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Slurry Pumping
by Ross Mackay

Slurry Pumping

"One Size Fits All" most definitely does not apply in this area of pumping. Even when we define a Slurry as a mixture of solid particles in a liquid that is usually water, we are still concealing a multitude of applications behind a simple sounding phrase. The variety of solids that are handled in slurry form covers an extraordinary wide range of products and waste material.

One of the key elements in slurry pumping is the size and nature of the solids being transported by the water and the nature of the abrasive wear it causes. As wear is a function of velocity, the pumps usually operate at 1200 rpm or slower.

The centrifugal pumps used in slurry handling are basically conventional water pumps modified in a variety of ways to handle the particular solids. While some of these modifications are minimal, some of them are quite extensive. The difference depends on the size and nature of the solids being handled.

Industrial Slurries

In general industry where water run-off in the plant may drain to a central sump and is then pumped out to a collection tank, the solids in the water usually represent plant debris and tend to be quite small. As they also represent a low percentage of the total volume, the slurry can usually be handled by a conventional centrifugal sump pump. The specific pump design in these services can be quite varied, but the traditional vertical submerged suction sump pump and the submersible pump are both widely used.

For special industrial applications a variety of pump designs have been developed. A popular option to the large closed impeller in some industries is the open impeller that operates with a tight clearance against a casing fitted with sacrificial wear plate as shown below.

Figure 1: Solids Handling Impeller with Wear Plate

Municipal Waste

In the municipal waste management applications, solids handling pumps as shown in Figure 2, are designed with the capability of handling specific spherical diameters. A few models of such pumps will have an open impeller while many will be designed with closed impellers having the necessary clearance between the vanes of the impeller and also between the shrouds.

For example, a 4 inch pump would have the ability to pass a 4 inch sphere through the impeller. The same pump would have at least a 4 inch diameter suction nozzle and a 4 inch diameter discharge outlet. This type of pump defies the normal design custom on a centrifugal pump of having the discharge being one size smaller than the suction.

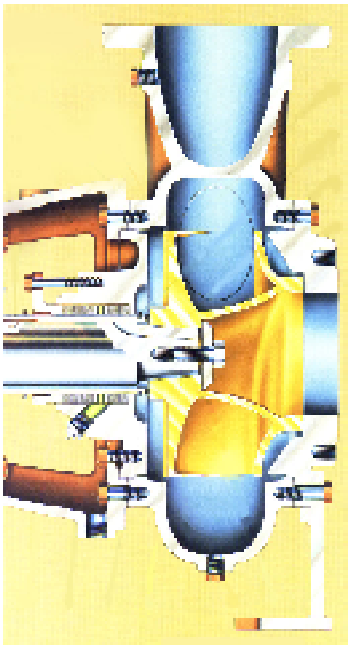

Figure 2: Typical Non-Clog Pump

In spite of the focus on the solids size in the specifying and purchase of pumps for municipal waste, the major problem in these pumping applications tend to be the stringy material. This material will invade the eye of the impeller, wrap itself around the shaft nut and eventually clog the pump.

Paper Stock

The small fibers in paper stock necessitate a pump capable of handling small particles which, in high densities, may have a tendency to clog the impeller. While the physical size of the individual fibers is not a problem, they do have a tendency to float in water. This requires constant agitation of the slurry to minimize the possibility of stratification. Unfortunately, agitation can introduce air which, in addition to being detrimental to the product, can create considerable pumping difficulties.

The amount of dry fiber content in the stock is referred to as the consistency and is expressed as a percentage by weight. Consistency can range up to about 20%, but it only starts to become a pumping problem when it reaches the 3% level. Above this level, pump performance will begin to decrease to the point that even the special impeller designs are no longer viable. In these high density applications the centrifugal pump is replaced by a positive displacement pump with twin intermeshing pump screws driven by external timing gears to maintain an efficient clearance between the screws.

Pipelines and Mines

These applications usually require very large pumps that are subjected to high levels of abrasion wear of different types.

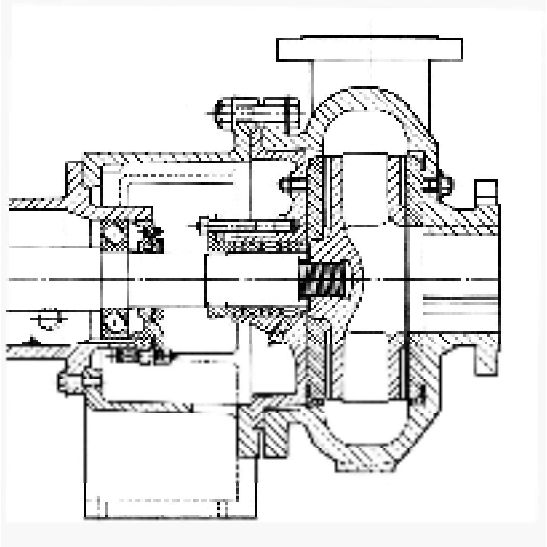

Figure 3: Hard Metal Pump

• Gouging abrasion occurs when coarse, angular particles tear fragments of the wearing surface.

