Keeping the deeps dry

Carly Lovejoy explores the types and configurations of dewatering pumps used in underground mines, as well as current industry trends

Right: Xylem produces dewatering pumps for both surface and underground applications

Every underground mine has to deal with some degree of water ingress, and will require dewatering at one time or another during its lifecycle. How that dewatering is achieved, and the scale of the operations is largely dependent upon the mining method and design used, the depth of the mine, its location, the geology of the host rock and the type of ore being mined.

The geology of the host rock is a critical factor affecting the amount of water that needs to be removed. The porosity of the rock will determine the ability of groundwater and throughflow from natural sources such as precipitation to travel through certain layers of strata. Fractures, voids and veins can also act as conduits for water as it filters through the rock. Due to gravity, water will naturally follow through these channels, run down cave and tunnel walls and accumulate in depressions, whether natural or made-made.

Gavin Doran, general manager of sales at Sulzer Pumps (South Africa), says: "Open-pit mining sees the ingress of direct rainfall water, as well as overland or storm water flows into the operation, while underground mines see water ingress via rainfall down shafts and adits, as well as seepage of rainfall and overland flow from crack zones in geological structures, and water from pressurised aquifers that have been around for thousands of years."

Mining in the proximity of large surface bodies of water or near coastal areas is also a concern and can lead to much greater degrees of flooding.

A Schwing bioset pump in action

In addition to natural sources, water is also used at many stages in the mining process, for example, to flush cuttings from drill holes during development or production activities, and to suppress dust. This can add to the problem of naturally occurring water.

Miguel Jahncke, director of mining at Schwing Bioset, says: "Hard-rock underground mines generally have to deal with two main water sources: water that is present in the surrounding ground and enters the operation through troughs, voids, cavities, and drill holes; and water that is introduced through the mining process, through drilling, and face and muck pile hosing to suppress dust (silicosis prevention is the number one reason for keeping dust down underground).

"To prevent mining into unknown underground water bodies and 'rivers', development longholes are typically drilled ahead of the development headings and new mining areas to identify and eliminate, where possible, potential risks. All of the water in the mine is then collected and channelled to the lowest point through a series of channels or ditches."

As water travels through the mine, it collects the fine particles of the rock (sometimes called fines or slimes) generated by the mining process. Downward dipping sections and working areas will collect additional water that can be pumped utilising small electric or pneumatic diaphragm pumps, or small submersible pumps. This water is pumped either to the mine dewatering channels or to one of the mine sumps. As the water reaches the lowest point of a mine, a series of settling ponds are typically used to settle the slimes, and supply cleaner water to the main sump where the main dewatering pumps are situated. These pump the water up to intermediate stages or directly up to the surface.

Buddy Morris, global slurry products manager at ITT Goulds Pumps, says: "Areas such as the base of ramps and at the face will need dewatering pumps. Water must be removed, so collection sumps will be placed at these locations with pumps to transfer water to the primary collection point, where it will then be pumped out of the mine."

Every mine is unique and the degree of water ingress and pumping requirements will vary. Dean Mills, district manager with Xylem USA, specialises in mining applications. He says: "Unwanted water in a mine is a tremendous problem – if the mine is filled with groundwater you simply cannot work. Operators need to get their mines up and running and revenue-generating as soon as possible. For the most part, the deeper the mine, the more water there is. One could say that pumps are the first things to enter a mine site when exploitation starts, and the last things to be removed from the mine at decommissioning."

Steve Sedgwick, product manager, pumps at Weir Minerals, says: "If a dewatering system fails or is ineffective, the impact of this can be enormous. At the very least it will cause delays to the project, but more serious flooding can

cause structural issues and even put workers' lives in danger.

"The factors that influence the scale of dewatering from a mine are many and complex. These combine in a dynamic system that needs to be understood before mining can start."

In the past there was substantial element of trial and error involved in understanding the level of dewatering required. Today, however, pre-feasibility studies for mining projects always involve detailed modelling of the hydrogeology surrounding the mine.

Mr Sedgwick explains that planning is often so good that it is not unusual for the complex flow and head requirements that need to be met by the dewatering system to be mapped out in advance for the whole 20 to 30-year life of an operation. A system is then designed that exceeds the maximum requirements that could foreseeably be needed at the project.

