

How to maintain uninterrupted flow of water for less



Addressing escalating energy costs, unbillable water, and challenges associated with increased maintenance costs of wastewater transfer

Water authorities, suppliers and wastewater treatment plants are facing major problems related to escalating costs of electricity in operation, impactful pipe leakage causing revenue loss in unbillable water and additional finances going towards predictive and reactive maintenance on wastewater transfer stations. This is being recognised across all water and wastewater pumping, treatment, distribution, and discharge activities.

Culprits of high energy bills in water applications

As the cost of electricity to run plants continues to rise, more effort is being applied to find out where this can be reduced. Regulatory bodies are also implementing more conditions around sustainability to encourage water authorities and treatment plants to become more conscious of reducing energy consumption to lessen environmental impact.

Energy costs at water plants is proportionate to throughput measured by the water capacity being processed per day. About 80% of energy costs for water suppliers at drinking water plants is attributed to the technologies used for operation such as motors for pumping. As such, suppliers are turning to new opportunities for better systems with upgraded equipment to offset rising electricity costs.

Implementing modernised application control systems enhance applications by analysing activity and networks and monitoring and controlling systems. Variable speed drives (VSDs), high efficiency motors, and smart sensors are examples of equipment utilised in intelligent control that can facilitate anywhere from 20-50% in energy savings.

Finding your best efficiency point in pumping on your pump curve

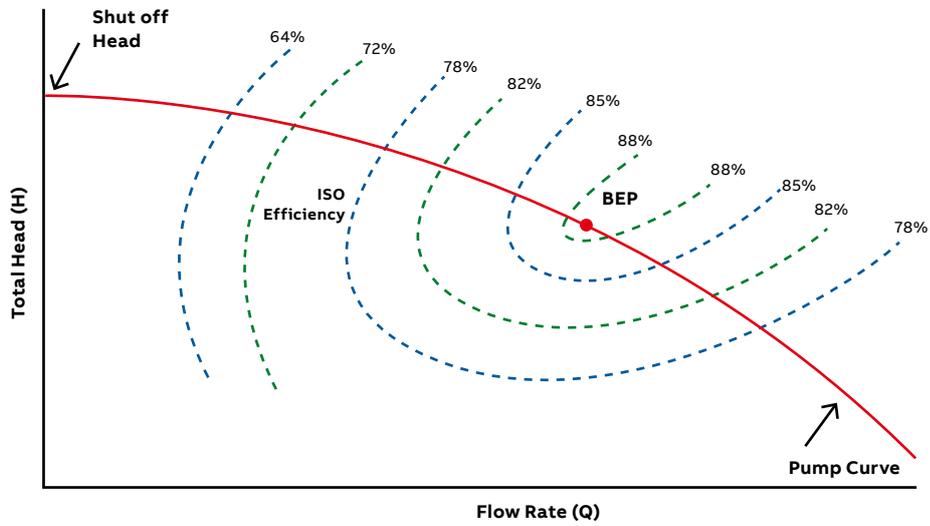
Pumps and pipes installed in plants and the distribution network are often oversized to accommodate peak demand and high water volume events. This can be counterproductive to process and energy efficiency for much of the time the system is operating. Utility companies are now taking on a more strategic approach to combat this.

A technique to recognise a beneficial way to pump water and generate savings is by finding the best efficiency point (BEP) on the pump. It starts by looking at the pump performance curve which shows how the pump will perform, efficiency at various pump points, as well as the BEP (Graph A). There can only be one operating point of BEP on the pump curve. By measuring flow, the operator can identify where they are pumping on the pump curve.

