Shoring Up Mine Water Management

A GUIDE TO MINIMIZE DOWNTIME, REDUCE MAINTENANCE COST AND IMPROVE EFFICIENCY

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Let's Solve Water

Wise investments in pumping and water management systems can help mines lower operating costs, enhance performance, and lay a foundation for lasting prosperity.

A period of soft commodity prices may not be the time to make huge investments in new mine properties or to expand existing operations. But it can be an excellent time for smaller, quick-return investments that boost efficiency, reduce costs, enhance profit margins and prepare an operation to thrive in better times.

In mines, as at any industrial site, it's common to find aging machinery in need of repair or replacement, equipment no longer sized properly for required demand, and systems performing at less than optimum because the operation has changed or evolved.

This also pertains to mine water equipment. Pumps, piping and controls for applications such as dewatering, tailings basin decanting, wastewater treatment, camp water transport, fire suppression and dust control may be in need of upgrade.

For instance:

- Pumps operating outside their optimum range waste energy and are subject to faster wear and shorter service life.
- Pumps no longer compatible with the water's physical or chemical properties can be at risk of premature failure, causing costly, unplanned downtime.
- Older pump hydraulic designs and fixed-speed installations may consume far more energy than the latest premium efficiency units with variable frequency drives (VFDs).

Current market conditions offer a prime opportunity to audit mine water management and pumping systems to identify waste and operating risks. Such an audit can form the basis for a program that optimizes pumping efficiency at a high rate of return on investment.

Roots of inefficiency

Inefficiency in mine pumping can begin with the original mine design. Selecting a pump is analogous to choosing a truck to pull a camping trailer. It's a mistake to choose too little power, (a half-ton pickup won't do), but also to choose too much. A semi-tractor would pull the camper but waste a great deal of fuel and likely deteriorate in doing work ill-suited for its design.

Pumps in mines are often misapplied – not as grossly as in the above analogy, but sometimes still to a significant degree. With each pump sold, manufacturers provide a pump performance curve (Figure 1) that plots the head (in feet or meters) against the flow (in gallons or liters per minute). Each pump's curve has a best efficiency point (BEP).

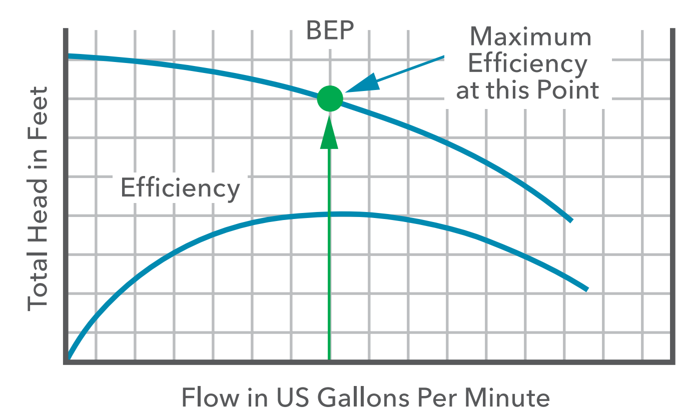


Figure 1: Sample pump performance curve

Ideally, a pump should operate at its BEP. That's difficult in the real world, but straying too far from BEP will reduce energy efficiency. When a pump runs significantly on either side of BEP, the pump could experience conditions such as vibration or shaft deflection that waste energy and lead to premature wear.

Experience shows that mine planners and engineers often intentionally oversize pumps. In dewatering, for example, designers size pumps not just for immediate needs but to anticipate enlarging or deepening of the pit. However, if significantly oversized for initial requirements, the pumps will run inefficiently and wear out faster than they should.

It's a common practice to select one large pump to serve two purposes within a mining operation. A single 150-horsepower turbine, for example, might be selected at a sand and gravel pit for water transfer and for wash plant supply, one being low head and the other higher pressure. However, these joint flow applications rarely operate at BEP, so a more energy-efficient selection might be to down-select multiple pumps, each ideally suited for the application. The cost of the second pump can be recouped through energy savings and underscores the importance for pump system designers to consider system efficiency and operating costs, as well as future capacity requirements when designing a system.

