Run Times
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When handling slurries, users frequently must choose between rubber-lined or metal construction for their slurry pumps. This article presents some of the trade-offs and limitations related to the application of either of these two slurry pump designs. Table 1 at the conclusion of this article provides summary comparison of both designs.

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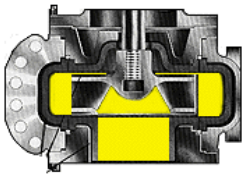
Slurry is a liquid with suspended solids. The abrasiveness of slurry depends on solids concentration, hardness, shape, and the solid particle kinetic energy transferred to pump surfaces. Slurries may be corrosive and/or viscous. Solids may include particulate fines or larger solid materials that are frequently of irregular shape and distribution.

Slurry pumps are characterized by heavier construction than process pumps. Slurry pumps typically incorporate larger shafts and bearings, thicker wall sections, heavier impellers, and larger diameter impellers operating at lower operating speeds than those found in standard process pumps. Slurry pumps cost more than standard process pumps, but when properly applied, provide a return on investment based on superior reliability and durability.

Rubber-lined pumps utilize polymeric or elastomeric lined impellers and pressure retaining wetted parts. Natural rubber is the most common material used, but other elastomers or polymers are commonly utilized for process compatibility.



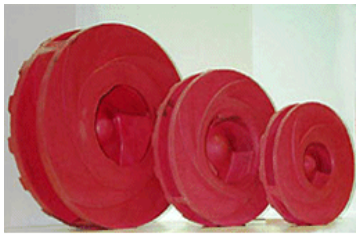
Metal pumps are manufactured in a broad range of materials based upon abrasion resistance and corrosion resistance. When designing a metal pump for abrasion resistance it is desirable to select a material that is harder than the solids being pumped. However, very hard abrasion resistant materials are not compatible with high impact loads. Therefore, more ductile materials may have to be used when large impact loads are likely.

By far the most common abrasion resistant material found in pumps is hard iron (ASTM A532 cl. III is typical although some manufacturers use non-ASTM proprietary formulations). A532 cl.III is readily machined in its annealed condition and can be subsequently hardened to approximately 600 brinell. A major drawback of metal pumps for slurry handling is that they are much more costly than their rubber-lined counterparts.

Rubber withstands abrasion by absorbing the impacting particle energy and returning it to the slurry. As long as the liner material energy limits are not exceeded rubber-lined

pumps work very well. When energy limits of a rubber lining are exceeded, resultant heat build-up breaks down the liner material causing failure. The energy associated with a solid is related to its mass and velocity. Consequently, designers place limits on solid size and velocity for rubber-lined slurry pumps. Most rubber-lined pump manufacturers limit maximum solid size to 6mm (¼ inch). However, there are some products that claim to handle upwards of 12mm (1/2 inch).

Metal pumps are commonly used for handling large irregular shaped solids. Metal slurry pumps are available that handle solids in excess of 500mm (20 inches). As mentioned previously, greater consideration must be given to selecting metals with greater ductility when dealing with impact type loads.



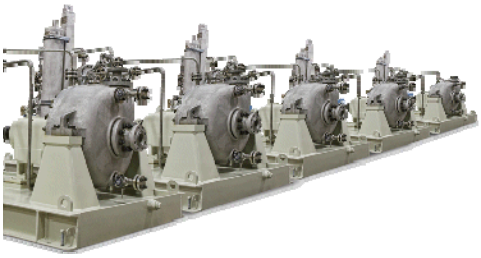
Rubber-lined Impellers

Rubber-lined impellers are limited to tips speeds of 25-28 m/s (80-90 fps). Above that speed centrifugal forces threaten to separate the elastomer from the impeller. The tip speed limitation restricts TDH to about 45m (150 ft). To avoid this limitation manufactures will sometimes offer a metal impeller in an otherwise rubber-lined pump.

Metal slurry pumps are available with tip speeds of more than 60m/s (200 fps) and can achieve heads of more than 215m (700ft) in a single stage. It should be noted that for any given slurry condition wear will increase exponentially (speed ratio$^{2.0\text{-}2.5}$). Obviously, a substantial wear life benefit can be realized by running pumps at slower tip speeds and in series. The added costs of additional pumps must be weighed against the savings involved with running at higher tip speeds. Multi-staging of impellers in abrasive slurries is generally impractical because of the difficulty in reliably sealing against interstage leakage (recirculation from downstream impellers back to earlier stages) when handling abrasive pumpage.

Natural rubber linings are limited to about 65^{o}C. (150^{o}F.). Other materials can reach higher temperature but most all elastomeric and polymeric materials are limited to less than 150^{o}C. (300^{o}F).

Metal slurry pumps are generally applied for temperatures greater than 120^{o}C (250^{o}F.). In the petroleum industry metal lined slurry pumps are routinely used for transporting abrasive hydrocarbon slurries at temperatures greater than 370^{o}C. (700^{o}F.). However, the application of slurry pumps at such elevated temperatures also requires additional design features not found on standard slurry pump designs.



Specialty high head slurry pumps for high temperature service

Rubber-lined pumps are a good choice for many low TDH, applications at low temperatures, involving small particulates because of their lower capital cost. For higher head, higher temperature applications, or applications involving large or non-uniform solids metal pumps are the preferred choice.

There are other specialty slurry pumps on the market that utilize carbides and ceramics that were not covered here in the interest of brevity. These are typically applied outside of the envelope of rubber-lined pumps or where corrosion and/or erosion considerations are so severe that metallurgy starts to become quite exotic.

In most cases it is generally a poor decision to use standard process pumps for applications where measurable erosion is likely to occur. It becomes a "pay now" or "pay forever" scenario, where users will spend countless thousands of dollars over many years applying coatings and weld overlays attempting to solve unnecessary and avoidable wear problems.

Table 1: Summary Comparison

Feature	Rubber-Lined	Metal Pumps
Max Solid Size	6-12mm (¼ in - ½ in)	Greater than 500mm (20 in)
Solid type	Not sharp	Pump material should be harder
TDH	< 45m (150 ft)	>215m (700 ft)
Temperature	< 150^{o}C (300^{o}F)	>370^{o}C (700^{o}F)
Chemicals	May change wear resistance and increase cost	May change wear resistance and increase cost
Capital cost	Lower	Higher