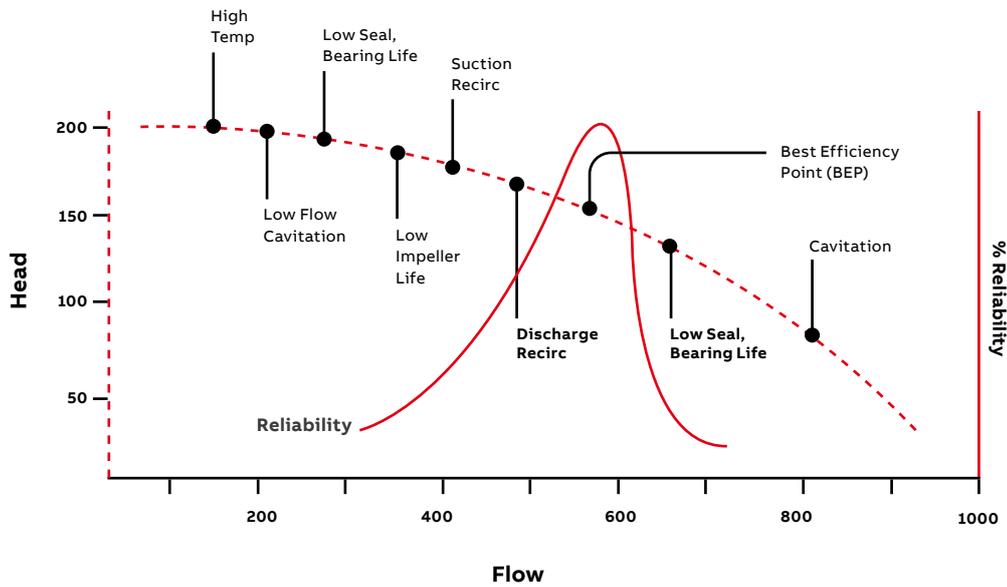
As the pumping point moves either higher or lower on the pump curve and away from the BEP, both efficiency and the pump's designed operational lifetime decreases. If the point of pumping becomes so high on the pump near the Shut-Off Head towards the point of maximum flow rate, this can be very detrimental to the pump's reliability (Graph B).

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 circle in Graph C, and manage flow with variable speed pumping.

Graph A



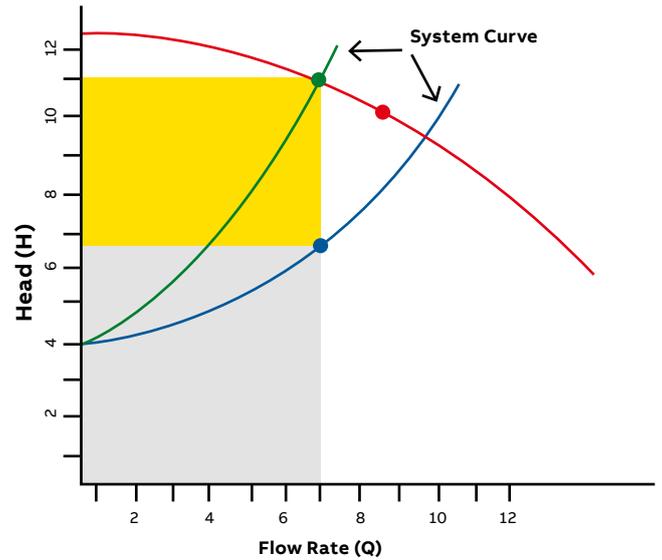
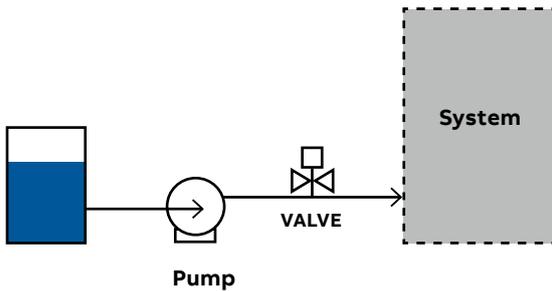
Graph B



Because of the oversizing of pumps, alternative measures must be taken to meet the designed system requirements. One of the ways to do this may be to utilise a throttle valve to manage flow rate. The open system curve represented by the blue line in Graph C when used with the selected pump would produce a flow rate or pressure much higher than desired.

As the throttle valve is closed, the system is restricted and the new system curve (represented by the green line) is developed. At this time, the flow rate reduces to the desired point however energy becomes wasted by operating in this way. This is represented by the yellow mass in Graph C.