TYPES AND CONFIGURATIONS

The type of pump used for mine dewatering depends on the water flow requirements. Small pneumatic /electric diaphragm pumps, or submersible impeller pumps are often used in the working areas, while larger submersible or centrifugal pumps are used at the main dewatering sumps.

Centrifugal pumps can achieve high flow rates, and can be used in series or in one stage to lift water to the surface. Although as the mine gets deeper, more stages are needed with more lift stations when using centrifugal pumps.

Electrical submersible pumps are the type most commonly used in mine dewatering applications, as they are simple to install and use, and can simply be plugged in for pumping to start. This becomes very useful when the number of pumps needed changes. Electric submersible pumps are also easier to service than many other types and don't generate diesel exhaust gases.

As the weight of a submersible pump varies from 25-550kg, the smaller ones can be controlled by hand. The bigger pumps can be handled by the normal lifting equipment in the mine.

All parts of mine dewatering can be handled by electrical submersible pumps, although many operations choose to use larger centrifugal or slurry pumps at their main dewatering sumps. The exception to this rule is pumping in very high heads (>200m). For this purpose, a special high-head clean-water pump might be necessary. At high heads, tandem connection of several pumps might also be a flexible solution, and in extreme heads multi-stage pumping might be necessary. As the mine gets deeper additional power will also be required to overcome the head pressure as the depth increases.

Mr Mills explains: "Different types of pumps are needed for different applications. Generally speaking, the smallest sizes of lightweight dewatering pumps are used to keep water out of working stopes and pump it to larger stage pumps more centrally located in drifts and on the ramp.

"Smaller dewatering pumps, up to 6kW, are used at rock faces since these are easy to move around, while pumps of up to 20kW are used for stage pumping, and up to 90kW in size for feeder pumping between intermediate levels."

He adds: "Dry-installed multi-stage, clean water pumps are the most common way to pump the water from the main stations up to surface, but submersible drainage pumps can be used if pre-settling is not possible."

In addition to submersible and centrifugal pumps, hydraulically driven piston-type slurry pumps can be used to pump 'dirty water', or those containing slimes. Mr Jahncke tells MM: "The reason these pumps are considered is that they are designed for pumping solutions with a high-solids content and highly abrasive materials (they were originally developed for pumping concrete). Piston pumps can withstand the hard-rock tailings and fines in the mine water mixture. They are also designed for high pipeline pressures, so pumping to the surface can be done in one lift."

Solids content and pressure are both determining factors in using a piston-type slurry pump rather than a centrifugal-type pump. Both types of pumps can be provided with corrosion resistant components to address acidity. Increasing solids content indicates the use of a piston pump in lieu of a centrifugal type.

Egils Dunens, of GIW Industries, says: "The reason for slurry pumps in this application is that when you pump from a pit with lots of water in it, you are basically pumping dirty water, and as the water level goes down it starts to pump a much denser material. This denser material is much more abrasive and satisfactory wear life can only be achieved with wear-resistant slurry pumps.

"Once you get above, say 15% solids, abrasion of the pumps starts to be an issue. Standard water pumps are not manufactured to last in these conditions, as they generally run at much higher speeds to get the required flows from smaller sized pumps."

Mr Doran says that the majority of small mining operations do not have room for settling areas that are used to remove solids from the water, and therefore slurry pumps offer a good solution to meet their requirements.

Mr Jahncke adds: "Centrifugal pumps have been the workhorse of the mining industry for decades and will continue to be the case. Piston-type slurry pumps can be used selectively in high-solids or high-pressure applications. Alternatively, piston type slurry pumps could be used to pump slimes from the main settling sumps periodically. This would eliminate the need for the much more intensive and time consuming processes that are currently used."

Colin Adams, Grindex's representative in Africa, says: "In most instances the type of pump used to dewater the mine is based on the engineering department's preference to a particular type of pump, as well as the miner's personal experience with this type of equipment."

He adds: "Slurry pumps are sometimes ►

Left: Xylem pumps dewatering at the Dannemora mine in Sweden

"Centrifugal pumps have been the workhorse of the mining industry for decades and will continue to be the case"

The dewatering requirements of surface mines are vastly different to those of underground operations

Top: Schwing bioset slurry pumps underground. Above: Sulzer Pumps' HPH 54-25 pumps installed in South Africa

used underground, but in many instances they are extremely heavy and quite cumbersome, and are therefore usually placed in fixed installations."

