Selecting the Right Slurry Pump

By Chuck Bonner, Product Manager ITT Goulds Pumps

Correct decisions when selecting a slurry pump will save countless maintenance hours and downtime dollars in the future.

Picking the correct slurry pump requires an analysis of a number of variables. First the slurry characteristics must be determined. Percent solids by weight, carrying medium, solids size and slurry pH at a minimum should be known as well as slurry temperature, solids specific gravity and viscosity. Once the slurry characteristics have been established, the system must be defined. Flow, total dynamic head and NPSHR are required to pick the proper pump. Most of the major pump suppliers now have computer software which, given the basic conditions of service, will suggest a number of pumps that should work on the service. However, to determine which of the selections is most appropriate and select the proper materials of construction, additional input from the customer is needed. Key considerations in the selection of the right slurry pump include rotational speed, materials of construction, application point and stuffing box sealing.

Rotational Speed

Rotational speed is a major factor in slurry pump life. Generally accepted policy says that, all other things being equal, the slower running pump on a service will outlast the faster running pump by the speed ratio to the 2.5 power (some manufacturers use 3.0 power). There are numerous arguments as to why this is the case. One of the more logical explanations is that the slower running pumps generally have heavier, larger diameter impellers and other wet end parts. This spreads the energy that causes wear over a larger area and the overall effect is not as significant as with a smaller pump. If speed were not an issue, it is unlikely that slurry pump manufacturers and customers would spend the money to make and buy pumps with 762 mm (30 inch), 1016 mm (40 inch) and larger diameter impellers. This is also a part of the selection process which requires some thought on the part of the buyer. If a smaller, faster running pump will give years of life on a light slurry, is it worth the extra money for a pump that will last five times longer? In the case of heavy slurries where parts life can be measured in weeks, the heavier, slower running pump will almost always be the selection.

Materials of Construction

Materials of construction bring us to the two main types of centrifugal slurry pumps, metal and rubber-lined. Rubber-lined pumps are often the choice for slurries containing solids less than 6.5 mm (1/4 inch) in size (newer, thick rubber-lined pumps can handle slurries with solids up to 12.5 mm (1/2 inch). A typical metal slurry pump is shown in Figure 1 and a typical rubber-lined pump in Figure 2.

Rubber-lined pumps are very effective at pumping fine slurries. The principal of a rubber-lined pump is that the resilience or the ability of the rubber to absorb and return the energy generated by the impact of the particles in the slurry allows the pump to operate with minimal degradation of the rubber components. Properly selected, a rubber-lined pump will provide excellent wear life at less cost than a comparable metal pump. Rubber-lined pumps are susceptible to damage to the rubber components from sharp particles and particles larger than 6.5 mm (1/4 inch). Sharp particles can cut the rubber. Rubber-lined pumps should not be used on slurries where the particles may have sharp edges (anthracite coal is a good example). Also, tramp material if allowed to get in the pump can cause major damage very quickly. Large particles can damage the rubber by putting more impact energy into the rubber than the rubber can return to the slurry. The result of this is a heat buildup in the rubber that can cause it to harden and crack.

Another limitation in the selection of a rubber is the tip speed of the impeller. Rubber impeller tip speeds are generally limited to 25 to 28 m/s (5000 to 5500 feet per minute) as faster speeds can cause the rubber to separate from the metal framework of the impeller. This limits the maximum head that can be generated by a rubber-lined pump to about 45 meters (150 feet). This limit can be exceeded by either operating pumps in series or replacing the rubber impeller with a metal one. Natural rubber is the primary material used in rubber-lined pumps as it has the best wear characteristics. Temperature, hydrocarbons and other compounds that attack rubber can limit its use. Other materials can also be used which is why rubber-lined pumps are sometimes referred to as elastomer lined pumps. Table 1 shows the most commonly used elastomers and some of their characteristics.

Metal slurry pumps are made in a variety of materials to suit the slurry being pumped. The most common material used for pumping abrasive slurries is a 28 percent chrome iron. This is a chrome containing hard iron normally poured to ASTM A532 Class III and hardened by heat-treating to a Brinell hardness of about 650. The hardness of the material is due to the formation of chrome carbides in the iron matrix. Another advantage of using a chrome iron is that the casting can be annealed to a Brinell hardness of about 380, machined and then hardened to more than 600 Brinell in the finished part. This enables precise machining of the parts. Virtually every slurry pump manufacturer has a chrome iron poured to meet ASTM A532 Class III. Other variations of chrome irons are also poured using higher amounts of chrome to alter the material's properties. A chrome iron with about 30 percent chrome and a low carbon content is often poured if pH values are above or below the range suitable for the standard 28 percent chrome iron. This material can be used for very alkaline materials like lime mud in a paper mill or acidic services with chlorides such as those found in flue gas desulfurization circuits in coal fired power plants. There is also a chrome

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Figure 1. A typical metal slurry pump.

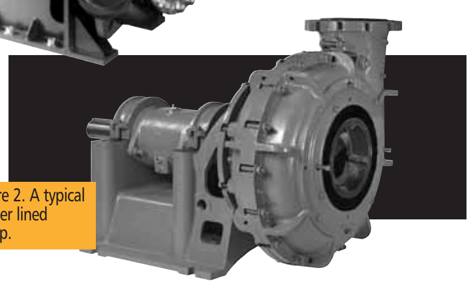

Figure 2. A typical rubber lined pump.