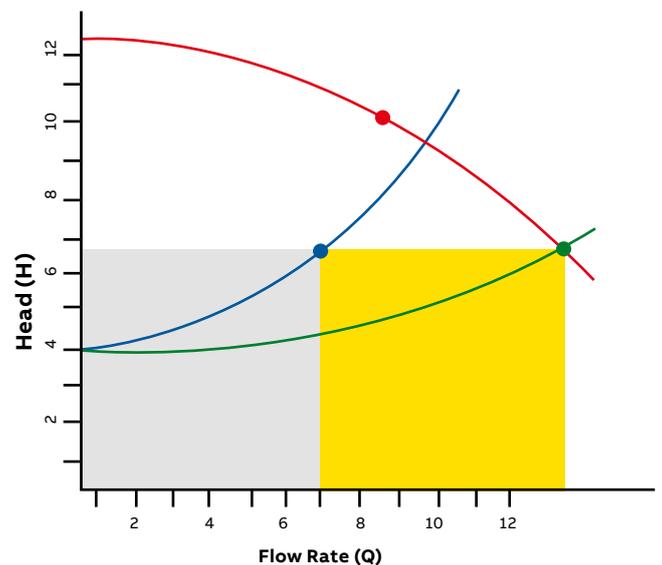
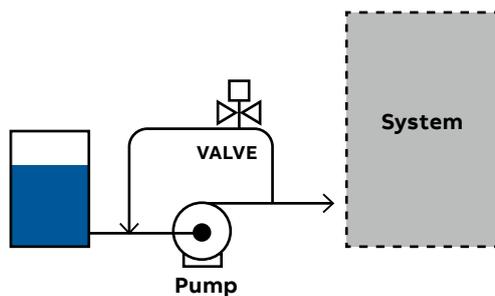
Graph C



An alternative control method is to utilise a bypass valve, commonly seen in pressure boosting systems as an example (Graph D). In this method, as the return bypass valve is opened, the net system output and resistance is reduced to meet the desired flow rate or pressure levels.

In summary, whilst mechanical system control is commonly implemented and effective, it does however often result in a significant amount of potentially wasted energy.

Graph D



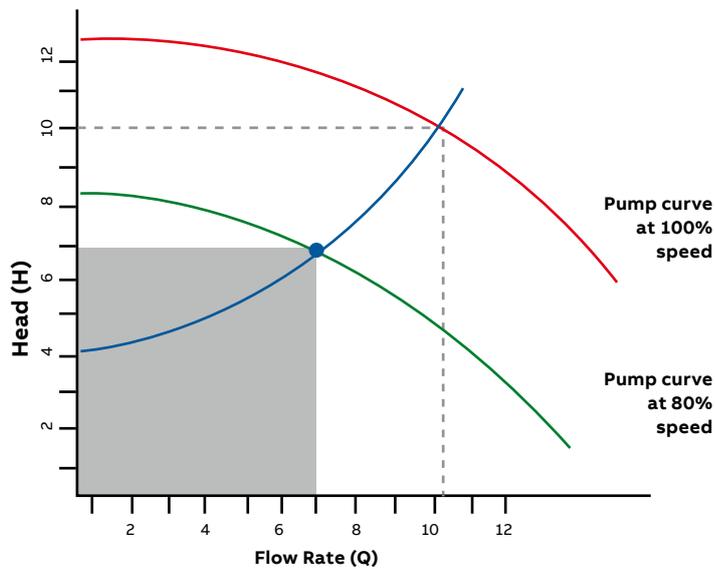
How variable speed drives are saving energy in pumping applications

VSDs not only provide effective motor pump and system protection, but they've also become widely used in most water applications for the purpose of wise energy management. They accommodate variable flow rates to meet future or periodic high flow requirements by having the ability to control the pump speed, full pumping potential and subsequent output capacity.

VSDs also offer the capability to run the pump in its most productive and systematic way during typical operations over the greatest amount of time.

When a VSD is used to control a pump motor it introduces the capability to adjust the impeller speed within the pump. Graph E shows an example that by reducing the speed of the pump by 20% a potentially enhanced pump curve is created that can meet the specific needs of the system at that time without wasting energy.