• Grinding wear of fine particles crushing between two surfaces in close proximity, such as at the clearances between the impeller and the front and back wear plates, or the casing itself.

• Erosion abrasion caused by the impact of solid particles on the wearing surface.

Tough materials of construction are necessary in most of these applications and include metal liners and/or wear plates with Ni-Hard and heat-treated high chrome iron. Natural rubber and other elastomers are also frequently used as a liner for abrasive services as long as they are chemically compatible with the slurry.

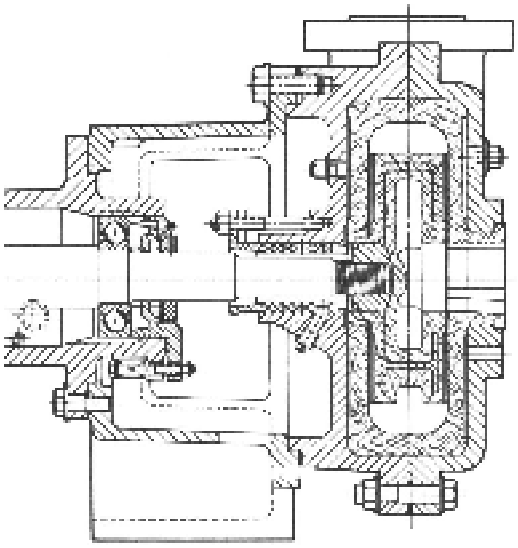

Figure 4: Rubber Lined Pump

It is worth noting that hard metal and rubber impellers cannot be machined to the necessary diameter in order to meet the required operating conditions. Consequently, they have traditionally been belt-driven and a change in operation is achieved by a change in sheave ratio to give the rotational speed required.

Special Pumps

In addition to centrifugal designs, a number of other pump types are used in varying degrees in the Slurry Pump market.

Recessed Impeller Vortex Pumps

While it is generally considered that the solid particles are a problem to be handled, there are many applications where the solid particles are the valuable aspect of the pumpage and the water is simply used as a mode of transport to render the slurry pumpable. In some cases there is also a need to protect the solids from damage.

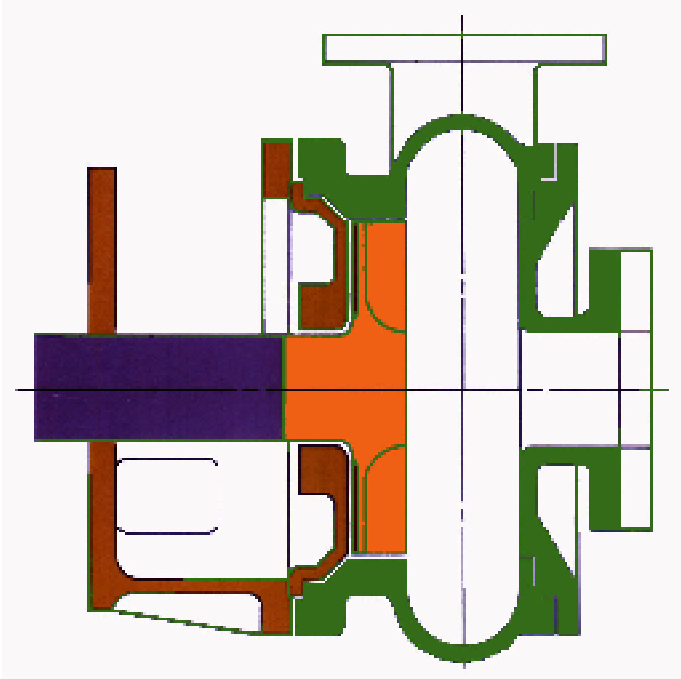

Figure 5: Vortex Pump

For such applications, a popular option is the recessed impeller (or vortex) design shown in Figure 5, that locates the impeller in a recessed position in the casing out of the normal flow pattern in the pump.

The impeller develops a vortex in the fluid inside the pump casing so that most of the solids never touch the impeller. While this tends to reduce the wear on the impeller, it also minimizes any damage to the solids.

The Diaphragm Pump

One of the original diaphragm pump designs actuates a single large diaphragm in a horizontal casing by means of a spring or a linkage mechanism. Many of these are still in service in the Municipal markets. The newer designs include the Air Operated Double Diaphragm (AODD) pump that has become an industrial standby in spite of the fact that is limited to low pressure applications and provides a pulsating flow.

The Progressive Cavity Pump

The Progressive Cavity pump has recently developed a place in the slurry market for delivering a smooth, non-pulsating flows. These pumps are particularly effective when pumping thicker sludges with limited amounts of small solid particles. They usually operate at less than 300 rpm. to minimize wear.

Conclusion

Although the emphasis on slurry pump is always on the size and percentage of solids to be moved, it is interesting to remember that many of these slurry applications are in services where corrosion resistance is also a factor.

If you need a slurry pump, make sure your supplier knows your industry and can provide one of the many types that is needed for your particular application. In this particular market, the phrase, “one size fits all” is definitely not appropriate.

Ross Mackay specializes in helping companies reduce pump operating and maintenance costs through consultation and education.

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