Mr Morris tells MM: "Slurry pumps are used when solids are present in the mine water, and removing them is not possible or practical given the configuration of the mine or other factors. Submersible slurry pumps and vertical cantilever designs are used as transfer pumps when solids are present, because they offer superior abrasion resistance. Submersible slurry pumps are often used at the shaft bottom, to pump slurry water up to a settling basin at the main pumping station, where the primary multi-stage pump or other pumps transfer the clean water to the surface. Multiple slurry pumps are sometimes used in series at underground mines as the main shaft pumps."

"Slurry pumps are used when solids are present in the mine water"

He adds: "Vertical turbines require minimal solids to work effectively. All of these pumps have very tight tolerances that are affected drastically by wear, which makes avoiding solids critical – typically, less than 1% is recommended as the maximum solids concentration. These types of pumps also operate at higher 2-pole or 4-pole speeds – and since wear is approximately the cube of the speed, higher speed means much higher wear."

Slurry pumps are designed with extra thick sections, and are constructed of hard metals or lined with elastomers to resist wear. They are also designed with large impeller diameters that allow operation at reduced speed to minimise wear. The 'Cube Law' described above also works in reverse, so reducing the speed by half will achieve approximately eight times longer in wear life.

The configuration of pumps employed depends upon the layout and depth of the mine and its design. Some mines can use gravity to remove water in certain areas and, in this case, only larger pumps are used at the lower levels to lift the water up to main sumps.

Mr Doran says: "Most mines are designed as such that the water will flow and accumulate at a certain point, for example a settling dam at the bottom of a ventilation shaft, or a sump at the bottom of a ramp or tunnel. The idea is really to get the water away from the operational area to a centralised point where the dewatering function can be consolidated."

The constant expansion of operations can make it difficult for the mines to use permanent installations of pumps, and many prefer to user light-weight pumps that give them the ease of being able to place and remove pumps as required.

The most common scenario is that of a small lightweight pump used at the working stope to handle inflow of ground water, as well as process water from the drill rigs. These small pumps then pump the water to larger pumps in sumps that can be located in the ramp. All low spots in the mine such as the bottom of shafts and the end of the ramp tend to flood with water, thus requiring drainage pumps.

Typically, every mine has one or several main pumping stations from where the water is pumped out of the mine, or if the mine is deep, to a main pump basin on a higher level of the mine.

For sump and face dewatering, single-stage pumps are more commonly used as they are more suitable for dewatering situations with a high percentage of solids in the water, which is usually the case in mines.

The layout of the mine is very important when it comes to the number of pumps used, for example, a flat coal mine will use a different pump set compared to a deep gold mine. Deep mines use multi-stage pumps to transport the water from deeper levels up to the surface, or in stages up to surface. Big settling sumps are built underground, the size of these clarifying basins or settlers depends on the inflow and amount and type of solids.

These sumps are fed by drainage pumps in different sizes, smaller pumps at the rock face (up to 6kW) and bigger pumps as stage pumps. Very often the clean water pumped by the multi-stage pumps is reused underground as process water for the drill rigs and therefore not pumped all the way up to surface.

Mr Mills says: "A measure for how much power would be needed to pump a certain flow against a certain head can roughly be estimated by the rule of thumb: 0.020 flow (litres/sec) x head (static + friction in meters) = the amount of kiloWatts pumping power needed. For example 50l/s, against 400m of head would need at least 400kW of pumping capacity.

"The lay out of the discharge system (including: solids content of the water, mainly horizontal or vertical distances to be pumped, pump availability, space considerations, the possibility to use multi-stage pumps or not, the possibility to construct intermediate pumping stations or not), will decide whether a single 400kW multi-stage pump can be used, or whether a system with ten 40kW pumps (or any other combination) is the better alternative."

Mr Adams adds: "Pump selection is critical to each application, and this is where companies with technical support at the customer end seem to have the edge over companies who never see the applications where their pumps are used."

