A New Slurry Pump Standard

The Hydraulic Institute

A new American National Standard, ANSI/HI 12.1-12.6-2005 Standard entitled *Rotodynamic (Centrifugal) Slurry Pumps for Nomenclature, Definitions, Applications, and Operation* has recently been developed by the Hydraulic Institute Slurry Pump Committee, under the leadership of Graeme Addie of GIW Industries, Inc.

The standard is intended to clearly outline information necessary to define, select, apply, operate, and maintain slurry pumps. The standard covers slurry pumps used for pumping and/or transporting mixtures of solids and liquids or so-called slurries.

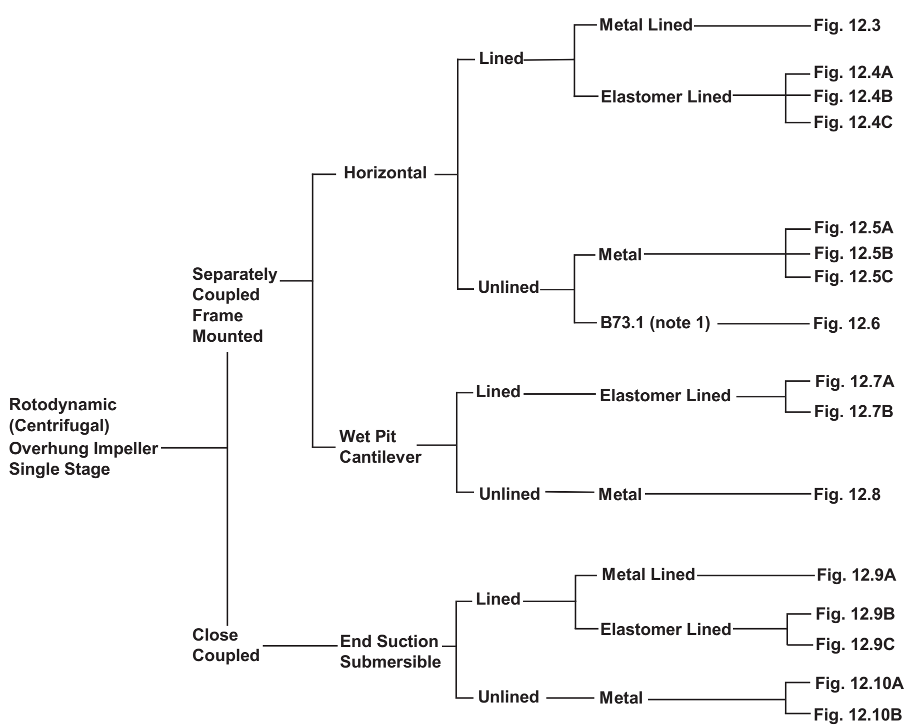
Slurries are typically abrasive and if not taken into account, abrasive slurries may cause rapid wear and shortened life of pumps. Unlike clear water, slurries alter the performance of the pumps and cause wear to the wet-end parts. Below a certain velocity, some slurries also settle out in the piping causing blockages. These differences are such that if they are not taken into account, the pumps will not work satisfactorily or not at all.

For this reason, the standard includes information about slurries and other effects, necessary to select, apply, operate, and maintain different designs and materials of construction for slurry pumps.

While there are no rigid rules about where different mechanical configurations are to be applied, initial cost, wear parts (maintenance) cost, and arrangement convenience are such that mechanical configurations tend to be aligned to certain services. Figure 12.1 from the standard shows classifications of slurry pumps based on mechanical configurations:

A slurry is a mixture of solids (specific gravity greater than 1.0) in a liquid carrier, usually water. It is often used as a means to transport solids. Slurries also occur when solids are present as an incidental part of the process. The properties of the solids and liquid, as well as the amount of solids, are variable. The solids size may vary from a few micrometers, often referred to as microns, up to hundreds of millimeters and the solids may settle below a certain transport velocity.

The properties of slurry, therefore, are highly variable. Slurry may behave like a Newtonian or non-Newtonian fluid. It may be abrasive and/or corrosive depending on the composition. Slurry pumps are usually employed to move slurries with solids concentrations between 2 percent and 50 percent by volume, and specific gravities of the slurry up to 5.3. Slurries containing solids consisting of wood, paper,



NOTE 1: B73.1 type pumps used in slurry services normally require greater than normal thicknesses on parts exposed to slurry

Figure 12.1 — Rotodynamic (centrifugal) slurry pump types

and other organic materials also exist but are not covered by this document.