On the flip side, a pump that was properly selected for a specific duty point may now be operating outside of its BEP as requirements, such as head or flow, have increased. Furthermore, digging deeper may lead to a change in the character of the water: more abrasive solids or more acidic (thus more corrosive) water may create different pump metallurgy, which may cause rapid wear, requiring intensive maintenance and early replacement.

On a more basic level, some pumps simply wear beyond their useful life and can be replaced or rebuilt. Replacement can reduce demands on the maintenance team and provide an opportunity for increased energy efficiency and materials upgrade for longer product life. These include pumps with advanced hydraulic designs, corrosion-resistant impellers or taking advantage of variable frequency drives to save energy and extend service life while improving operational flexibility.

Finally, mines can put critical processes at risk by becoming dependent on pumps that lack redundancy appropriate to their degree of criticality. The failure of a critical pump means unplanned and extremely expensive downtime.

Pumps and their applications

Here is a quick look at the types of pumps typically deployed in mines and the specific applications for which they are well suited.

VERTICAL TURBINE

Maximum Capacity:
20,000 gpm/1,000 ft head.

Attributes: Alloy construction with external flush of critical wear areas available for corrosive/abrasive services. Available in 316, duplex, or super duplex.

Applications: Extraction of water from aquifers, rivers, tailing ponds, etc.

LARGE BOREHOLE/ SUBMERSIBLE TURBINE

Maximum Capacity:
2,300 gpm/2,200 ft head

Attributes: 8-, 10- and 12-inch sizes. Up to 540 hp. Full stainless steel or duplex stainless steel.

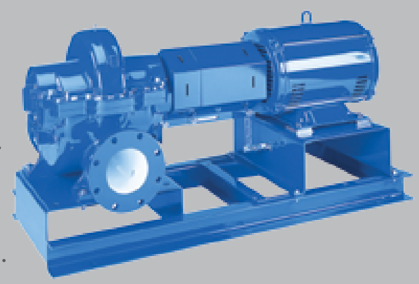
Applications: Extraction of source water from aquifers and management of water levels.

MULTI-STAGE

Maximum Capacity:
1,500 gpm/2,780 ft head.

Attributes: Maintenance-friendly design. Cast impeller design for high-pressure models. Vertical and horizontal models available. Available in cast iron, ductile iron or duplex stainless steel.

Applications: Wide range of boosting applications, including process boosting, treatment, dust suppression, mine shaft boosting/dewatering.

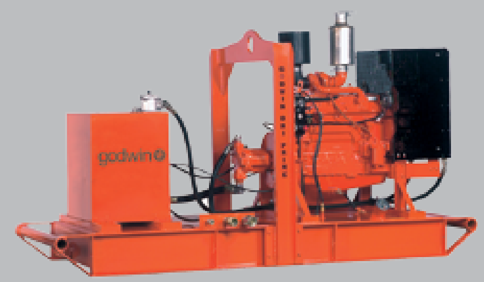


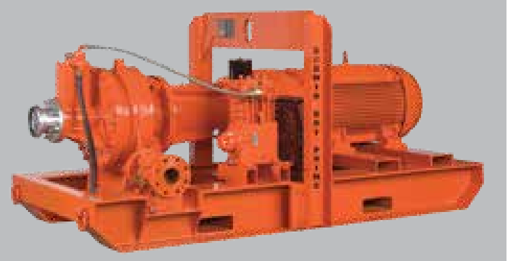
SPLIT CASE

Maximum Capacity:
12,400 gpm/620 ft head.

Attributes: Double-suction, base-mounted, long- coupled, split case. Internally self-flushing mechanical seals for maximum lubrication, debris removal and heat dissipation.