Other factors to consider when selecting the style, size, number and configuration of pumps to use include:

- Static lift: A static lift should be considered when it is not economical to install sumps at frequent stages. The cost of constructing more sumps in order to utilise lower-power pumps, which are less expensive to run, needs to be weighed up against the cost of constructing a static lift capable of holding one pump of significant power. While it is more expensive to operate a large pump, the cost of constructing a number of sumps to operate smaller pumps may indeed outweigh that operating cost.
- Length of discharge: The length of discharge is an issue because as the discharge gets longer the more friction loss the pumps have to overcome. It is often more cost effective to put in a smaller discharge pipe as it is easier to handle and less expensive, but the smaller the line the more friction loss the pump has to overcome. For example, 150m of 10cm discharge pipe with 300m of static lift may operate fine with a pump of 20-40kW. Conversely, 1,200m length of the same pipe will require a pump of 150kW range. The change can mean significant cost, but will require fewer pumps.
- Amount of space available: The issue of space comes back to the economics of moving material. Constructing a sump requires an investment of both time and money. The cost of drilling, blasting and

removing additional waste in order to create more or larger sumps needs to be considered. In mining, as with any business, the number of times that the material is handled, the more cost associated with it.

COSTS

The cost to dewater a mine can be significant. Capital costs, maintenance and energy provision must all be accounted for. In terms of the overall operating cost of a mine, pumping costs in some operations can account for 40% and, as such, the design of the dewatering operation is paramount to ensure that profitability can be maintained.

Mr Doran says: "Each deep-level mine has its own requirements and limitations. There is no one design that fits all."

"Each mine has its own requirements and limitations. There is no one design that fits all"

Some mines for example, are restricted in terms of infrastructure to get large dewatering equipment into the lower levels of the mine. In this case, they might use numerous small single-stage submersible type units to transfer the water to a level higher that does have the infrastructure and space to install larger multi-stage units. These can then take the water from that level to surface in one lift.

Mr Doran says that deep gold mines in South Africa always plan and design their high-lift dewatering stations in such a way that they can carry out the least number of lifts necessary to get the water to surface. This allows them to create the space and infrastructure in their mining plan for large multi-stage pumping operations.

PUMP WEAR

Regardless of pump selection, acidity and solids content will yield accelerated pump wear and higher maintenance costs for mine dewatering.

Most of the pumps commonly used for dewatering are not designed to handle significant solids, such as drill cuttings, or slimes, hence the introduction of slurry pumps into these applications. Small submersible dewatering pumps typically are constructed of stainless steel or cast iron and operate at two-pole motor speeds, so any significant presence of solids means reduced life.

A Grindex lightweight portable pump

Joost Reidel, mine technology leader, North America at Schlumberger, explains: "Submersible electric pumps have poor tolerance to solids because of the intrinsic bearing design."

Multi-stage shaft pumps are constructed of cast iron/bronze or alloys, and require a settling sump to remove slimes before pumping. Failure to remove slimes will lead to high wear rates on the pump, with significant down time and maintenance costs. These pumps are always installed with a standby pump to deal with upsets and occasional solids inherent in the process.

Reducing pump wear has become a major concern for many manufacturers. Mine water typically contains a low percentage of solids – <10%. However, the solids are usually very abrasive and will quickly wear out pumps not designed for these types of applications. Some of the pump ranges used in mining feature corrosion-resistant stainless steel housing to protect the pump against acidic mine waters, and high-chrome cast iron for the impeller to resist abrasive wear.

Mr Dunen says: "Each pump manufacturer has its own range of proprietary materials that have been developed to handle the various conditions. Each application would be unique with its own unique solution."

A spokesperson for Pioneer Pump says: "The percentage of the solids is irrelevant to a degree. You may get only one large piece of rock going through the pump in an hour, but that rock could be big enough to break the pump. What really matters is how abrasive a solid may be." He adds: "In most cases, slurry pumps are sold as a multi-functional pump that can be used for both clear liquid and solids handling applications. Although theoretically this allows the end-user to use a 'two-for-one' pumping system, therefore reducing their costs, in practice this is not advisable. Each application should use separate, specialised pumps for maximum efficiency."

To combat acidity in solutions equal or lower to pH 4, Pioneer equips its pumps with Duplex stainless steel CD4MCu, and 316 stainless steel to minimise corrosion. Singaporean producer Sakuragawa says it offers two options; 'hard materials', such as high-grade chromium or manganese steel for the impeller, casing, lining and other wetted parts, or 'soft materials' such as rubber compounds for very abrasive applications.

Mr Mills of Xylem adds: "Slurry pumping is probably one of the most challenging pump selections to get exactly right. Contrary to common belief held in some areas, stainless steel is not always the best choice. Stainless steel offers notably less resistance to abrasion than other materials. A wide variety of pump construction material is available and this should form part of the selection discussions with any pump supplier."

Material is not the only solution to wear resistance of a pump. The design of the impeller and the volute is equally as important, as a more efficient pump will be more wear resistant.

