Mining

Re-powering water reclaim systems

In the mining industry, production is directly related to the plant’s total pumping capacity, and reclaim systems are the main source of water. With the pressure on to improve processes, Petar Ostojic discusses how pump manufacturers can help mining companies re-power their reclaim water systems with custom engineering solutions, improving pump capacity and reducing energy consumption.

In recent years, good copper prices have motivated the world’s biggest mining companies to improve processes, increasing production with the shortest payback period and minimum operational intervention. Re-powering reclaim water pumping systems represents a huge opportunity for pump companies to incorporate engineering consulting to their service portfolio, providing fast and custom engineered solutions to their clients, so optimizing efficiency and reliability.

The pumping system

Los Pelambres Mining Company, based in Chile, has one of the ten largest copper deposits in the world. In 2011 the company ordered several studies, searching for areas of improvement in their processes. One study showed that its reclaim water system represented a good opportunity to improve pumping capacity and reduce electricity consumption.

The reclaim water pumping system consisted of two fixed pumping stations, as shown in Figure 1, originally designed to pump a total capacity of 950 l/s. These pump stations, named ER1 and ER2, were located with a difference in altitude of 249 m and approximately 60 km of 32 inch piping. Each station was equipped with six vertical turbine pumps (VTPs) with a total dynamic head (TDH) of 390 m and 382 m respectively. Each station had a 1500 HP motor.

The study showed that pumps on both stations were operating at off-design flow (to the left of the best efficiency point - BEP), intersecting their system curves at 910 l/s and 935 l/s respectively, both with the same low efficiency performance of 69%, thus operating in a highly loaded condition. This situation was damaging the equipment and generating high operational costs because of the high energy consumption.

However, the piping system could still withstand an increase in capacity of approximately 16%, being able to reach up to 1100 l/s. Three different options were studied in order to accomplish this goal, but only one was economically and technically suitable for the client.

The options

The first option studied was to modify the piping and get the pump to BEP flow; however, this was not economically feasible because of the length of the piping system and it would require considerable civil works.

A second alternative was to re-engineer the existing pumps, taking advantage of the existing main components to minimize purchase costs; however, this option would require lengthy downtime of the equipment on both pump stations in order to obtain the desired duty point, such as adding an extra stage per pump, changing all impellers to their maximum diameter and replacing all shafts because of its new pump length.

Figure 1. The reclaim water system was originally designed to pump a total capacity of 950 l/s.
This alternative would also require significant structural modifications and civil works on the first pump station (originally designed to operate with only six pumps) because the station would require three new pumps and motors in order to accomplish the desired pumping capacity of 1100 l/s. Even if this work were carried out, the study showed that the modification would reduce ER1’s pump efficiency by almost 10%, thus increasing total power consumption of the station by 61% - increasing electricity costs by US$1,682,490 per year.

Re-engineering ER2's pumps would also require the replacement of the existing six 1500 HP motors with six 2000 HP new ones, increasing power consumption by 37% and increasing electricity costs by US$991,100 per annum. The second alternative would increase energy consumption by US$2,673,590 each year.

The only option was to install new pumps that would meet the desired performing conditions with a better efficiency and that would require relatively minor intervention to the stations.

Custom engineered

Neptuno Pumps, an engineered industrial pump company based in Iquique, Chile, was asked to develop a satisfactory solution. Using computational fluid dynamics (CFD) and finite element analysis (FEA) technology, (as shown in Figure 2) Neptuno Pumps recommended the VTP 850X; a vertical turbine pump with a radial impeller design and high head/stage, which would suit both pump stations’ duty points, reaching a maximum TDH of 507 m, with seven stages and 80% efficiency at its BEP.

This custom engineered pump incorporated several special features in order to guarantee a steady and reliable operation. The fluid was clean water with low solids concentration, so no special material was needed.

Ductile iron ASTM A536 was selected for all its wetted parts because of its excellent mechanical strength, in order to withstand high pressures, and for its low manufacturing cost.

17-4 PH stainless steel was specified for the shaft, because of its high yield strength, especially designed to withstand a highly loaded condition. The design also considered the hydraulic balancing of all its impellers by including a fully independent axial thrust bearing assembly in the pump discharge head that could withstand the high hydraulic thrust, including the weight of the impeller and shaft. This would improve the thrust bearing’s life and maintain the pump and its motor running safely.

This tailored solution represented several technical and economical improvements compared with the old pump’s re-engineering alternative, reducing operating equipment on both stations by 33% and using the available space for stand-by equipment, thus increasing the system’s availability and reliability.

Furthermore, the new pump curves intersected the system curves at the pump's BEP at a capacity of 1194 l/s, providing 9% more flow than originally expected. This high efficiency pump design also allowed the re-use of six 1500 HP motors on the first pump station, as shown in Figure 3, requiring the purchase of only six new 2000 HP motors for the second station, reducing the initial investment required.

The new engineered pumps in both pump stations, as shown in Figure 4, provided a 31% and 25% increase in pumping capacity and a reduction in energy consumption of 34% and 20% - a total saving of US$1,197,460 per year in electrical costs, while increasing pumping capacity by 9%.
Expensive re-engineering

It is widely accepted in the industry that the initial pump purchase represents only 10% of the total costs of ownership in the pump’s life, while 90% corresponds to maintenance, operation and installation. As a result, customers tend to consider re-engineering the existing pumps before considering a complete new solution with new equipment.

However, this case shows how the re-engineering of existing pumps can be more expensive in the long run, because of a low efficiency operation and high energy consumption. High technology pump companies can offer engineering consulting and cost effective custom engineered solutions to their clients, optimizing their processes, incrementing their pumping capacity and reducing their energy consumption, allowing the shortest payback periods for their projects.

This case is just one example of how the old paradigm of transactional relationships between providers and end users is being left behind, opening the path to a new way of doing things in the mining industry. Mutual co-operation, commitment and technology are allowing pump manufacturers to provide custom engineered solutions to its clients, not only optimizing their processes, but also exceeding their initial requirements and expectations.

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