Application Note to the Field	**Super Bullet for Abrasive Service**
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There are many applications with abrasive solids that demand a positive displacement, pulseless (gear) pump.

One such family of fluids is colloidal silica used in the paper industry. In the search for maximum surface area, the particulate has become extremely small, oblong and irregularly shaped. As silica, it is very hard and abrasive. Since the carrier fluid is water, the working viscosity is 1 cP @ 20°C and the apparent viscosity is about 10 cP. This does not even give the benefit of a bit of "cushion" to keep the parts away from each other with a hydrodynamic lubricating film.

The subject application called for approximately 2 GPM at 70-100 PSI differential pressure.

Wear of the original pumps was not even limited to where people would normally expect to see it. The small size of the particles (about 2-10 µm) means that they can get into extremely small crevices. Once there, the very minute relative motion that is normal between any two parts that are not interference fit would allow the abrasiveness of the product to cause wear to the point that parts would start falling off. Gears would become so sloppy on their shafts that the keys would fall out, etc.

Due to the nature of the product, the users were not able to find any pump that would work successfully, even for a relatively short period of time. Essentially, they would be ground into dust. Even the tungsten carbide coatings on the shafts that had been used were ruined.

Working with one of its distributors, Liquiflo has successfully developed a pump that has now been employed in this service for several years, and in multiple installations.

There were two basic ways the problem would be addressed:

1) Eliminate as many parts in relative motion with each other as possible.
2) In the cases where this was not possible, make the parts out of materials that demonstrated the ability to survive. Certain materials had been tried by the distributor, and found to hold up well to abrasion. These were bearing grade (BG) PEEK, silicon carbide (SiC) and ceramic aluminum oxide.

The pump that was developed is hydraulically similar to a model 45. It was constructed as follows:

- Two special BG PEEK gears: This material runs well against itself, and has excellent abrasion resisting properties. The material change allowed the drive gear teeth, which had been 316 SS previously, to not be destroyed. They were shrunk fit and pinned to the shaft to eliminate crevices. Additionally, they are slightly oversized in outer diameter to compensate for the fact that the pump basically doesn't wear, and so will not "break in" in the traditional sense.

- Specially-sized SiC bearings: SiC bearings had already been demonstrated to work well. Standard SiC bearings are a slightly looser fit in the front and rear housings than other offered materials, such as carbon or plastics. This is because SiC is so much harder than the 316 SS housing that it will dig into the bore and jam on installation attempts if there is not more clearance. Strangely enough, there never was a problem with wear in this area, even though the product can thoroughly flood it. This feature was not changed for this reason, other than the size of the bearings to accommodate the larger overall shaft diameters.

- Special SiC-sleeved shafts: As tungsten carbide shaft coatings were not working, the decision was made to sleeve the shafts with silicon carbide, such that SiC would run against SiC. The sleeves are a different grade with a small amount of carbon graphite content to allow this without failure, although it is important that the pump not be run dry. It should optimally be allowed to flood prior to being used, or at least a bit of water should be allowed to remain in the pump after it is assembled and tested, and between uses. The sleeves are glued in place to seal the annular gap that would otherwise result. This also prevents rotation of the metal shaft relative to the SiC sleeve.

- Ceramic wear plates: These were standard ceramic aluminum oxide items, as there had been no problem with this aspect of the standard unit. (Liquiflo has since upgraded this standard wear plate material to SiC, which is even more wear-resistant than ceramic alumina.)

- Special front and rear housings: These had to be fabricated in order to accommodate the larger diameter bearings.

The net result of the above modifications ended up being the only pump that would stand up to the product's abusive nature that the customer has tried. They initially tested it by running it on a continuous loop with the product, and charted the flow rate over time on a circular chart recorder, holding operating speed and differential pressure constant. After several months, there was only one line around the chart. There did not appear to be any significant wear at all.

This special pump was officially designated: 45S-533, but also was nicknamed the "Super-Bullet" by the distributor. It might be a good candidate for other applications where abrasive wear has resisted the best efforts of other manufacturers' products, and Liquiflo's standard offering.

The above product was produced as a special design for an extremely difficult application. However, Liquiflo's standard material offerings can often be enough to effectively combat wear. By using two non-metal gears, such as BG PEEK, SiC wear plates and bearings, and Tungsten Carbide (TC) coated shafts, wear rates can be significantly reduced – especially when pumping thin fluids.

The physical wear rate of a gear pump, which determines its practical lifetime before maintenance is required, is dependent on many factors. These include operating speed, differential pressure, fluid viscosity, duty cycle, starting and stopping frequency, abrasive particles in the fluid, size and shape of these particles, and the wear properties of the materials used to construct the pump. By optimizing any of these factors for a given application, satisfactory lifetimes can usually be achieved.

Please contact the factory with any questions.