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# Prevention of "Wear" in Slurry Handling Piping

There are three separate causes of shortened service life in piping - regardless of the materials of construction. Those causes of shorter service life are:

1. **Corrosion.** Most people are familiar with corrosion attack. Corrosion wear is the chemical attack and resulting deterioration of the materials of which the pipeline is made. Over the years, there has been a significant body of knowledge and information developed on this subject. Based on coupon media testing, corrosion tables for each of the materials of FRP composite construction have been developed and published by the thermoset resin companies.

2. **Abrasion.** Abrasion can also cause accelerated wear in piping materials. Abrasion wear is a function of the type and shape of the solid particles that are being carried, the hardness characteristics of the abrasive solids, and the velocity of the stream. An example of abrasive wear is the inverts of highway culverts being abraded away from and rocks being carried in the streams. Another example would be long pipelines handling fly ash or bottom ash.

Once the type of particles and the velocity are defined for an abrasive wear situation, it is possible to predict the expected service life. Abrasive wear can be compensated for, increasing the service life of piping materials, by using abrasion resistant FRP liners, rubber lined pipe and fittings, and proper selection of piping materials of construction.

3. **Erosion.** A newer wear phenomena is "erosion". New thinking and additional studies have determined that what had earlier been thought to be abrasive wear is actually wear from erosive forces. For example: Liquid streams having no solids or abrasive particles can still cause erosion. An example would be the erosive cutting away of a stream bank at the end of a culvert, or at the bend in the river. Here, the wear "medium" is just water.

We are finding that accelerated wear in pipelines handling lime and gypsum slurries is often occurring not because of abrasion - but rather from erosion. The areas of erosion seem to be typically occurring at reducers located at the inlet and outlet of pumps; the piping upstream and downstream from certain types of ball valves; and in changes in direction of the flow stream, where branches come off the headers.

We knew that cavitation and turbulence were being created in the flow at these points of critical wear. What we probably did not understand originally was that the turbulence itself was not causing piping wear. What we are now gaining a better understanding of is that the cavitation that is created at these points allows entrained air in the streams to almost literally explode with the release of tremendous levels of energy. It is these explosive energy releases that are causing the “erosive” wear. This has been substantiated in part by the wear patterns - which are often almost like grooves that are worn in the piping - and reducers, axially to the direction of the flow.

For erosive wear, the use of abrasion resistant FRP composites, and special hardened metals, while providing somewhat longer service life, are not the sole or best answer. Preventing erosion in a pipeline is a function of the design and layout of the piping system itself. Just as with culverts, the use of tapered inlet and outlet end sections can reduce erosion wear. The straightening of a stream channel can similarly prevent erosion of the banks.

Similar design changes need to be made in enclosed piping systems. Some of those changes that will provide longer service life include:

> The use of bell mouth or tapered "knee-type" transitions for branches coming off of piping headers.
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> The use of longer tapers for the reducers used as inlets and outlets on pumps and ball valves. That taper needs to be approximately five times+ the difference in diameter.
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> When reducers are used adjacent to pumps and ball valves, recent investigation would recommend the use of eccentric reducers, installed with the flat side of the eccentric **up**. This is counter to standard piping practices. We think that by putting the flat side up, you help prevent cavitation from occurring. This layout prevents pockets of low pressure from forming that allows the stored energy of the entrained air to explode.
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> While there has not been a lot of investigation undertaken, there has been some evidence that indicates that some types of ball valves have the potential for creating greater cavitation, than other types of valves, or even other types of ball valves. We cannot yet point to which type of valve does allow cavitation to occur, and which does not. We can only suggest that if you are finding erosive wear occurring on either side of a valve, you explore, as a test, the possibility of switching that valve out with another type of valve. See if the new valve makes the erosive wear situation better or worse.

Again, this whole area of erosion wear, caused by cavitation, is a relatively new concept. As a result, the existing body of knowledge is far less than what is available for corrosion wear. For example: In determining corrosion wear, it is easy to put coupons of various materials in various types of corrosive service media to determine whether they are attacked or not; and the rate of attack.

It is more difficult to determine if cavitation is occurring in a pipeline, and the design steps that should be taken to prevent such erosion wear. There are some major studies going on right now at Kodak using Doppler radar, sonar, acoustical emissions, etc. to try to pin point where in the pipeline such cavitation is occurring. These Kodak studies are clearly demonstrating how such cavitation can cause erosive wear of pipelines, fittings, and pumps. We continue to monitor those tests, as part of our search to help our customers better understand this new phenomena of **erosive** wear.

We have several background articles on cavitation and erosion. In particular, we have one article that has recommend the use of eccentric reducers, with the flat side mounted upward for piping adjacent to pumps. We also offer a textbook page that shows the friction factors for various types of inlets. These examples would be also indicative of the situations occurring where branches come off of a piping header. Besides the higher friction value, we also call your attention to the area of cavitation that is occurring just inside of the branch for certain types of inlets.  Please feel free to fax us your request for copies of any, or all, of these articles.

We do want to re-emphasize that “erosion” wear occurs irrespective of the type of material of construction used for pipe and fittings.  We have examples of stainless steel reducers that have a demonstrated life of only four to five months.  Chrome plating increased the service life of these stainless reducers to only nine months.  Simply substituting other types of materials, such as abrasion resistant FRP composites, while perhaps offering somewhat longer life, will not solve a design and piping schematic system problem that is occurring from erosion wear.

We do thank you for your interest in Industrial Fiberglass, and this opportunity to share with you the expanding body of knowledge that we have been accumulating on what causes accelerated wear in certain abrasion piping circumstances.