Pumping Energy Costing

As the cost of energy, and the pressure to reduce greenhouse gas emissions increases and combines with the problems energy supply companies have maintaining supply during peak times, the issue of energy efficiency becomes much more important. Field tests have shown there is a large variation in pump efficiencies and costs in many of the irrigation sectors in Queensland, and the nursery industry is no different. On-farm pump performance tests completed over a period of 10 years, as part of the Rural Water Use Efficiency Initiative, found that irrigation systems that functioned poorly were often linked to poor pump performance. This testing showed a significant variation in efficiency, with some results as low as 23% and an average around 48%.

When designing a pumping system, it is critical that the pump selected matches the duty required to operate the irrigation system. Pump efficiencies vary significantly, and the best time to determine if a pump is suitable for the intended purpose, is during the design phase, as it is unlikely that the system could be modified sufficiently to improve pump efficiency once the pump is installed. When designing new pumping systems, the aim should be to select and operate a pump as close to its Best Efficiency Point (BEP) as possible. Pumps not operating at their BEP will have higher operating costs, and will suffer additional stresses on the pump, which can reduce the life of the equipment and lead to premature failure of the various components. As a rule of thumb, a minimum of 70% pump efficiency is desirable, but some pumps can’t achieve this level even when new.

For existing systems, pump performance can be evaluated in the field to determine how the pump is performing under actual operating conditions. One way of assessing the effects of efficiency on operating costs is to determine energy consumption per megalitre (ML) of water. The importance of knowing this information can be seen when it is realised that 80% of the total cost of a pumping installation over its lifetime is due to energy costs.

The first step in calculating energy costs is to measure the flow rate being produced by the pump. For the results of flow tests and energy measurements to accurately reflect the true situation the system must be operating under its normal load. Measuring flow rates can be difficult in systems where there isn’t a flow meter installed and the easiest way to measure flow rates in this situation, or to verify a flow meter reading, is to measure the output of the emitters on the system, and from this, calculate the total flow rate. The accuracy of this method depends on the amount of leakage in the system. If the calculated flow rate varies from the measured flow from the meter, or the calculated flow rate the pump should produce, this may highlight areas where there are problems in the system.

The second measurement required for energy cost calculations is energy consumption. If the pump has a separate electricity meter, this information can be read directly from the meter while the pump is operating. However, in situations where the energy consumption of the pump isn’t metered separately, obtaining this information can be a challenge. One method is to turn off all other appliances so that only the pump is operating, otherwise, a current draw test will need to be done, and this usually requires the services of an electrician if the electricity supply is hardwired or three phase. Once energy consumption figures are obtained, the cost per kilowatt hour needs to be identified. If the tariff is a time of use tariff it can be useful to calculate the difference between the high and low tariff rates. This may show where savings in electricity costs can be made simply by adjusting irrigation scheduling to take advantage of off-peak tariffs.

From these two measurements the kilowatt hours per megalitre (kWh/ML) can be calculated, and from that, the pumping cost per megalitre derived. Calculate the flow rate in L/hr and then the kWh of electricity the pump has used in an hour. Divide the kWh by L/hr and multiply by 1,000,000 to give the kWh/ML. This is then multiplied by the cents/kWh at the appropriate tariff to give the cost/ML e.g. 1.5kWh ÷ 5000L/hr X 1,000,000 = 300kWh/ML x $0.25/ kWh = $75/ML.

Once these calculations have been made, investigations into how pumping costs can be reduced can then be made by either changes to scheduling, or changes to the pumping and piping layout. If this exercise is done regularly, the energy consumption over time can be compared and be used as an early indicator of declining system performance.

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