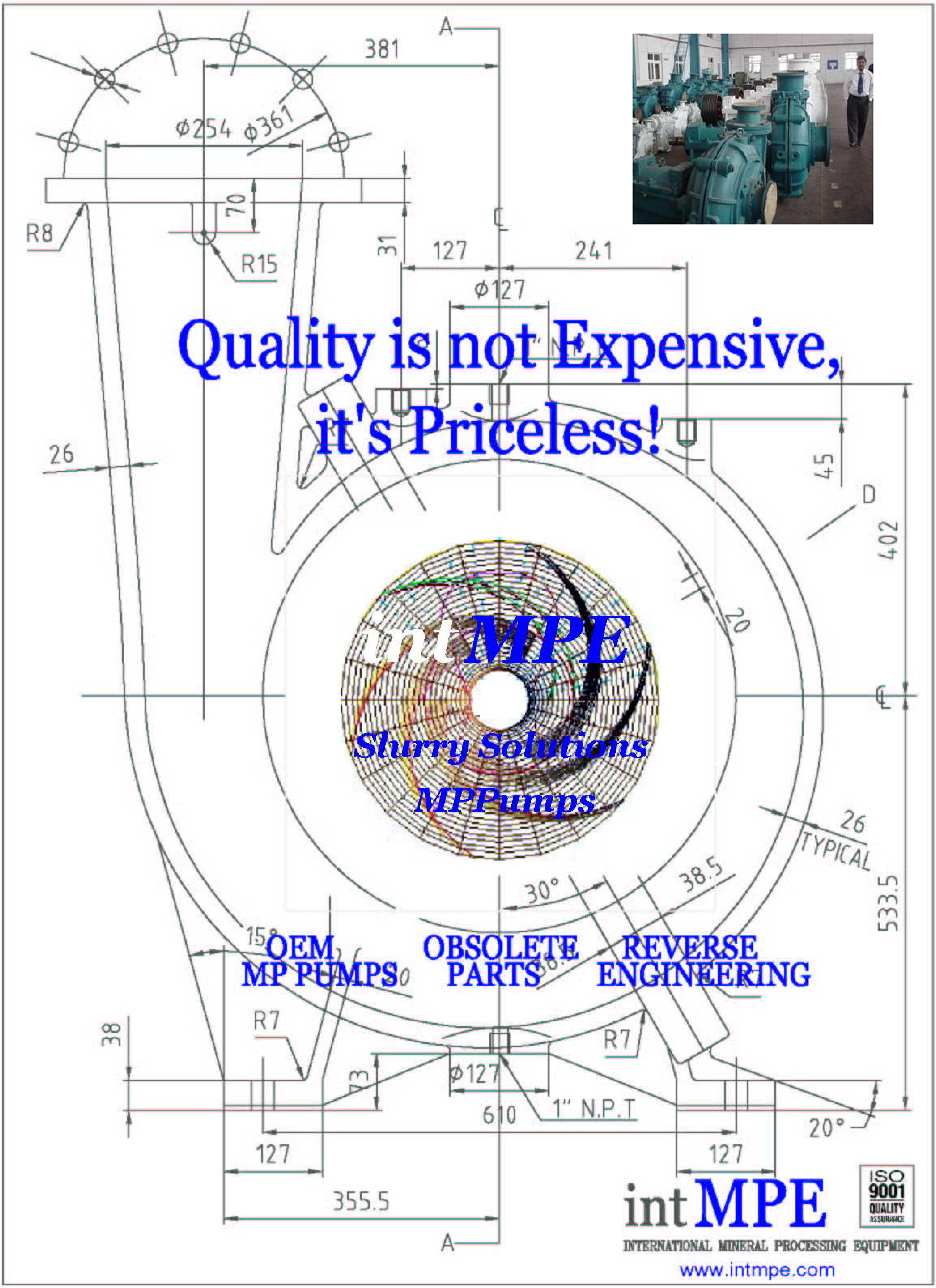
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A
381
Ø254
Ø361
70
R8
R15
31
127
241
Ø127
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45
D
402
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TYPICAL
38.5
30°
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R7
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73
Ø127
1" N.P.T
610
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355.5
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THE NATURE OF SLURRY

When selecting and designing slurry pumps, the abrasive nature of some slurries must be a consideration. When there is excessive wear on wet end pump parts due to highly abrasive slurries, the operational life of those parts is limited. Abrasive considerations are the abrading mineral itself, abrasive hardness, particle velocity, density, directions, sharpness, shape, size, and corrosiveness.

Ni-hard and rubber are abrasion resistant materials that are used for impellers, casing, suction covers, and so on, when the pump components are exposed to abrasion.

