Site report

Two HSP 3080 high density solids pumps convey sludges containing sand from a depth of 1,250 m to the surface and replace 43 centrifugal pumps

The following report shows an interesting solution on how to mechanize the cleaning of settling basins in coal mines and draw off the sludge collected there. This is a well known problem in the mining industry all over the world and in many collieries it still results in unnecessary high costs.

The problem

Since 1870, large amounts of hard coal have been mined at Houillères du Basin de Lorraine (HBL) in France. The problem at this colliery is that more than 50 million m^3 of water has to be pumped out of the mine to the surface every year. In addition to the natural water ingress, there is also the muddy water from the working faces which has to be pumped by hydraulic stowing. During the stowing phases the volume of water to be pumped is increased by approx. 500 m^3/h. The sand content is above 40 g/l. The water and solids are separated in settlement lagoons. In 1993, the volume of the sands and sludges deposited in this way from all the HBL mine workings amounted to 97,000 m^3.

Sludge disposal system

When comparatively small amounts of high density solids are to be conveyed, the transport problem is usually solved by using conveyors which load the sludge into mine cars.

This method has however the disadvantages of tying up the colliery fleet and the roads and filling stations are heavily soiled. The high volume of material to be stored from the Vouters workings each year amounts to 2 million m^3. This led them to set up their own disposal system which conveys the sludges from a depth of 1,250 metres to the surface.

As soon as the lagoon is filled (capacity 1,000 m^3) the sludges are suspended by injection of pressurized water. A submersible pump conveys the sludges into a sump where they are then uniformly distributed by injecting compressed air.

Above: The solids pump HSP 3080 has been installed since Feb. 1993. It pumps sludge from the 686-metre level invert to surface. Therefore there is no need for further relais stations.

Below: Suspending a sludge sump with water jet

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The old conveying plant

In the past a total of 43 single chamber centrifugal pumps connected in series were fed from this sludge sump (output 200 m³/h). They pumped the sludges containing sand through five invert levels to the surface ie. 1,250 m vertically. The maximum size of the largest grain was 20 mm, 70 % of the solids were smaller than 6 mm.

With coal workings at ever increasing depths the existing centrifugal pumps had already reached the limits of their performance. Furthermore, a dramatic decline in solids concentration was noted whilst pumping. This "dilution" of the sludges being caused by the necessary injection of gland seal water into the pressure seals of the centrifugal pumps. As more and more centrifugal pumps were connected in series as stage

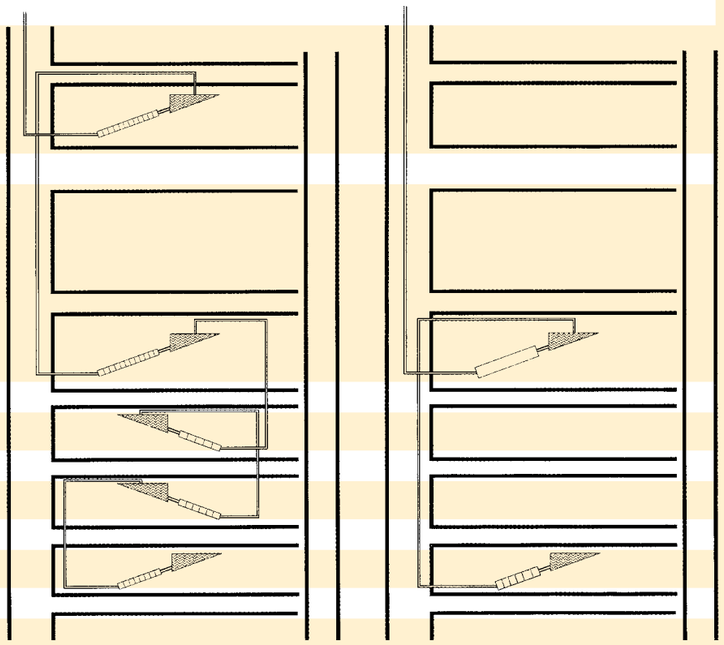
View into the former sludge pump room on the 686-m level invert.
The 12 single chamber centrifugal pumps are connected in series and convey the sandy water over 141 m to the next 545-m level invert.

Reduction of solids concentration

Level of invert m	Spec. gravity of suspension kg/m³	Solids content g/l	Solids content cm³/l
on surface	1072	144	72
315	1091	182	91
686	1115	230	115
836	1139	278	139
1036	1149	298	149
1250	1360	720	360