"Pumping" and "Slurry" terms are described and defined along with the different types of services. Easy to use charts are provided to identify different slurry types, to convert relative density into solids concentration, and to establish solids transport rates and pipeline velocities. In the case of settling slurries, a nomograph for the determination of the solid deposit velocity being moved inside a horizontal pipe is also provided:

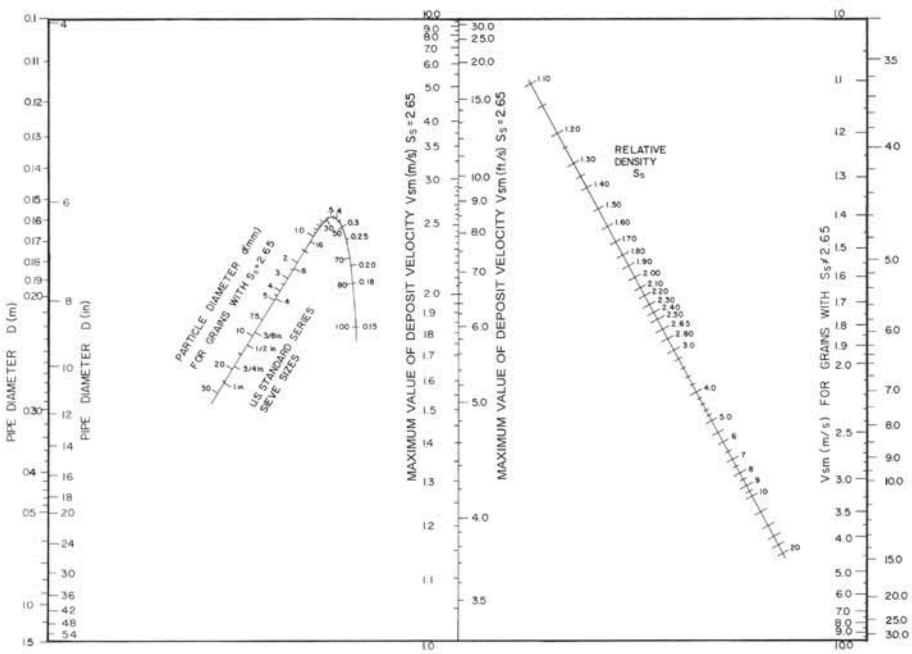


Figure 12.18 — Nomograph for maximum velocity at limit of stationary deposition of solids

Centrifugal pump performance on slurries will differ from the performance on water, which is the basis for most published curves. Head (H) and rate of flow (Q) will normally decrease as solids size and concentration increases. Power (P) will increase and starting torque may also be affected. This "solids effect" is shown schematically in Figure 12.19, along with the head and efficiency derating terms used.

Where the slurry is heterogeneous, Figure 12.20 can be used to determine the head and efficiency reductions from the original water performance for different sizes of pumps for a slurry mixture concentration by volume of 15 percent and with negligible portions of less than 75-micrometer fines.

For solids of S_s other than 2.65, for concentrations other than 15 percent by volume, and with significant amounts of fines present, the values of Rh shall be modified by multiplying them by the correction factors Cs, Cfp, and Ccv provided in the standard.

Slurry pumps are usually designed for specific applications. When this involves transporting large solids and/or high concentrations, component wear will be a major factor and must be considered in the selection of the pump and the configuration of the pump installation. The major slurry erosive mechanisms inside a pump are sliding abrasion and particle impact. Sliding abrasion typically involves a bed of particles bearing against a surface and moving tangentially to it. Impact wear occurs where particles strike the wearing surface at an angle.

Abrasive wear varies with the number of particles or volume concentration of the solids, the velocity of the eroding particles to a power of 2.5 to 3, the abrasivity of the eroding solids, and the wear resistance of the surface being impacted.

