

ARTICLE

How to maintain uninterrupted flow of water for less



Identifying your best efficiency point in pumping for guaranteed water flow and minimal energy usage

Water authorities, suppliers and wastewater treatment plants are facing major problems related to escalating costs of electricity in operation, impactful pipe leakage and predictive and reactive maintenance on wastewater transfer stations.

This is being recognised across water source, pumping, treatment, distribution, and wastewater discharge applications.

In Australia, power consumption in wastewater treatment plants accounts for approximately 40% of operational costs.



This is on account of systems involving aeration, pumping and solid waste processing. Outside of the size of the plant, the technologies used on site have an impact on how much power is needed.

As the cost of electricity to run plants continues to rise, more effort is being applied to find out where costs can be decreased. As regulatory bodies pursue rules around sustainability, water authorities and treatment plants are also becoming more conscious of reduced energy equating to reduced environmental impact and subsequently improved process efficiency.

About 80% of energy costs for water suppliers at drinking water plants is attributed to the operation of motors for pumping. The amount of energy needed for pumping water has become an issue of increasing importance as suppliers turn to new opportunities for better systems with upgraded equipment. These systems are the foundation for improved energy management to offset rising electricity costs.

Typical example of energy consumption sources at a wastewater treatment plant

Reactive maintenance costs to address burst pipes in the water transport network is costing Australian utilities providers hundreds of millions of dollars every year. Implementing equipment like variable speed drives (VSD) is helping these companies to not only realise achievable energy cost savings in operations but also to succeed in cause prevention and maintenance efforts to eliminate unplanned downtime.

Culprits of high energy bills in water applications

With dated equipment, system processes such as pumping and aeration operations can decrease the energy efficiency of operations leading to high electricity bills. Implementing control systems that can improve applications by analysing the activity in applications and networks by monitoring and controlling systems, such as variable speed drives, high efficiency motors, and variable speed application control can facilitate anywhere from 20-50% in energy savings.

Equipment in plants and pipes are often oversized to solely accommodate peak load. T his deters process optimisation. Also, when this equipment is used beyond their expected lifecycle, they fail to function at optimal points. To counteract this, water suppliers should first understand their current energy usage to then be able to better manage it.

Finding your best point efficiency pumping with the pump curve

A system to recognise the most efficient way to pump water to generate savings is by finding the best point of efficiency pumping (BEP). This starts by looking at the pump performance curve (Graph A), which describes how the pressure and flow that a particular pump delivers are related.



Graph A

In Graph B, the BEP is identified by looking at a pump operating at rated speed. There can only be one operating point of BEP on the pump curve.



As Head increases from BEP, efficiency decreases as the operating point moves up the pump curve towards the Shut-Off Head (Graph C). As Flow increases (which means Head decreases) from BEP, efficiency decreases as the operating point moves down the pump curve.



Graph C

In Graph D, the system curve is represented by the green line incorporating throttle control to manage flow. When overlaying the system curve and the pump curve on the same axis, the point at which a particular pump is pumping is a fixed spot which can't be changed without mechanical control. Because most pumps in water networks are oversized, they tend to pump on the lower part of the curve, resulting in significant wasted energy once mechanically controlled. The goal is to both find the BEP, as denoted by the red square also in Graph D and manage flow with variable speed pumping. Variable speed drives have become the most energy efficient pumping control solution in most water applications. They accommodate an oversized pump to meet future or periodic high flow requirements by having the ability to slow down or speed up water flow pumping without wasting energy during the majority of operation.





Graph D

How variable speed drives are saving energy in pumping applications

Oversizing pumps in an attempt to maximise flow and head and to achieve safety margins is a widespread industry practice however this induces inefficient pumping. In Graph D, we look at the process of controlling flow with a throttling valve. A common control strategy is to add a discharge valve to the pump to control flow into the pumping system. This valve increases the system resistance, thereby causing the issue of an operating point to move up the pump curve.

Variable speed drives have become the most energy efficient pumping control solution in most water applications. They accommodate an oversized pump to meet future or periodic high flow requirements by having the ability to slow down or speed up water flow pumping without wasting energy during the majority of operation. The controller on the VSD enables the slower speed of the pump to then drop from what would be the red line in Graph E, to the green line, to support a steady flow of water. Case studies of water suppliers who have implemented VSDs have shown up to 50% cost savings in electricity by using this feature. Alternatively, control from a VSD supports the precise matching of the pump operating point with the system's specific needs (see Graph E).