Elastomer	Shore (A) Hardness	Max Temp Limit	pH Range	Abrasion	Resistance to Moderate Chemicals	Oils Hydrocarbons
Natural Rubber	40	154° F / 68° C	5-12	E	G (1)	P
Polyurethane	81	149° F / 65° C	3-11	E (3)	G (1)	E
Neoprene	60	212° F / 100° C	3-12	G	G (1)	G
Nitrile	60	220° F / 104° C	4-12	G	G (1)	E
Hypalon	55	230° F / 110° C	1-14	G	E	G
Chlorobutyl	50	250° F / 121° C	3-12	G	E	P

(1) Poor for oxidizing chemicals and strong acids
(2) Standard formulation. Max. temp. to 212° F (100° C) with special formulation.
(3) Fine particles only (150 mesh or less).

E = Excellent
G = Good
P = Poor

Table 1. Most commonly used elastomers.

iron with more than 35 percent chrome that is used for acidic services with high chlorides and fluorides present as are seen in the phosphate industry.

For light slurries, cast iron is used on occasion due to low cost. For corrosive slurries 316 stainless steel (CF8M) or a duplex alloy such as CD4MCu can be used. Typical materials for a metal slurry pump are summarized in Table 2.

Application Point

The location of the condition point on the pump curve can have a major influence on the operation and parts life of a slurry pump. A pump should be selected where the condition point is just to the left of the best efficiency point (BEP) for the pump. This not only provides the best wear characteristics but also maximizes pump efficiency for optimum power consumption. A common mistake in pump selection is to pick too large a pump, which results in the condition point being well to the left of best efficiency. This results in shorter parts life and increased energy consumption for the pump.

Stuffing Box

How to seal the stuffing box on the pump is another factor that must be considered. A problem common to all pumps handling abrasives is keeping the pumped solids out of the stuffing box. This is usually solved by injecting clear water into the stuffing box to flush out the solids. The water also serves as a lubricating and cooling medium for the packing. However, maintaining sealing-water pressure and controlling dilution of the pumped product by the sealing water may be difficult in some applications. Sealing an end suction slurry pump (the most common type now in use) normally requires water at a pressure that exceeds the pump discharge pressure by about 10 percent. The flow required is determined by the shaft sleeve diameter and the configuration of the stuffing box.

Several stuffing box designs can be specified for efficiently handling the most extreme conditions without major modifications to the pump. Their selection is contingent upon the abrasiveness of the liquid handled and the permissible product dilution. For highly abrasive slurries where product dilution is not a problem, a "high dilution" or "full flush" packing arrangement is often used. The seal cage or lantern ring is inserted first and the remainder of the stuffing box is filled with packing. This arrangement has the advantage of keeping all of the packing away from the slurry and generally results in the longest packing life. The disadvantage is that large amounts of water at the required pressure are needed and if the slurry cannot stand dilution such as where a slurry specific gravity must be maintained or water is at a premium, this is not a sealing method to use. Another arrangement is the "low dilution" or "weep" where two rings of packing are inserted before the seal cage. This results in a much lower water volume requirement but increased packing wear.

Replacing the conventional shaft seal with a dynamic seal can effectively control dilution and minimize sealing water requirements. The dynamic seal produces a negative pressure in the stuffing box that prevents the slurry from getting to the packing. A dynamic seal is often used in cases where no flush water is desired or available. A spring loaded grease cup or a small amount of water, if desired is used to lubricate the packing. The two issues with dynamic seals are that they only work when the pump is running (a secondary seal of some type is needed when the pump is shut off) and that additional horsepower is required for the dynamic seal.

Finally, in recent years, slurry mechanical seals are seeing more acceptance. These are heavy duty seals with silicon carbide seal faces and metal parts often made from chrome iron. Most can run with or without a water flush. These seals are still very expensive and require careful application.

Materials of construction, pump speed, application point and stuffing box sealing are all items that should be given careful consideration when selecting a slurry pump. Paying attention to these items will result in the selection of a slurry pump that will provide maximum life with minimum maintenance.

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MATERIAL	BRINELL HARDNESS	pH RANGE	APPLICATION
CAST IRON	180	6 - 9	LIGHT, NON-CORROSIVE
28% CHROME IRON	600 - 700	5 - 12	ABRASIVE, MODERATELY CORROSIVE
30% CHROME IRON	500 - 550	4 - 13	ABRASIVE, pH PROBLEMS FGD SERVICES
35% CHROME IRON	400 - 450	1 - 13	ABRASIVE, SEVERELY ACIDIC, CHLORIDES, FLUORIDES
316SS (CF8M)	160 - 200	3 - 11	LIGHT, CORROSIVE
CD4MCu	225 - 325	2 - 12	SEVERELY CORROSIVE, CHLORIDES

Table 2. Material Selection Guidelines

Goulds Pumps in famous Paris Museum

How do you protect some of the world's most treasured art? Call Goulds Pumps. Goulds France has been selected by CLIMESPACE company to do just that. Six large vertical turbine pumps type VIT 30 BHC, each unit producing 3000 m3/h @ 27 m head, will be the heart of the new air-conditioning system of the "Palais de Tokyo" museum in Paris. The famous "Palais de Tokyo" Museum is located near the Eiffel Tower. The climate control system keeps humidity and temperature perfect for the art and human comfort.

The underground plant will also be equipped to produce district air conditioning for state and government buildings like the French National Assembly as well as luxury hotels in the area.

Palais de Tokyo museum located near the Eiffel Tower.