump is performing?