The kinetic energy that the impeller creates with the water will be transformed to pressure by the diffuser. However, this is not the case with solids. The kinetic energy working on the solids cannot be transformed to pressure but only to heat and wear, thus it is important to keep the solids in a homogenous mixture with the water.

A homogeneous flow velocity throughout the pump is needed to achieve the highest possible efficiency when pumping solids. The more homogenous the flow, the higher efficiency and less wear on the pump.

When dealing with solids that are highly abrasive the most suitable material is high-chrome, but Mr Mills says that rubber lined pumps are also common, especially in large slurry pumps used in processing plants where the pumped media is controlled in a better way than the liquid content can be in a mine.

Mr Mills adds: "When dealing with high acidity, stainless steel construction materials are a good choice. For water with chlorides, such as sea water, contrary to what many believe, the best choice is not stainless steel pumps but cast-iron pumps equipped with zinc anodes."

Also, almost all pumping systems now involve some sort of interlocks to protect the equipment. As well as preventing equipment damage, this minimises the labour required to operate them.

UNDERGROUND VS OPEN PIT

The dewatering requirements of underground mines differ quite significantly to those of open-pit operations. Open-pit mines drain and collect all excess water at the bottom of each pit. Large portable pumps are typically used to pump the water to ground level, which in most cases does not exceed 300m in elevation difference. Periodically, wheel loaders are used to

"muck out" the sludge from the collection points at the bottom of the pit and this is loaded out on trucks.

Mr Jahncke explains: "At these depths, most of the water that needs to be contended with is from the water table. 300m is about the shallowest depth for underground mines. Underground dewatering issues are significantly more complex, and typically, significantly more flow is handled."

Underground mines also have the added complications of pumping from multiple levels and on uneven ground.

Surface mines tend to use fewer but larger pumps, and often dry pumps that are more or less fixed when installed. Mr Reidel says: "For open-pit mines, electrical submersible pumps are commonly used in perimeter wells to facilitate dewatering in advance of mining."

Tailing ponds and similar applications are more heavy-duty 'industrial' situations, and fixed installed dry and submerged pumps can be used. Cast iron can be used in the construction of these pumps as weight is not as important for fixed installations.

Mr Adams says: "A pump used in shaft dewatering is mainly chosen by the total delivery head, and the flow seems to be less important. When dewatering an open-pit mine, a lot of the time the actual volume of water being pumped is the main driving factor in pump choice. I think this is largely due to the constraints of the working area, which are far more restricted in underground mining than in opencast. For example, in underground coal mines EX- or MSHA-approved pumps might be necessary, which is not always the case in open-pit operations."

Open-pit mines do not always have access to electricity so diesel pumps are more common. In both open-pit and underground applications, pumps need protection against falling rocks, and open-pit operations need protection against extreme weather, especially torrential rain.

AUTOMATION

The use of automation can protect pumps from overloaded or starved operating conditions that can lead to excessive wear or damage without constant manual supervision. However, there are a multitude of real-world variables that automation cannot anticipate and that human operators are needed to respond to.

Some advantages of implementing automation, whether it is just remote monitoring or fully automated operation include: more efficient use of skilled operators; optimisation of pumping operations; energy savings; improved maintenance; and the fast identification of faults.

Mr Adams says: "In South African mines, the widespread use of automation is not yet common practice. However, I have no doubt that in the, future cost saving on automating a mine's dewatering process will exceed the capital outlay and then this may become a viable option."

There are a variety of monitoring controls that can be used with dewatering pumps. Xylem offers a supervisory control and data acquisition (SCADA) system that can work in conjunction with a monitoring system, enabling the operation to be monitored from above ground. This gives operators access to critical data from one location, and allows operators to monitor equipment, troubleshoot and identify trends, and diagnose and resolve issues quickly and easily.

Control systems provide ease of operation, flexibility and reliability, ensuring more uptime, greater energy savings and less operating and maintenance costs. However, as with all monitoring systems, human management is also necessary, and it is important that the controls are monitored regularly to avoid an issue becoming unmanageable if left to escalate.

Mr Doran says: "Automation/remote ►

"Control systems provide ease of operation, flexibility and reliability"

A Grindex electric submersible pump in operation

operation is already being widely used in the bigger pumping installations in mines. This type of control is critical in big mines, as they are dealing with many pumps at many different levels within the operation, some in remote areas that all need to be constantly monitored and switched on and off depending on the different requirements in different areas."

