Effective mine dewatering:

Water management in mineral extraction

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Water management for copper mining

Effective water management is critical in any mining operation, so finding innovative mine dewatering and fluid transfer applications is essential for today’s mineral extraction processes. Petar Ostojic discusses how custom engineered barge pump systems help accomplish this task in two copper mining companies.

Centrifugal pumps are widely used in the global mining industry, from mine dewatering to hydrometallurgy extraction processes, and are considered the heart of any mining operation. Several of the most respected engineering, procurement, and construction management (EPCM) companies are developing a record number of projects for the world’s biggest mining companies that are currently operating in Chile, Peru and the rest of Latin America. Most of these projects are mainly based on the extensive use of centrifugal pumps.

The current boom in the price of metals is pushing EPCM companies and their providers to deliver fast engineering solutions without compromising project’s costs and operational safety. This scenario has allowed pump manufacturers to work closely with engineering firms developing innovative solutions in order to accomplish these objectives.

Pumps on barges

Barge pump systems (Figure 1) represent a great alternative for today’s mining projects, delivering efficient, fast and cost-effective solutions for current mining requirements. Such a system is really simple in its design, consisting of a centrifugal pump, usually in vertical disposition, attached to a free-floating barge. Among the main advantages are that a free-floating barge design requires no civil works, the barge can be easily handled and installed, it is always at the correct submergence, no priming is required, and the design needs the minimum of space.

However, as simple as it may sound, there are still some considerations that have discouraged clients over the years in selecting this as a viable alternative for their projects. First, it is difficult to find a complete single-vendor pumping station supply that includes pump, motor and barge; second, most manufacturers use vertical cantilever sump pumps providing low heads (usually up to 60 m) and low efficiencies of around 60-70% - usually a booster pumping station is required next to the pump to reach higher total dynamic heads.

All-in-one package

Neptuno Pumps, an engineered industrial pump manufacturer based in Iquique-Chile, wanted to develop a complete pre-packaged modular barge pump system, which could provide larger heads, avoiding the use of intermediate booster stations and diminishing the total number of pumps used on a single project.

The design comprises a centralized individual high-head and highly efficient vertical turbine pump (VTP) attached through a metallic reinforced base plate support to a custom engineered free floating barge. Vertical turbine pumps are widely used in the mining industry because of their technical and practical advantages, making them perfect for the use in a barge pump system.

The design’s modular multistage construction offers higher efficiencies on high head and high flow applications, and allows the pump to be customized for many applications. No priming is required because the impellers are submerged in the liquid, and the first stage impeller can be lowered to provide the desired NPSH margin.

The barge system was designed as a modular concept using 3D CAD/CAE and finite element analysis (FEA) modelling (Figure 2), ensuring that the pump set and pontoon are balanced for optimal stability. It is custom manufactured on high-density polyethylene (HDPE) with non-collapsible, foam filled flotation chambers, which eliminates the chance of catastrophic failure from chamber leak and maintaining the system always at proper submergence.

Using high-pressure vertical turbine pumps, with total dynamic heads up to 350 m (1,148 ft), and high efficiencies up to 85%, eliminates the need for an immediate booster station, reducing the amount of equipment used in the mining operation.
Open-pit mine dewatering

Compañía Minera Doña Inés de Collahuasi is thought to be the world’s fourth-largest copper mine and it counts as one of the biggest open-pit mine operations on the planet. It is located at 4,400 m above sea level in the Andean plateau of northern Chile’s Tarapacá Region. Mine dewatering at Collahuasi was achieved by pumping continuously from a series of dewatering wells around the mine and installing low-head pumps in special sumps on the mine floor to remove surface water. However, one main characteristic of this mine site was the existence of huge lagoons in the bottom of the mine pit, collecting enormous volumes of water which needed to be pumped back to the surface. This needed several pump stations located at strategic positions and depths.

In 2010, a mine dewatering programme was devised to reduce the impact of groundwater on the mine. The project incorporated 10 75 kW (100 hp) and 112 kW (150 hp) barge pump systems (Figure 3), engineered as a modular, light-weight design, with a total dynamic head of 150-250 m (492-820 ft), that could be easily transported as the exploration advance and mining conditions change in the open-pit.

Over time, this arrangement allowed a reduction in equipment through the use of high-head pumps, reduced haulage costs because of having dry ore and waste, improved in-pit transport and operating conditions, plus reduced wear and tear of machinery. Also, the stability of mine walls was improved during and after excavation.

Copper hydrometallurgy

Compañía Minera Lomas Bayas is located in the Atacama Desert, 120 km east of Antofagasta in northern Chile. This open pit copper mine is one of the world’s lowest-grade copper operations with average grades of 0.27% soluble copper. Copper hydrometallurgy processes, such as solvent extraction/electrowinning (SX/EW), can efficiently and economically process lower-grade ores with lower water consumption. This technique consists basically in using an aqueous solvent to dissolve or leach minerals for ores.

In the SX/EW process, the ore is leached with sulphuric acid, and then the copper is extracted from the acid leach with a solvent which flows to the leach pad where it is collected and directed to flow into the leach ponds. Pumps then transfer it to the SX plant and the copper is subsequently electrolytically refined.

The solutions used in this process are chemically aggressive because of their acid nature, and they require the use of special materials with superior corrosion resistance, such as high alloy stainless steels, for all of the pump’s wet parts.

The other important aspect is that generally it is not possible to control the level of the liquid in the pond, so vertical turbine pumps represent the best choice because of their design flexibility.

In these stations, the length of the pumps is designed such that the impellers are submersed at all times, even when the fluid level reaches its minimum. Sometimes, when this length is too high, equipment’s cost can increase considerably because of the high costs of materials used for the pumps.

All the above considerations, plus the extensive use of ponds in the process, make the barge pump system the ideal
solution for this application. Neptuno Pumps engineered a barge pump system (Figure 4) that included, depending on precise fluid characteristics, fully cast duplex 2205, super duplex 2507 or 254 SMO vertical turbine pumps capable of handling these highly corrosive solutions, while providing high total dynamic heads up to 200 m (656 ft).

HDPE has also a superior chemical resistance to acid solutions, making the material ideal for the construction of the floating barges. This system required minimum civil works and it was engineered to stay at the proper depth, requiring no priming. This allowed the use of much shorter vertical turbine pumps, further reducing the project’s cost.

Custom engineered barge pumping systems

Neptuno Pumps offers custom engineered barge pumping systems for the most diverse mining applications, including the following:

- Water supply
- Mine dewatering
- Tailings – post processed solutions
- Solvent extraction/electrowinning (SX/EW)

Operating parameters:

- Head up to 300 m (1000 feet)
- Capacities up to 3000 m³/h (13,200 gpm)
- Power through 750 kW (1000 hp)
- Frequency 50/60 Hz
- Bowls sizes from 20.32 cm (8 inch) to 50.8 cm (20 inch).

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