Graph E



The impact of pipe leakage

Although there have been advancements in pipeline technology, there is 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 can be experienced. This can account for up to 28% of unbillable water in some extreme circumstances. Leakage has been the major cause. Significant investments are being made to identify and repair the location of leaks but unfortunately, many leaks remain unidentified due to runoff into underground or river systems. Leakage can also have a large environmental impact. This should be considered at a time when the world is becoming increasingly concerned for water scarcity and availability.

Because of these factors reducing 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 or a pump inducing suction instantaneously.

What results is the kinetic energy of the water transferring into strain energy on the network, sending a shock wave through the system thereby putting un-

due pressure on network assets leading to burst pipes. Without effective control, weak points in the network begin to suffer micro fractures that can develop into large scale leaks over time. Pipe bursting is arguably the biggest cost to utility companies at present. Millions of dollars are spent on reacting to burst pipes each year, outside of additional revenue losses associated with unbillable water.

VSDs can assist in preventing leaks from occurring in the first place. They can successfully manage pump starting and stopping to provide a smooth, gradual increase or decrease in flow and pressure. Direct-on-line (DOL) pump starting can be detrimental to the motor, pump and system in this regard. VSDs can also significantly reduce the number of pump starts and stops within the network which are damaging overall. This is thanks to a proportional-integral-derivative controller (PID) feature. When the PID reference is identified the water flow rate can be intelligently ramped up or down. PID functionality also extends the lifetime of the piping and pump system by avoiding pressure peaks and harmful repercussions. When systems are controlled in this way the number of destructively frequent pump starts and stops can be significantly decreased.



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Water operator
using ABB's ACQ580
variable speed drive

The growing problem of sewage transfer pump blockage

Sewage pumps are being subjected to increasing quantities of non-processable waste. Unfortunately, people are putting many substances into the sewage network that are not bio-degradable or cannot be easily managed by sewage transfer pumps. Additionally, changes in the dietary habits of people in communities that are gravitating more towards fat-laden foods are causing a byproduct coagulation of hardened fat and solids in the network. As this happens, blockage in the network becomes more recurrent.

In severe circumstances, if all pumps within a well become blocked there is a potential for overflow. If this happens, nearby communities can be exposed to untreated waste matter causing serious health concerns. It's for this reason that these occurrences should be avoided at all costs.

When a pump becomes blocked the common reaction is to have it manually uninstalled, clean it, then return it to service. Mobile crane hire is typically brought in as the pump is removed, stripped and cleaned, before being reassembled and lowered back into the housing.

Specially trained mechanical and electrical staff with certain vaccinations are also obligatory for carrying out this task to avoid an extreme safety hazard incident. The entire process can take up to a day and is both costly and disruptive to the network. VSDs are helping to eliminate the manual cleaning of these pumps. Because VSDs can monitor pumps in these applications, the potential exists to immediately detect when a blockage manifests in real-time.

The moment the blockage occurs the drive can trigger an automatic system response without the need for operator intervention. The drive also eliminates the need to install and program a separate programmable logic controller (PLC) system that has the potential to become redundant in the event control is switched to manual, localised operation mode.

Pump cleaning or de-ragging can also be programmed into the drive to unclog pumps before they become bound and inoperable. This functionality acts as an automatic preventative measure to avoid the need for manual maintenance on the pump.

Saving water, saving energy

As the population continues to grow, so will the demand for networks to increase utility services. Consequently, the necessity for increased electricity for infrastructure and operating at water facilities and on network systems will grow proportionately. The rising cost of electricity production and distribution is also continually increasing and causing great significance in operations.

Today's energy efficient technologies such as VSDs offer water operators new opportunities for substantial ways to save money in electricity and operational costs. Upgrading equipment to support the sustainable treatment and delivery of water to residential and commercial users throughout the network will not only help to further reduce potential water loss due to pipe breakage, but also assist in reducing maintenance costs and those associated with repairs and unplanned downtime. Making the switch will increasingly become inevitable. There will be little time for reluctance to change practices or hesitation to adapt new technologies.