Applications: General water transport process applications.



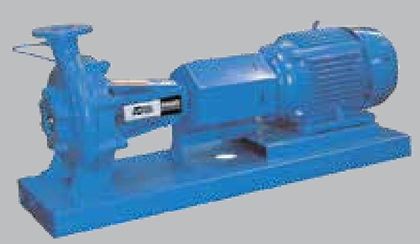


DIESEL AND ELECTRIC DRY-PRIME

Maximum Capacity: 15,000 gpm/500 ft head.

Attributes: Fully automatic self-priming.

Applications: Multiple purposes.



END SUCTION

Maximum Capacity:
3,100 gpm/360 ft head.

Attributes: Maintenance-friendly design. Standard motor designs for North America and Europe markets.

Applications: General water transport process applications.

SUBMERSIBLE

Maximum Capacity:
6,500 gpm/330 ft head.

Attributes: Compact, lightweight design. Wide range of flows and pressures. Self-cleaning ability. Slurry handling.

Applications: Dewatering.

Taking charge

Without a strategic plan and maintenance program for pumping systems, a mine can find itself with a patchwork of equipment that has not kept pace with project growth and evolution and, therefore, increases the risk of downtime. Instead, mines can maximize profits by applying the same rigor to pumping system optimization as to mining machinery, mine haul trucks, processing equipment and other mission-critical assets. This process comprises four basic steps.

STEP 1 PERFORM A PUMPING SYSTEM AUDIT

It's common for businesses to perform energy audits; the exercise almost always reveals areas where risk for downtime is more likely and money can be saved. The results are the same with an audit of a mine pumping system, except that the benefits are potentially broader. The process includes a thorough inventory and assessment of pumping assets.

For each pump, the audit asks:

- Is it sized properly?
- Where is it operating relative to its BEP?
- What is its maintenance and repair history?
- Does its general age and condition warrant overhaul or replacement?
- Would a different type of pump perform more effectively in the application?
- Could an upgrade to a premium efficiency model be cost-justified?
- What are the consequences if this pump were to fail?
- Do the consequences of pump failure merit a redundant solution?

Beyond individual pumps, the audit examines the overall pumping and water management system, which includes piping, valves and controls. An analysis of basics such as recorded flow data, pressure gauge readings, site topography and elevations, pipe diameters and general piping layout can help determine whether friction loss in the piping is hindering efficiency and causing excessive

Pumping system installation for leaching at a gold mine.

pump wear. In particular, sections of undersized piping can severely compromise efficiency and are relatively inexpensive to replace and upsize. Valves improperly sized or located can also cause energy losses. A pumping system audit is a team effort that should involve multiple functions: equipment operators, maintenance technicians, electricians, engineers and others, ideally assisted by a third party with specialized expertise in mine water management.

STEP 2 OPTIMIZE PUMP ENERGY CONSUMPTION

In acting on opportunities discovered during the audit, a basic aim should be to enable pumps to operate more closely to their BEP across a broad range of operating conditions. Prime candidates are pumps that move large volumes of water over long distances or to much higher elevations, notably dewatering and tailings pond decanting pumps. Where pumps are not operating at or near their BEP, replacement may be warranted.

For pumps that have reached end of life, it is an opportunity to re-evaluate the pump configuration to maximize total life cost. A review of options can yield opportunities for meaningful efficiency gains and uptime considerations. Was the existing pump improperly sized or misapplied? Would an entirely different type of pump better suit the application? Would the latest-model pump of the same type bring energy benefits through superior hydraulic design?

The vertical line shaft turbine or submersible pumps typically used for tailings basin decanting can be compromised by improper design of piping that traverses uneven terrain. One smart practice is to ensure that air releases are installed to prevent the trapping of air at high points in the line. Such air pockets cause pumps to work harder and consume excess fuel or electricity.

Goulds vertical turbine being installed for a mining application.

