

Slurry, Paste and Cake

Transport by hydraulic driven Piston Pumps

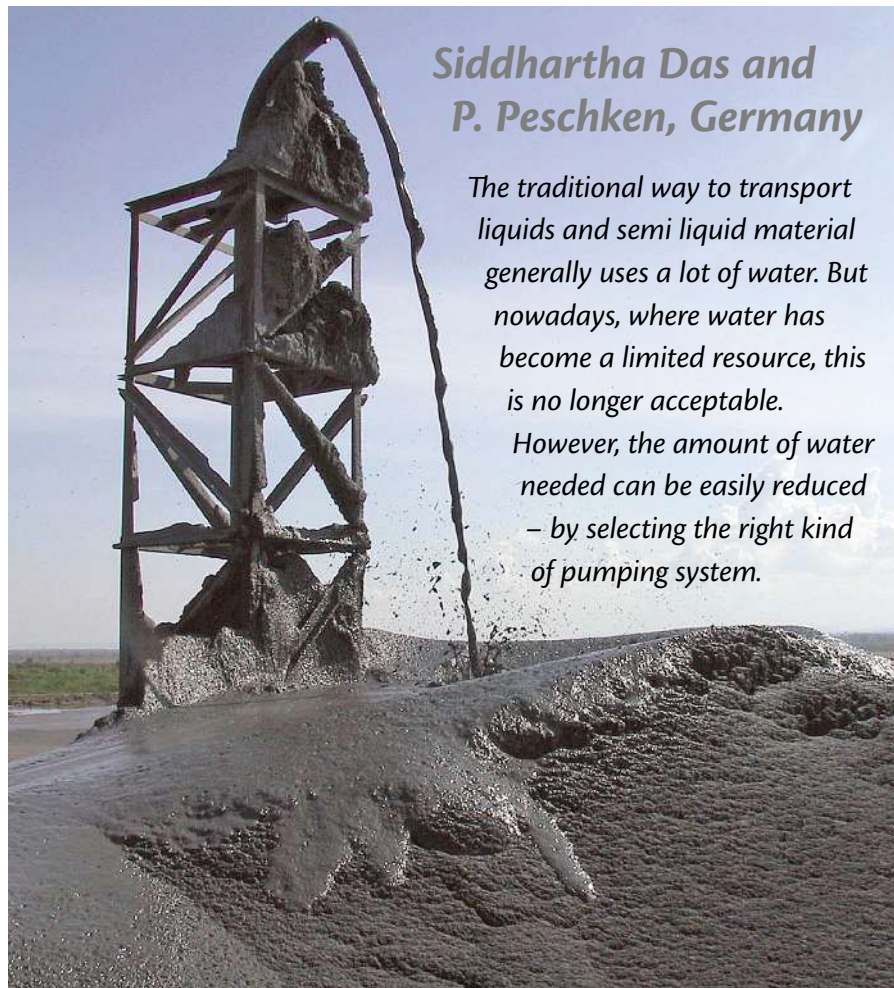


Fig. 1: Hydraulic tailings deposit at Bulyanhulu gold mine, Tanzania.

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The traditional way to transport liquids and semi liquid material generally uses a lot of water. But nowadays, where water has become a limited resource, this is no longer acceptable. However, the amount of water needed can be easily reduced – by selecting the right kind of pumping system.

In search for a solution to reduce the amount of water needed for the hydraulic transport of solids, Putzmeister Solid Pumps has developed, in the last couple of decades, a pumping system that needs less water for transportation of any kind of materials compare to the traditional way of pumping. For more than 30 years double piston pumps are in operation in various industries. They are proven to transport materials which have earlier been described as not pumpable. Today it is state of the art to pump high density slurries, paste and cakes safe, economic and environmentally friendly, which results in a better acceptance by the public.

Material Characteristics

Hydraulic driven piston pumps can handle all materials from slurry, high density slurry, paste and cake (Fig. 2).

Slurries, if they are not abrasive and if the delivery pressure is low, can be handled by centrifugal pumps. If multi-stage centrifugal pumps are needed and the material is abrasive the costs for wear and energy and the downtime due to repairs will influence the economy of the project. The material has to be pumped at high speeds through the pipeline to achieve enough turbulence to avoid sedimentation.

High density slurries are often pumped over distances of 5 to 15 kilometres. Depending on the distance the delivery pressures are between 20 and 100 bar. At the German Coal Mine Walsum a high density slurry was pumped over a distance of 11 kilometres. This material was fine grained and it could be pumped with low speed laminar through a high pressure pipeline, reducing the wear on the pipeline.

Pastes normally require positive displacement pumps. Paste is a non Newtonian plastic material which does not settle. It can be pumped at low speeds through the pipeline. At least 30 per cent ultra fine material smaller 30 µm is needed in the mix to make the material pumpable and to avoid sedimentation in the pipeline.

