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Controlling Pipe Flow Velocity to Reduce Abrasion Wear?

Pipelines handling high suspended solids, regardless of the materials of piping construction, can present the engineer an abrasive wear "challenge". From time to time we are asked to provide input on what is a "safe" maximum fluid velocity for a pipe handling potentially abrasive solids. The thought of the inquirer being that by lowering the pipeline velocities abrasive wear will be minimized.

Fluid velocity, solids content of the fluid stream, the specific gravity of the solids, particle size, the shape of the particles, and how the solid particles "wear", will all affect the abrasive wear rate of the pipe.

If particle wear produces smooth round particles, like small ball bearings, the subsequent pipe abrasive wear down-stream will be reduced. If, on the other hand, particle wear occurs by the constantly "breaking" of new sharp and jagged particle edges and surfaces, the abrasive wear will be aggressive throughout the piping system.

In studying the many handbooks on hydraulics and hydraulic design, one is quickly overwhelmed by the great number and complexity of hydraulic formulas and guidelines. In analyzing pipeline velocities there is little agreement between these handbooks as to the formulas that might apply, or be used. There is even less agreement on velocity wear rates based on laboratory test results and field observations. This lack of reproducible abrasive wear testing is probably due in great part to the differences in testing protocol that were used.

With the possibilities of an almost infinite variation in the type of solids, the selection of the specific solid content to be tested, and the size and shape of the particles; it becomes difficult to establish uniform and closely controlled (duplicated) testing conditions. Thus, the typical way of comparing and selecting pipe materials and velocities for abrasive pipelines has been by installing field test spools. Or, alternatively, piping materials and velocities have been selected on the basis of case history and prior experience on what has, and has not, worked at that specific plant - for their specific service environment.

Establishing a safe velocity for selecting piping sizes is often a balance between establishing a velocity that is high enough to prevent the suspended solids from "settling out" and keeping initial piping costs low; and, keeping the velocity as low as possible to minimize abrasive wear and operating costs.

As discussed above - for the reasons of the great, and almost endless, differences in service environments; this selection of the optimum velocity must be empirically established on a case by case - project by project basis.

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From strictly an abrasion wear basis - the ideal velocity would be zero. (While obviously not practical, at zero pipeline flow there would be no wear.) We do know, from historical data that for high rates of suspended solids and abrasive particles, that velocities from 7 to 10 feet per second can be quite abrasive, requiring proper selection and specification of the more abrasion resistant piping materials.

As a rule of thumb, we believe that to prevent particulate settling or "plating out" in the pipeline the **minimum** velocity probably needs to range from 1.5 to 2.0 feet for the finer particle sizes. For the larger particle sizes (such as fly ash) that **minimum** pipeline velocity perhaps should be 2.5 to 3.0 feet per second.

Establishing the maximum velocity to be used for designing the piping system becomes a juggling act between abrasive wear and initial piping cost. With the understanding that there are no validated laboratory and controlled field test results on which to "hang one's hat" - we suggest that the **maximum** pipeline velocity target might be a velocity of 4.0 to 5.0 feet per second? The selection of the maximum velocity again depends upon all of the other variables: including solids content, particle size and shape, etc. In the final analysis the designing engineer must use his best judgement.

Fortunately for the piping engineer there are "time-tested" FRP composite systems that will provide proven long life in corrosion and abrasive wear service environments. For superior abrasion resistant performance, where the primary abrasive wear will occur on the inside of the pipe, we recommend consideration of our Series 5000-A and Series 9500-A filament wound FRP composite pipe.

For those applications where abrasion can also occur on the outside of the pipe, for example on headers and branches inside of flue gas desulferization (FGD) scrubbers, we recommend our Series 5000-AA and Series 9500-AA filament wound FRP composite pipe. The Series 5000-AA and Series 9500-AA FRP pipe have a balanced corrosion and abrasion resistant liner/barrier both inside and outside.

Technical Product Bulletins and Guide Specifications are available for these Series of abrasion resistant FRP composite pipe, fittings, and flanges.