Wear must also be controlled by proper pump application. Wear is related to the relative velocity between the pumped liquid and the pump parts. Liquid velocities must be reduced for more severe

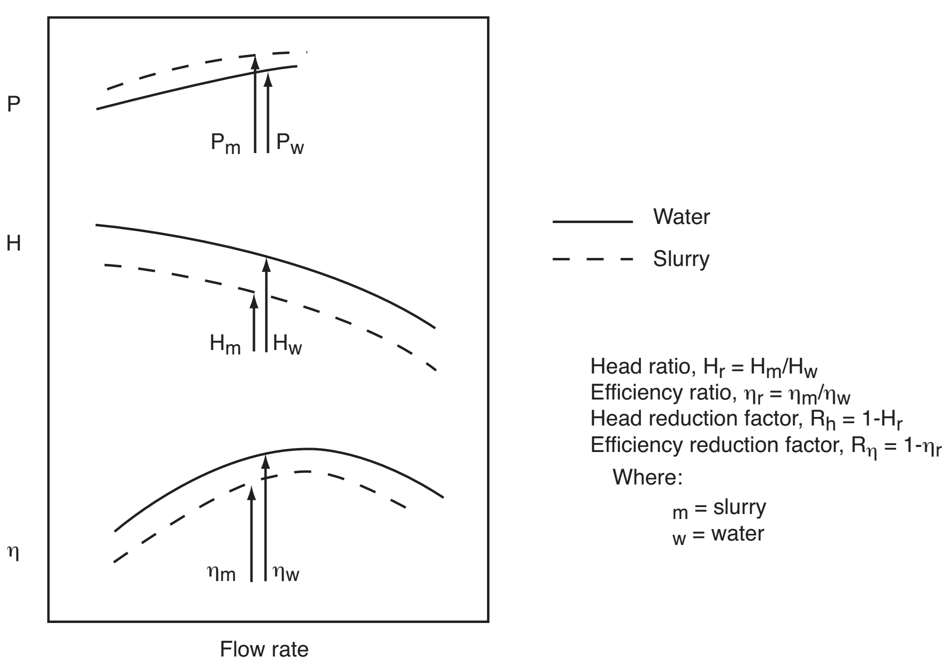


Figure 12.19 — Effect of slurry on pump characteristics (schematic)

services to obtain satisfactory life. The suction liner, impeller, and casing components and their wetted surfaces are exposed to different velocities, slurry concentrations, and impingement angles, making it difficult to provide limits that cover all cases and all components.

Ranking the slurry into light (class 1), medium (class 2), heavy (class 3), and very heavy (class 4) services as shown in Figure 12.24 below provides a practical tool for pump selection.

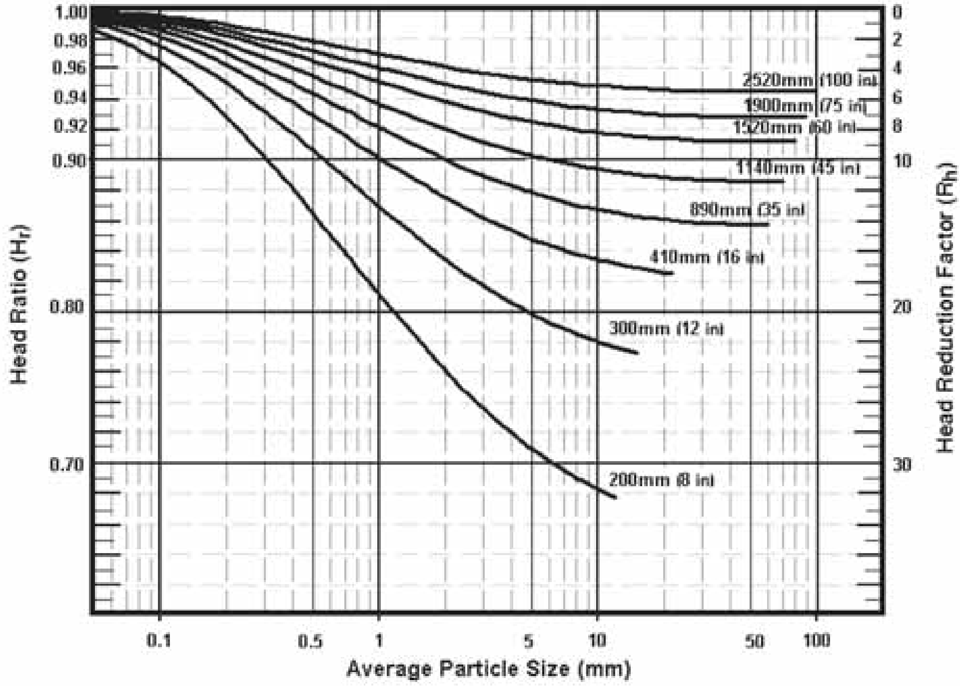


Figure 12.20 — Effect of average particle size and impeller diameter on H_r and R_h (For solids concentration by volume, C_v = 15% with solids S_s = 2.65 and a negligible amount of fine particles. Impeller diameters are given in mm and inches.)