STEP 3 OPTIMIZE PUMP COST OF OWNERSHIP

Energy is not the only contributor to the total cost of ownership. Pump technologies should be chosen and maintenance practices fine-tuned to minimize unplanned repairs and extend service life. By some estimates, unplanned downtime costs up to 10 times as much as planned downtime, such as routine maintenance.

Accurate service records, as captured in a computerized maintenance management system (CMMS), can help determine where maintenance can be improved and where a given pump may be less than ideal for the application. Reports from the CMMS help spotlight pumps that appear to be generating excessive work orders, parts and labor costs and downtime.

There are applications in which the most energy-efficient pump is not necessarily the most cost-effective. For example, for moving water with a low pH or water that contains highly abrasive suspended solids (sand, coal dust, kaolin), pump metallurgy may be the most compelling factor. The higher initial price for a hardened shaft and impeller and specialized materials in seals and bearings will likely be justified in substantially longer life. Similarly, harsh mine environments call for highly protective pump motor enclosures, sealed against dirt, dust, moisture and other contaminants.

With the appropriate equipment in place, long service life and low cost depend on effective maintenance. Today's tools enable condition-based maintenance practices in which tasks are performed at the ideal time – neither earlier than required (thus wasting time and resources) nor too late (after premature wear has done damage requiring costly repair).

Standardization can also help control costs. Reliance on a limited number of pump models from one or a few manufacturers can help reduce and simplify parts inventories, simplify maintenance and minimize training requirements.

STEP 4 OPTIMIZE THE SYSTEM

The ultimate goal should be to ensure that the entire pumping system performs at the highest efficiency level, delivering the performance required at low costs for energy and maintenance, and with the bare minimum of unplanned downtime.

Here, technology can offer a major boost. For example, VFDs enable pumps to respond smoothly and efficiently to fluctuations in demand. Today's VFDs are robust, reliable and cost-effective, helping users conserve energy and avoid the wear and tear of repeated on-off cycling. Motors have also improved greatly in recent years; a change to the latest premium efficiency model may bring fast payback in energy savings.

SCADA systems employed by some mines enable remote monitoring and control. Today's mobile applications allow personnel to check on pump operating status and make adjustments, not just from dedicated workstations but wirelessly from any location using a smartphone or tablet. This eliminates the cost of sending technicians on rounds to check equipment.

Finally, an optimized system includes built-in protection against downtime caused by equipment failure. The first line of defense is effective monitoring and maintenance, but the most critical equipment requires contingency planning and emergency backup. This can include:

- Installing a redundant pump in parallel with a critical unit so that it can be activated immediately and automatically if needed.
- Keeping a replacement pump in inventory – or at minimum an adequate on-site inventory of replacement parts.
- Prearranging with a pump distributor or rental supplier to deliver a replacement immediately in case a critical unit fails.

Getting help

Now is an opportune time for mines to review pumping operations for efficiency, performance and longevity. A wise approach is to work with an advisor well versed in mine pumping technology and deploy appropriate pump types for the best fit in each application.

Pump manufacturers offer an extensive product range, have applications expertise and work closely with mining equipment distributors. These businesses have the knowledge and experience to help mines evaluate pumping and water management systems and recommend ways to optimize efficiency, reduce maintenance and avoid downtime. Taking action now will help mines improve margins in challenging market conditions and get into lean-running shape for better times to come.

Vertical turbine pump installation.

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1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're a global team unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to www.xyleminc.com

About the author

Nate Maguire is an Americas Business Unit Director with Applied Water Systems, a unit of Xylem Inc., organized to solve challenging water problems. The company's multiple pumping products and water balance solutions are field-proven in surface and underground mining. He can be reached at +1.949.608.3925, Nathan.Maguire@Xyleminc.com, or on Twitter @natemaguire.

xylem
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Xylem, Inc.
2881 East Bayard Street
Seneca Falls, NY 13148
Tel +1.866.325.4210
Fax +1.888.322.5877
www.goulds.com