Old: Illustration of the conveying plant consisting of 43 centrifugal pumps

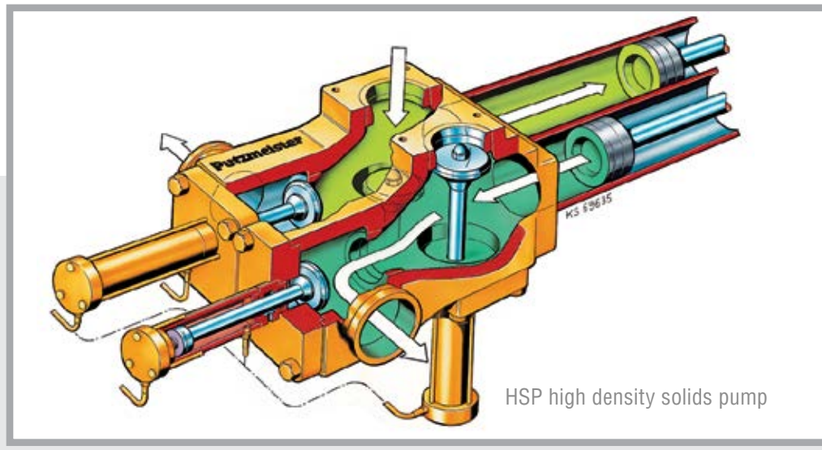
New: Illustration of the new pump circuit



pumps, the unintentional effect was that the dilution factor added up. The result was that the solids content declined from 720 g/l (1,250 metre level) to 144 g/l on the surface. This led to high operating costs both of energy and maintenance of the pumping plant.

The new method

Because the existing plant was working at full capacity and with its enormous wear and energy costs HBL looked for an economic alternative.
Their aim was to increase the conveying capacity, reduce the number of pumps and pump relay stations used thereby reducing the current operating costs using extensive mechanization.
During the modification work 43 centrifugal pumps using 2,365 kW of power were replaced by two large capacity double piston pumps using only 320 kW drive power each. This means that only a fraction of the previous power consumption is now consumed. The reduction of energy costs and the capability to pump constantly to the surface, the sandy water with approx. 700 g/l has improved the total economic efficiency of pumping sludges. A valve controlled HSP 3080 double piston pump at the Vouters Colliery is now the only relay station and pumps the sandy water from the 686 metre deep invert to surface. This has been in operation since Februar 1993. Because of the good experiences with the first Putzmeister double piston pump a second HSP 3080 high density solids pump was installed in December 1995 and this sited at the 1,250 metre level replaces the remaining 19 centrifugal pumps.



HSP high density solids pump

Set-up and function of the HSP high density solids pump

The high density solids pump used here is the powerful twin cylinder piston pump, model HSP 3080. Putzmeister designed this unit for a continuous simultaneous performance of 90 m³/h and a working pressure of 100 bar in the medium conveyed. The high density solids pump consists essentially of two hydraulic cylinders, two delivery cylinders as well as a plate valve controlled pump head. An explosion proof electrohydraulic power pack provides the 320 kW.

The pump head has a suction and pressure valve per delivery cylinder and Putzmeister has dimensioned these components especially large and designed for tough continuous operation. The hydraulically controlled plate valves in the pump head are arranged in such a way that the conveyed material cannot enter into the hydraulic circuit. The delivery cylinders have a stroke of 3,000 mm and 280 mm diameter and are lined internally with a double hard chrome layer and honed. The pump discharge outlet is on the side of the pump head and can be sited on the left or right according to the required position ot the delivery line. It is safe for the pump to run dry as the pressurized oil lubricates the delivery pistons continuously.

The HSP range of high density solids pumps is based on a modular design system. Piston stroke, delivery cylinder and valve diameters, max. output and conveying pressure can therefore be combined individually and depending on the specific operating conditions can be remotely or automatically controlled.
There are also different valve shapes available. For more liquid materials resp. very fine and extremely abrasive silica sludges the valve plates have an elastomer seal.
To facilitate service work, Putzmeister has designed the valves, seats and delivery

Two hydraulic units each 160 kW supply the HSP high censity solids pump wiht the necessary drive performance. Free-Flow-Hydraulics provide high efficiency.

pistons of the HSP high density solids pump in such a way that they can be exchanged quickly and easily without having to dismantle the delivery line.

Damping measures prevent "impacts" in the delivery line

The HSP high density solids pump of HBL has an LPD 250 damping system ("low power dampener") fitted on the suction side of the pump which prevents water hammering. An excellent damping effect is obtained on the pressure side when conveying this highly aqueous and non-compressible medium by injecting air directly into the delivery line.
The conveying system is supported on the pressure side by an HPD 750 high pressure dampener. The hydraulic pulsation dampener is positioned close to the pump outlet on a T-piece in the delivery line (100 mm diameter).

The hydraulic cylinders and the vertical HPD high pressure dampener. The dampener is responsible for the uniform delivery velocity.

During the pumping stroke of the HSP pump, the dampener cylinder fills itself with the conveying medium. Just before the pump stroke is completed, the dampener is activated and discharges the stored material into the delivery line (during the short interruption phase while the delivery pistons switch over). In this way a uniform delivery velocity is achieved and decompression impacts are minimized.

Conclusion

With the help of these measures, optimum conditions were created at the HBL mines in Lorraine for pumping sludges containing sand at constant solids concentration with only two high density solids pumps from a depth of almost 1,250 m without uncontrolled pressure peaks in the delivery line. This method of conveying sludge from mine settling lagoons is reliable and economical.

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