Table 12.6 provides recommended service limitations for different service classes that, when coupled with proper design and material selection, has resulted in acceptable wear life.

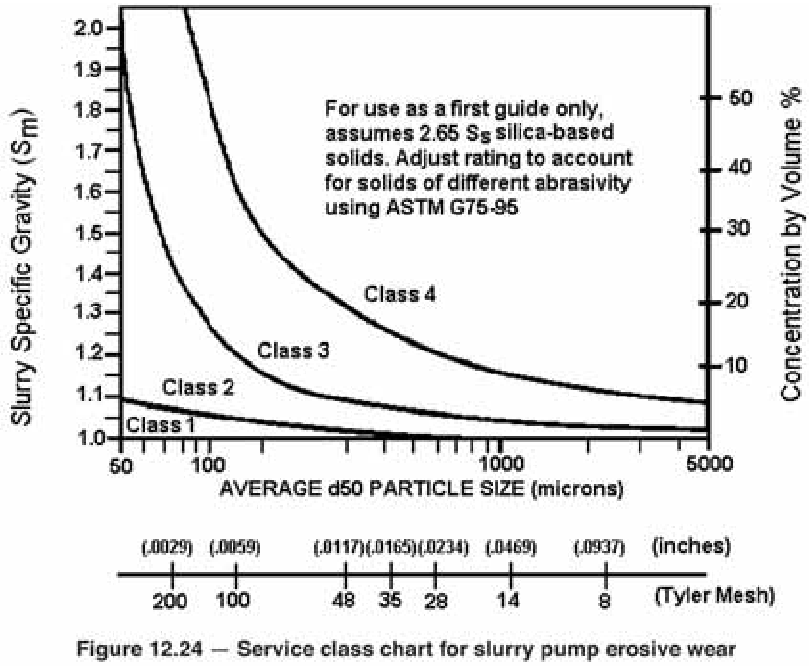


Figure 12.24 — Service class chart for slurry pump erosive wear

A large variety of metals and elastomers are used for slurry pumps, due to the diverse range of applications. Slurries can be erosive, corrosive, or erosive/corrosive. Proper material selection depends on knowledge of the properties of the mixture to be pumped and the pump design. Figure 12.24, introduced earlier, may be used to rank various materials commonly used in these services along with their appropriate erosive wear service class.

This standard provides the following information essential to successful operation slurry pumps:

- A table of minimum calculated bearing lives for the different service classes and provides recommendations for acceptable bearing housing seals.
- A method of determining the maximum allowable branch nozzle loads is provided that can be used in conjunction with information provided by the manufacturer.
- A recommended equipment data sheet is provided along with an extensive list of source material and references. As with the rest of the standard, these are provided in both metric and US units.

The standard on *Rotodynamic (Centrifugal) Slurry Pumps for Nomenclature, Definitions, Applications, and Operation*, is over 90 pages in length and is designated by HI product code A128. It is available from the Hydraulic Institute for $195.00, may be purchased in hard copy or on a CD-ROM with other HI Standards, and is available in secure PDF format. Please visit the e-Store on the HI web site: www.pumps.org. The online service provides virtually instant access to HI pump standards as PDF documents on a worldwide basis.

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Graeme Addie is vice president of engineering and research and development for GIW Industries, Inc., based in Grovetown, Georgia. Addie has been chairman of the Hydraulic Institute (HI) Slurry Pump Committee for the last five years, leading the development of "Centrifugal Slurry Pumps for Nomenclature: Definitions, Applications and Operation," the first ever national slurry pump standard.

Table 12.6 — Suggested maximum operating values for acceptable wear

	Service class			
	1	2	3	4
Maximum head per stage: meter feet	123 400	66 225	52 168	40 130
Maximum impeller peripheral speed: All-metal pump (m/s) (ft/min)	43 8500	38 7500	33 6500	28 5500
Rubber-lined pump (m/s) (ft/min)	31 6000	28 5500	26 5000	23 4500

Table 12.8 — General suitability of wetted materials

Wetted Material	Abrasive characteristics of pumpage	Applicable wear service class	Corrosive characteristics of pumpage
Gray cast iron	Very mild, fine particles	1	Noncorrosive
Ductile iron	Moderate	2	Noncorrosive
White irons	Severe	4	Mildly corrosive
Martensitic stainless steel	Moderate	3	Mildly corrosive
Austenitic stainless steel	Mild	1	Highly corrosive
Duplex stainless steel	Moderate	2	Corrosive
Elastomers	Severe, fine particles	3	Mildly corrosive