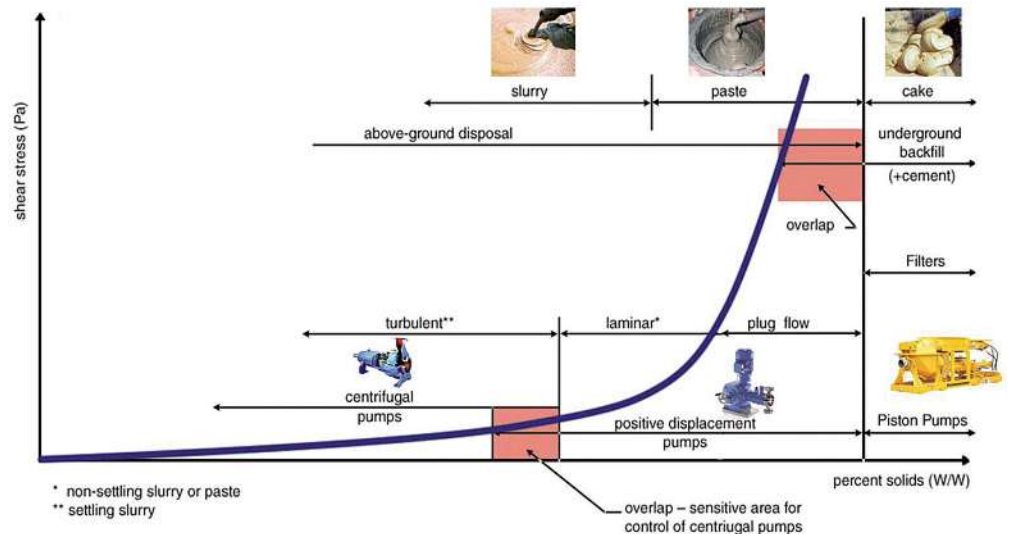
Paste will produce no bleed water and the slump is higher than 6 inch and lower than 11 inch. In case there is no cement or other active material in the paste it can stay in the pipeline for a certain time without plugging. Due to the high yield stress of a paste, to restart a high pressure of a positive displacement pump is needed. The pumping distances are up to 5 kilometres and the delivery pressures up to 150 bar.

Cake is a very stiff material, for example sewage sludge with 35 per cent solid content by weight (see Fig. 2), can only be handled by hydraulic driven piston pumps. This material is fed into the pumps by feeding screws to achieve a good filling efficiency of the delivery cylinders. Due to the stiff material the pressure loss per meter can go up to 2 bar per meter and due to this the pumping distances are short.

Mining Applications

In the mining industry tailings with or without cement are pumped back into the underground mine for stabilisation and for environmental reasons. The pump is normally placed above ground to use the full static energy of the shaft line for transport. This material is normally a cemented paste with a slump value of 6 to 9 inch.

Fig. 2: Slurry-Paste-Cake diagram taken from "Paste and Thickened Tailings – A Guide" by R.J. Jewell and A.B. Fourier.



For the tailings placement above the ground the paste is often delivered from a deep cone thickener with a slump value of 10 to 11 inch. This allows a self levelling at the deposit with angles of up to 5 degree in arid areas.

Another application for high density solids pumps is the high rise pumping of liquid, but sandy and very dirty mine water at high pressures. Concrete, mortar and shotcrete material is pumped in mines and tunnels with high density solids pumps too.

Types of Pumps

High density solids pumps are hydrostatically operating machines which displace the medium being pumped and thus create a flow. One piston of a double piston pump sucks the material out of a hopper into one delivery cylinder while the other piston pushes the material simultaneously into the delivery pipe. The following Putzmeister piston pumps are normally used for conveying slurries, pastes and cakes.

- KOS double piston pump with S-transfer tube for coarse grained slurries, pastes and cakes.
- HSP double piston pumps for fine grained slurries, pastes and cakes.
- KOV double piston pump for fine grained slurries.
- EKO single piston pump for cakes and material which is not pumpable.

All this machines are driven by hydraulic power packs. These power packs supply the pressurized oil which is necessary to drive the piston pump and to control

the valve system. While one piston sucks the paste into the delivery cylinder from the feed hopper the other piston pushes the material out of the second delivery cylinder into the pipeline via a valve control system. Depending on the pump type the control system consists of an S-transfer tube, seat valve, ball valve or a gate valve. The delivery cylinder and the hydraulic cylinder are separated by a water box which cools and flushes the delivery cylinder and guarantees that no material will contaminate the hydraulic oil.

Advantages of Pumping

Reduced dust potential: Compared with a dry placement the paste transport in a pipeline generates less dust. The pipeline is a closed system and if fine grained material is transported on belts or trucks dust formation can occur. Truck transport creates additional dust and dirt as well as noise and exhaust emissions.

Flexible transport routes: With pipeline transport the topography does not matter. Materials can be pumped several hundred meters upwards, even vertical if required, without any problems. No roads are necessary and the pipeline transport is clean, safe, does not create any dust, dirt and noise or smell. Going around corners, difficult layouts in buildings are easy to handle too. On the deposit, as a final layer, a surface paste crust can be produced, e.g. with cement or fly ash, to prevent dust lift-off.

Less workforce and mechanical equipment: Dry material has to be transported and levelled on the deposit with graders

and dozers. This creates a lot of wear, costs and downtime on those machines. Also a lot of workforce is needed at the deposit site. A well prepared paste levels itself.

Almost no free water: In arid areas the paste like medium will dry out by evaporation. No seepage water goes into the ground water or into the environment. Fresh, clean water is very valuable and a reduced fresh water take up reduces the costs.

Reduced danger of dam failures: When a media is transported as a paste and then allowed to dry out like at Bulyanhulu, a gold mine in Tanzania, a dam is not necessary, see Fig. 1.

The material builds up a new landscape and is stable. This helps to get a progressive reclamation and an improved closure of the deposit area. In areas where more rainfall is expected, the paste can be mixed with cement and fly ash to achieve the requested stability. This is the way they work at Zhongzhou Aluminium in China. ■

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