Diesel versus electric pumps

Provided there is easy access to the electricity network, converting from diesel-driven to electric pumps will improve pumping efficiency and reduce costs. Typical efficiencies for electrical centrifugal pumps range between 70 and 80 per cent, whereas diesel pumps have an efficiency of just 30 to 40 per cent. Other advantages of electric pumps include lower maintenance requirements, less environmental impact and more easily implemented pump controls (such as variable speed drives).

Introduction

Diesel irrigation pumps are common in Australian agriculture as typically they are required in remote areas where access to electricity networks is limited. However, the running cost of diesel pumps is high compared to the cost of electric pumps, with current (2014) prices standing at between $400 and $500 per MWh generated. Diesel pumps also have higher maintenance requirements than electrical pumps.

When connection to grid electricity is economically feasible (no major line extensions are required), replacing a diesel pump with an electric one can reduce operating costs significantly, as current average electricity prices are around $150–$250/MWh.

Other advantages of electrical pumps include: lower labour and maintenance requirements; ease of integration with digital control systems; and reduced environmental impact, such as emitting less noise.

Technical explanation

The specific fuel consumption of a diesel engine is about 0.25 L/kWh for most large engines (over 70 kW) and around 0.3 L/kWh for smaller ones. This is equivalent to a generation efficiency of approximately 30 to 40 per cent.

Assuming a diesel price of $1.50 per litre, the running cost of diesel pump can therefore vary between 250 L/MWh * $1.50/L = $375/MWh and 300 L/MWh * $1.50/L = $495/MWh. If you consider that average electricity prices are typically between $150 and $250/MWh, this represents more than double the running cost of an electric pump.

A key factor behind the high running cost of a diesel pump is its low overall efficiency. The table below summarises the range of efficiencies for diesel and electrical pumps:

Pump type & efficiency	Low	High
Pump hydraulic efficiency	60%	90%
Overall diesel pump efficiency	18%	36%
Overall electric pump efficiency	48%	86%

Table 1: Pump efficiency.

Example: payback period calculation

An irrigation pump runs 2,000 hours per year and is run by 20 kW diesel engine. Assuming the same pumping conditions, we can analyse the cost benefit of replacing the diesel pump with an electric pump of the same size.

The 20 kW engine generates 20 kW * 2,000 h/yr = 40 MWh/yr of electricity. Using a specific diesel consumption of 0.3 L/kWh (33% efficiency), the annual diesel consumption is 40,000 kWh/yr * 0.3 L/kWh = 12,000 L/yr.

At a diesel price of $1.50 per litre, the annual running cost is 12,000L * $1.50/L = $18,000.

If the diesel pump is replaced with an electric centrifugal pump of the same size (20 kW), the annual electricity use is 20 kW * 2,000 h/yr = 40 MWh/yr. Assuming the site pays an average electricity rate of $200/MWh, the annual electricity cost is 40 MWh/yr * $200/MWh = $8,000, which results in $10,000 per annum in cost savings.

The capital cost of a new 20 kW centrifugal electric pump has been estimated at $8,000 and the installation cost is assumed to be 100 percent of the capital cost. The cost of a one-kilometre power line extension for an HV line is estimated to be $15,000 and the cost of a transformer, $8000. With a total cost of $39,000, the simple payback for this project is $39,000 divided by $10,000 p.a. = 3.9 years.

Key factors when evaluating quotes

The running cost of a pump is a key factor to consider in your economic evaluation. The price of diesel versus electricity and the operating hours of the pump will determine your energy savings. For example, high electricity costs (e.g. >$200/MWh) and short running times will provide relatively low savings, especially if you're able to buy diesel at low cost.

The cost of a power-line extension is also an important consideration as generally, this is expensive. The typical cost for systems up to 90 kW (HV line) can range between $15,000 and $20,000 per kilometre. If the distance between the pump and the electrical supply point is greater than one kilometre, it will probably affect the viability of the project.

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When comparing options, it is recommended that you check the following information:

- duty point for the application: average and maximum flow rate (L/s) and head (m) – i.e. the height difference between suction and discharge points, pipe length, and pipe diameter,
- pump efficiency (hydraulic and motor) at duty point,
- control option (manual versus automatic),
- power supply (single or three-phase), and
- water quality: define the materials/coatings that will protect the pump against erosion and corrosion.

Calculate the life-cycle costs of different options and compare these against one other and against your existing diesel pump running costs to determine the anticipated savings.

Further information

NSW Department of Primary Industries
Agriculture > Natural resources and climate > Water & irrigation > Water use efficiency
www.dpi.nsw.gov.au/agriculture/resources/water/irrigation/efficiency/irrigators-caring-for-the-rivers

Pump & Systems March 2013
'Powering the Pump: Diesel Versus Electric Motors'
www.pump-zone.com/topics/motors/powering-pump-diesel-versus-electric-motors

References

Industries, N. D. o. P., 2004. *Is Your Diesel Pump Costing You Money?,* s.l.: s.n.

Robinson, D., 2002. *Construction and Operating Costs of Groundwater Pumps for Irrigation in the Riverine Plain.* [Online]
Available at:
www.clw.csiro.au/publications/technical2002/tr20-02.pdf

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