Oversized pumps waste energy

Irrigation pumps are typically over-specified at the design stage, resulting in significantly higher power consumption and operating costs. A pump is generally oversized when it is not operated at or within 20 percent of its best efficiency point (BEP), although it is normally considered acceptable if the duty point falls within 50 and 110 percent of the BEP flow rate. By replacing oversized pumps with smaller ones, energy and maintenance savings can be achieved due to lower power consumption requirements and less wear and tear.

Introduction

Energy used in irrigation can account for upwards of 50 percent of a farm's total energy bill. Pump duties are often overestimated at the design stage of an irrigation scheme, which can result in the installation of oversized pumps. As well as costing more to install, larger pumps consume more electricity and so have higher operating costs.

Operating too far from a pump's best efficiency point (BEP) can risk overloading the pump's motor. It also increases the risk of cavitation. Cavitation occurs when pumps exert excess force, creating rapid changes of pressure within the pump liquid. This can cause bubbles and air pockets to form and then, subjected to higher pressure, these air pockets can implode, damaging equipment.

Selecting the right pump for the job will ensure that the pump runs efficiently, increasing the lifespan and reliability of the equipment. By replacing oversized pumps with smaller ones, or by reducing the size of the pump impeller, energy and maintenance savings can be achieved due to lower power consumption and less wear from excess flow energy.

Design for the best efficiency point

Generally, a pump is oversized when it is not operated within 20 percent of its BEP, although normally it is considered acceptable if the duty point falls within 50 and 110 percent of the BEP flow rate. This allows for a greater margin for error in the event that the system designer overestimates the actual resistance curve.

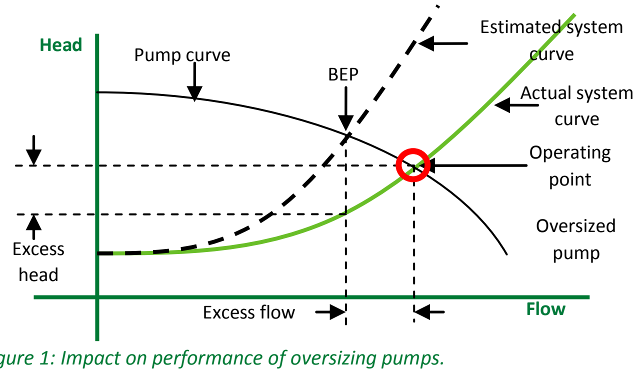

Figure 1: Impact on performance of oversizing pumps.

Is your pump too big?

- **Pump operates to the right of the best efficiency flow rate.** Using the pump curve provided by the manufacturer, check that your pump is not running too far from its BEP, outside the recommended operating range.
- **Increased risk of high-flow cavitation.** Check for signs of cavitation, such as abnormal sound and vibration. Check if pump internals have been damaged by cavitation during pump maintenance.
- **Increased risk of overloading pump motor.** Check that the pump motor is not running beyond its maximum current (FLA) rating and that the load factor (in amps/FLA) is not greater than the manufacturer's acceptable service factor (e.g. 1.15).

Guidelines for correct pump sizing

Consult with irrigation planners or engineers and follow the following guidelines:

- Determine the total dynamic head (TDH) of the system using flow rate requirements (L/min), pipe length and diameter, and height between suction and discharge points. TDH = static head + dynamic head (line friction).
- Using manufacturer pump curves for different pump and impeller sizes, select the combination (pump + impeller) that gives the best efficiency for the required operating conditions (flow rate and TDH).

For example…

A pumping system was designed to transfer 250 L/min of water from a dam a horizontal distance of 200 m from a storage tank up an incline of 10m through 50 mm (2") pipe. The height from the pump to the dam water level is 3 m.

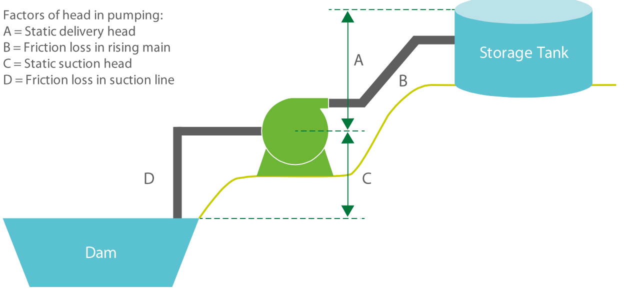

Figure 2: Example of a pump system with a reservoir.

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Where:

- A = 10 m
- B = 30 m (friction loss 200 m of 2” pipe@ 240 L/min)
- C = 3 m
- D = 0.37 m[1]

Therefore, the total dynamic head (TDH) of the estimated system curve is:

A + B + C + D = 43.37 m

Based on this, the selected pump (2” x 2” pump, max head 60m, max flow 450 L/min) has a duty point of 43.37 m head and a flow rate of 250 L/min.

However, an 80 mm (3”) line is finally implemented, and the total head of the actual system curve is, instead:

A + B + C + D = 23.09 m

Where:

- A = 10 m
- B = 10 m (friction loss 200 m of 3” pipe@ 250 L/min) [1]
- C = 3 m
- D = 0.093 m[1]

The actual flow rate using the same pump fitted with 3” suction and 3” discharge is approximately 400 L/min (@32 m).

The effect is illustrated in the following figure.

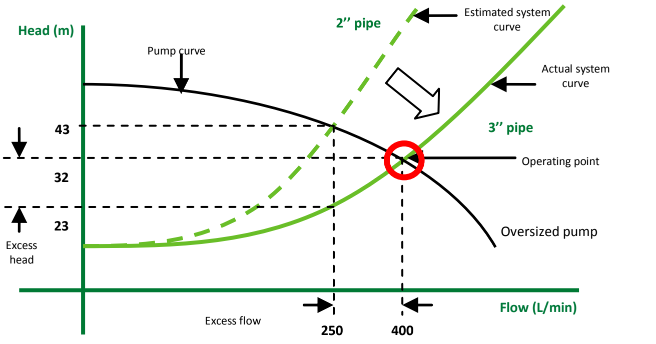

Figure 3: An optimised system, achieved by changing the width of piping from two inches to three inches.

Further information

Pumps and fans, opportunities, case studies and key resources

eex.gov.au/technologies/pumps-and-fans-2/
http://ee.ret.gov.au/node/1145

References

Unit, G. B. E. T. S., Best Practice Programme, G. B. & Department of the Environment, T. a. t. R., 1998. *Good Practice Guide 249, 'Energy savings in industrial water pumping systems'*, s.l.: UK Department of the Environment, Transport and the Regions.

US Department of Energy, 2006. *Improving Pumping System Performance.* [Online]
Available at:
www1.eere.energy.gov/industry/bestpractices/pdfs/pump.pdf
[Accessed November 2013].

[1] From friction loss tables.

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