He adds: "It also gives the ability to be proactive in an emergency situation, where a mine starts flooding for example, and pumps can be switched on remotely without having to send a person down into a dangerous area."

The reliability of all the pumps underground can also be monitored remotely at a single point of control, thus allowing effective management of the dewatering operation, for example, by knowing which pump is due for maintenance and when.

Remote and automated operation is also becoming more common as variable-frequency drives become more widespread. The obvious advantage is that an operator does not physically need to be at the pump in order to make changes to the speed it is running or to start and stop the unit according to different conditions. This reduces the time commitment required and also has health and safety benefits. The operator can control the unit from a remote console that is connected with the pump either by cables or wirelessly or via the internet, allowing adjustment from mobile devices.

"We are witnessing an increasing demand for more efficient pump systems"

Mr Sedgwick adds: "Automated control, where pump frequency responds automatically to the water level in a given location, is a further advancement that allows the system to get on with its job efficiently and reliably without need for regular operator input."

INDUSTRY TRENDS

When asked about current industry trends, Mr Mills says: "We are seeing new trends in the application of pumps – mine operators are starting to plan and develop sumps that help maintain the life of the pump."

Mine operators are also becoming more conscious of energy saving. "We are witnessing an increasing demand for more efficient pump systems," adds Mr Mills. "This requires better pump hydraulics and more efficient electrical motors and diesel engines, as well as more efficient pump sumps, settlers and pipe arrangements."

In addition, mine workforces are becoming more highly educated and therefore, more expensive, thus there is a trend towards smarter and more reliable pumps that are less labour intensive.

Mr Adams supports this: "We are seeing a demand for more intelligence to be built into pumps. Pumps must be able to run dry or be left on snore for a period of time (with a closed outlet), and they need to be easier to maintain and service."

Mines are also getting deeper and more mechanised. The result of this is more water and longer distances to pump, but it also means that the mine requires more water to operate.

There is also a growing need within the mining market for expert providers of complete, turnkey dewatering solutions. While companies may have some of the technical expertise in-house that is required to manage and operate dewatering projects, more limited budgets due to challenging economic conditions mean that they often do not wish to make significant investments in equipment purchases that may just be required for a one-off project.

Jeff Halford, marketing manager for Xylem's rental and dewatering services, says: "We are noticing an increased demand within the mining industry for dewatering services to be supplied as a complete package, including the pump and water treatment systems, engineering expertise and project management. The Xylem onsite dewatering service provides customers with turnkey solutions from a single source. This limits customers' administration and management efforts, and provides peace of mind as they are contracting dewatering experts."

PRODUCTS

MM spoke to a selection of pump manufacturers to find out which of their products could be used in certain mine dewatering applications.

Sulzer Pumps

Sulzer focuses on providing for deep level dewatering operations using its HPH and HPL range of ring section pumps. The company has supplied more than 4,000 units to the South African and Southern African market over the past 45 years.

Sulzer says these pumps are suitable for delivering large volumes of water at high pressures. The material combinations, along with advanced coating technologies, allow for long periods of trouble-free operation before any maintenance or refurbishment is needed.

Sulzer also has a range of submersible pumps from the well-known ABS brand that are widely used in mine dewatering. ABS J electric submersible drainage pumps range from 0.5-56kW, and the JS- range of sludge pumps are rated from 0.9-8kW. There are high-head versions available, and serial connectors for dry installed dewatering pump systems. Sulzer says the number one-application worldwide for J and JS pumps is at open-pit operations, although they are also used in underground mining installations in accordance with equipment regulations by country.

"We have recently received an order for the supply of 18 large HPH dewatering pumps to complement the fleet of 64

HPH units that have already been installed at a copper mine in Zambia," says Mr Doran. "Renowned as being the wettest mine in the world, these units will be installed in batches of three and six at different levels within the mine." The HPH pumps installed at the mine produce heads between 435m and 1,100m.

Mr Doran adds: "We are continuously getting orders for HPH pumps from Kazakhstan for mine dewatering. These pumps are being selected for their ability to dewater the mine in one lift, are energy efficient, and have proven to be reliable and good value for money."

Schwing Bioset

Schwing Bioset specialises in manufacturing piston pumps for high solids, high-pressure slimes pumping. The company employs chrome-lined or induction hardened pumping cylinders, and carbide or alloy wear parts to manage corrosion and abrasion.

