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 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 i.e. 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 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 pumping sludges. A valve controlled HSP high density solids pump was installed in December 1993 and this sited at the 1,250 metre level replaces the remaining 19 centrifugal pumps.

2. 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

<table>
<thead>
<tr>
<th>Level of invert m</th>
<th>Spec. gravity of suspension kg/m³</th>
<th>Solids content g/l</th>
<th>Solids content cm³/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>on surface</td>
<td>1072</td>
<td>144</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>315</td>
<td>1091</td>
<td>182</td>
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<tr>
<td>686</td>
<td>1115</td>
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<td>139</td>
</tr>
<tr>
<td>1036</td>
<td>1149</td>
<td>298</td>
<td>149</td>
</tr>
<tr>
<td>1250</td>
<td>1360</td>
<td>720</td>
<td>360</td>
</tr>
</tbody>
</table>

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 290 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 of 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 density solids pump with 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).

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.