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Graph E

The impact of pipe leakage

Although there have been advancements in pipeline technology, there are still a large percentage of old pipes in sewerage and water distribution systems. When water is transferred from treatment plants to customers a significant amount of water loss is experienced as a consequence. This can be up to 28% of production. Leakage has been the major cause. Leakage created not only a large environmental impact but additionally an economic one. The fallout is pipe network damage which eventually triggers pipe erosion followed by massive pipe breaks that then impact structural damage to roads and buildings.

Reductions in pipe leakage is a high priority for many water authorities. Pressure transients in a water network can stem from several different causes, but the most damaging ones by far are created rapidly over a small distance. These can include valves being opened or shut too fast, a pump inducing suction instantaneously, or a large water usage such as an industrial plant operating or shutting its supply.

The aftermath is the kinetic energy of the water transferring into strain energy on the network, sending a shock wave through the system and thereby putting undue pressure on network assets leading to burst pipes. Pipe bursting is arguably the biggest cost to Australian utility companies at present. Approximately \$250 (AUD) is spent on reacting to burst pipes each year, outside of additional revenue losses associated with unbillable water.

Variable speed drives can assist in preventing leaks from occurring in the first place. They can successfully manage big shocks that happen in the system due to high numbers of aggressive starting and stopping in pumps which damage the network. They also significantly reduce the motor and pump hard starts or stops that can damage both the pump and network. Without control, weak points in the network begin to suffer micro fractures that lead to large scale leaks. The drive mitigates this by smoothly increasing the pressure on the pipeline to reach the desired setpoint.

With proportional-integral-derivative controller (PID) functionality, the PID reference is identified and water flow rate intelligently ramped up or down. This means that the pipe fill time can be specified to avoid unnecessary pumping if the PID setpoint is not reached. The PID feature extends the lifetime of the piping and pump system by avoiding pressure peaks and harmful repercussions.



The increasing problem of sewage pump blockage

Sewage pumps are being subjected to increasing quantities of non-processable waste. When this happens, blockage can materialise causing storage tanks to potentially overflow, inundating residential or business areas with raw sewage and costing wastewater plants large sums of money in compensation. Wastewater sites are being monitored evermore closely for blockage and the requirement of record maintenance for non-availability is being enforced.

When blockage occurs, a mobile crane hire is typically brought in as pumps are removed, stripped and cleaned, before being reassembled and lowered back into the housing. Highly skilled mechanical and electrical staff with specified vaccinations are also obligatory for carrying out this task. The entire process can take up to a day and is both costly and an extreme safety hazard for all workers involved.

Variable speed drives are helping to eliminate this cleaning operation which puts plant operations at a standstill. They will instantly detect blockage the moment it occurs and trigger an automatic system response without the need for operator intervention. The drive eliminates the need to install and program a completely separate PLC system that can become redundant in local or manual operation mode.

Pump cleaning or de-rag can also be programmed into the drive to unclog pumps before it's made inoperable. It's an automatic preventive maintenance on the pump. By using a variable speed drive, pressure transients are also eliminated, reducing wear and tear on pumps and associated motors.



Saving water, saving energy

Upgrading equipment to support the sustainable treatment and delivery of water to residential and commercial users throughout the network – from water source to distribution, will not only help to reduce potential water loss in the system due to pipe breakage, but also assist in reducing maintenance costs and those associated with repairs. As the Australian population continues to grow and environmental regulations become tougher, so will the demand for networks to increase water distribution.

The reliance on electricity at water utility and wastewater treatment plants is expected to grow by about 20%. Today's energy efficient technologies such as variable speed drives offer water suppliers and wastewater treatment plants new opportunities for remarkable water savings in operations and consequentially significant energy savings - all whilst enabling increased water security.

Making the switch will increasingly become inevitable. There will be no space for reluctance to change practices or hesitation to adapt new technologies. The result of saving water will also be a reduction in carbon emissions because of energy savings that would otherwise be used to generate, treat and transport water.

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