Schwing Bioset recently installed a KSP 50 V(HD) piston pump at the Turquoise Ridge mine in Golconda, NV, US, (currently owned by Barrick). The pump is used intermittently to dispose of slimes that have accumulated during normal mine operation. The high head capacity of the pump permits the mine operator to pump the slimes for surface disposal in one lift. The disposal pipeline is designed to maintain a critical pumping velocity to keep solids entrained and to avoid settling.

The KSP 50 V(HD) also incorporates poppet-type control valves to prevent backflow from the high vertical head. Typical control valves, as used in concrete pumps, permit momentary backflow of material at the end of each stroke; this backflow creates a hammer effect which can damage the pipeline and increase pump wear. The poppet valves used by Schwing Bioset serve as a check valve to prevent backflow, and the discharge valves do not open until pressure in the pump is equal to pressure in the pipeline.

ITT Goulds Pumps

ITT manufactures an extensive line of submersible slurry, horizontal slurry, vertical cantilever, vertical turbine and process pumps that may be used for dewatering services. The company says it offers so many models, sizes, features and construction materials for each pump that virtually every unit is custom-manufactured to meet the specific needs of its customers.

ITT particularly recommends its XHD Extra Heavy Duty Lined Slurry Pump. Released in 2011, the XHD can be used in a variety of applications, including dewatering, and can easily tackle abrasive slimes. Mr Morris says: "The XHD pump can replace existing slurry pumps without retrofitting, and can be maintained even while running, with parts that are more accessible and adjustable than in other slurry pumps.

Grindex

Grindex says its entire range of pumps is designed for dewatering in mines. In extreme conditions, such as a very high or low pH, the company recommends its INOX family of stainless steel pumps. In the case of highly abrasive slimes, the BRAVO family of slurry pumps is recommended.

BRAVO slurry pumps are designed for use in applications that require very-high durability. They can handle liquids with pH values from 5.5-14. The BRAVO 400 to 900 models are equipped with an agitator beneath the pump intake, to stir up settled material and increase its uptake. These models can also be fitted with an optional cooling jacket for use in dry-pit applications.

INOX pumps are designed for use in corrosive waters. In some mines, water can become caustic and destroy conventional pumps in a matter of days. The pumps may also be used in applications where saltwater needs to be pumped, and can handle pH values from 2-10. They can also be equipped with zinc anodes for extra protection.

Over the past 18 months, Grindex has supplied two different underground mines with an extensive range of equipment. The first is a platinum mine that ordered: six Mega H pumps (to act as emergency shaft bottom pumps); 20 Maxi H pumps (for various pump stations); 20 Minex pumps (used to keep key areas underground dry and clean); 10 Master H units (midway pump stations/ booster pumps); 80 Major H pumps (face dewatering and decline sumps); 40 Sandy H (face dewatering and decline sumps), and six Bravo500 and 700 pumps (for slurry pumping and dam cleaning).

The second operation (a gold ►

Between May 2009 and February 2010, Xylem pumps removed more than 3 million m³ of water from the Dannemora mine in Sweden

mine) ordered the following:

- 10 x Mega H pumps (emergency shaft bottom pumps);
- 12 x Maxi H pumps (various pump stations);
- 40 x Minor H (face dewatering);
- 50 x Major H (various uses from face to sumps);
- 60 x Sandy H (face dewatering and sumps); and,
- 10 x Inox Minette (plant).

Pioneer Pump

Pioneer recommends its PP- Pioneer Prime series of vacuum-assisted, self-priming pumps for dewatering applications. The company says it sold over 3,000 units sold in the first four years of producing the range.

Available in sizes from 50-450mm, Pioneer manufactures 260 models of the Pioneer Prime pump in various construction materials, and with a range of mounting configurations. The models can cater to flows up to 4,000m³/h, heads up to 200m and can handle solids up to 95mm in diameter. They are driven using Pioneer's sound-attenuated diesel driven pump sets, and can be adjusted for fixed or portable applications.

Construction materials include: standard ductile iron casings and impellers, with options of 316 stainless steel, CD4MCu, or CA6NM.

So far, Pioneer has only sold Pioneer Prime pumps for surface applications but says there is also potential for their use underground.

"Pioneer recommends its PP- Pioneer Prime series of vacuum-assisted, self-priming pumps for dewatering applications"

Thompson Pump

Thompson focuses primarily on surface mine dewatering and wash down operations, but says some of its pumps could also find use underground. The company offers a variety of pumps, including high-head, high-pressure, and hydraulic submersible pumps.

Its hydraulic submersible units range in size from 7.5-30cm diameter. They can handle solids up to 11cm diameter and can pump up to 27,000l/min. Thompson says the range is ideal for applications with high heads or when high lifts are required. The submersible pump end eliminates suction lift limitations, allowing pumping in deep mines, while the heavy-duty cast iron and steel provide high reliability and maximum versatility. These models are also available with automatic controls and sound attenuation options.

Thomspon also has a selection of high head and high-pressure solids handling pumps. The JSC Enviroprime centrifugal pumps are dry running, portable, automatic priming, diesel driven pumps that can handle solids up to 10cm, and are designed for water with moderate flows or high discharge heads containing solids.

Thompson says its 8JSCW is ideal for mining operations because the pump provides a maximum flow of 16m³/min, a maximum discharge head of 200m and handles 5cm diameter solids. In addition, Thompson offers a range of high head and high-pressure, clear liquids pumps but says these aren't used much in mining.

The company offers corrosion- and abrasion-resistant wetted parts for its pumps, including stainless steel and hardening to 500BHM. It has found that this is an increasing trend for pump longevity.

Sakuragawa

Singapore-based Sakuragawa offers a range of pumps suitable for underground operations. The company explains that its lightweight UC and UCF pumps are rated at 4-22kW and are suitable for use as primary pumps (to collect water from sumps). It also offers the U-Series of pumps, which are rated at 37-164kW and are suitable for use in high heads.

Its pumps are used at many operations, including Mamut Copper Mines in Sabah, Malaysia and Cibaliung Sumberdaya gold mine, in East Java.

Xylem

Xylem is a relatively new company that was spun off from ITT Corp last year. Its product range includes the Flygt and Godwin brands, which are well-known in dewatering applications.

Mr Mills says: "The type of Xylem pumps most relevant for dewatering are Flygt transportable, submersible pumps and Godwin electric drive stationary, Dri-prime pumps for installations of a more permanent nature.

"Generally Flygt drainage pumps can reliably pump up to 10% solids by weight, sludge pumps can handle up to 20%, while slurry pumps can be selected and configured to handle up to 40% solids by weight."

Xylem's Flygt 2600 series pumps are extremely durable, wear-resistant, lightweight and portable. They feature Xylem's patented Dura-Spin hydraulic system that minimises impeller wear, fewer components, and Xylem's Spin-Out design that minimises clogging, protects the outer seal and extends the service life by expelling abrasive particles from the seal.

The Flygt 2000 series comprises a selection of mobile submersible pumps that feature a compact design for easy installation and operational reliability, while the 2700 series all-stainless steel pumps are suitable for handling corrosive and abrasive liquids with pH values between 2 and 10.

Xylem says its Flygt 5000 series slurry pumps are intended for use in the most abrasive applications where transportation of solids is the main operation and the water is merely the carrying fluid. The compact design and the fact that the pumps are submersible make them easy to install and ensures quiet operation.

The Flygt D/DY8000 corrosion resistant vortex pumps can also be used for pumping corrosive liquids and sludge, as well as large solids. These are available both as submerged and dry installed units.

From the Godwin range, Xylem offers the HL series of Dri-Prime automatic self-priming dewatering pumps, which can handle air/liquid mixtures, solids and are capable of flows of up to 1,200m³/h. The HL series can pump heads of up to 200m using a single-stage impeller. The pumps are available with diesel engines or electric motors for use in underground mine drainage.

Weir Minerals

Weir offers the MULTIFLO MF heavy-duty self-prime dewatering pump for mine dewatering. Featuring an auto vacuum system, which eliminates priming problems, the pump has several types of mounting options including heavy-duty skid bases, steel pontoons or mining trailers.

Other customised options include monitoring and instrumentation and an auto start/stop facility.

The WARMAN WBH slurry pump has low power usage, reduced maintenance requirements, long wear life and high performance, while the WARMAN SJ submersible dewatering pumps are designed to offer an optimal combination of durability, hydraulics and materials technology. Featuring a low-weight pump design, Weir says the WARMAN SJ range is easy to install, making operation easy and safe.

Weir is involved in several feasibility studies for large surface mining projects that are planned to reach final depths of around 300m.