The pump velocity should be kept low with abrasive handling pumps. Velocity is related to pump developed pressure, so with high head applications they will wear much more rapidly than low head applications. Pump part hardness is inversely proportional to abrasive wear, and wear varies directly with particle concentration.

Slurry pumps used for particles that are small and round can be made in synthetic and natural rubbers which have superior abrasion and corrosion resistance, and because of this, they exceed the Ni-Hard or other metals. Sharp and hard solids with high energy are unsuitable for rubber application because they can cut the rubber material. The dampening effect of rubber is low for impact angles greater than 20 degrees. Also, rubber is generally unsuitable for applications with heads over 150 ft. and where particles size exceeds 1/4 inch. Wear resistant metals such as Ni-hard are used on more coarse and harder slurries.

Metal/Rubber Slurry Pump Selection Criteria

Use Metal-lined Pumps when:

*Solids are greater than 1/4 in.
*PH is greater than 4.5
*Abrasive service is above 100 ft. head
*Temperatures go to 250 degrees F
*Hydrocarbon based slurries

Use Rubber-lined Pumps when:

*Solids are less than 1/4 in.
*PH is less than 6.0
*Abrasive service is below 100 ft. head
*Non-abrasive service is below 100 ft/sec-impeller peripheral speed
*Temperatures are below 150 degrees F

Hardness of Common Minerals

Soft	Medium	Hard	Very Hard
Asbestos Rock	Limestone	Granite	Iron Ore (taconite)
Gypsum Rock	Dolomite	Quartzite	Granite
Slate	Sandstone	Iron Ore	Granite Gravel
Talc	Coal	Trap Rock	
Soft Limestone		Gravel	

SLURRY RHEOLOGY, VISCOSITY

TERMS:

Rheology - the study of deformation and flow of substances.

Fluid - a substance which undergoes continuous deformation when subjected to shear stress

Consistency (apparent viscosity) - a slurry's resistance to deformation when subjected to shear stress. This term is applied to differentiate from absolute viscosity which is used in conjunction with Newtonian fluids (see types of Newtonian fluids below).

Kinematic viscosity - the absolute viscosity (consistency) divided by the mass density (mass density = weight - acceleration of gravity) of the fluid.

Fluidity - the inverse of viscosity.

Plasticity - the property of a fluid which requires a definite yield stress to produce a continuous flow.

Rigidity - the consistency of a plastic fluid in terms of stress beyond the yield.

Newtonian fluid - A fluid whose viscosity is constant and is independent of shear rate, and where shear rate-shear stress relationship is non-linear.

For either Newtonian or Non-Newtonian fluids, viscosity (or consistency) is the rate of shear (flow) per unit shearing stress (force causing flow).

TYPES OF NON-NEWTONIAN FLUIDS

Bingham-plastic fluids - a fluid where no flow occurs until a definite yield point is reached. This yield stress is necessary to overcome static friction of the fluid particles. Most slurry mixtures used in pipeline transportation exhibit Bingham plastic characteristics.

Pseudo-plastic fluids - substances with no definite yield stress which exhibit a decrease in consistency with increasing shear rate.

Dilatant (inverted) plastic fluids - a fluid which exhibits an increase in consistency with increasing shear rate - these fluids have the property of increasing their volume when stirred.

Thixotropic fluids - a fluid which exhibits a decrease in consistency with time to a minimum value at any shear rate. It will break down when stirred, but rebuild itself after a given time.
Examples: drilling muds, gypsum in water, paint

CRITICAL CARRYING VELOCITY OF SLURRIES IN PIPES

Particles have a tendency to settle while a slurry is conveyed by the turbulent flow through a pipe. The critical velocity of a slurry flow in a pipe is that velocity in which particles start forming a sliding bed on the bottom of the pipe. This will cause the flow to become unstable and the pipe will eventually clog. General slurry pipeline practice is to design the pipe velocity to exceed the critical velocity by at least 30%.

This pipe velocity will depend upon the diameter of the pipe, the concentration of solids, and the properties of the fluid and solid particles. To prevent settlement in the pipeline, hydraulic conditions, within a slurry pipeline, should ensure turbulent flow.

An approximate guide for slurries with particles sizes under 50 microns, a minimum velocity in the range of 4 - 7 feet per second is required, providing this velocity gives turbulent conditions.

For larger particle size slurries (over 150 microns) and volume concentration of up to 15%, an approximate guide for minimum velocity is 14 times the square root of the pipe diameter.

SLURRY HEAD CORRECTION

The lowest pressure loss is obtained at the transition between the laminar and turbulent flow when there is a given solid through out a pipe diameter. At this minimum pressure loss, there will be the most economical running point (power per pound of solids), but the operating velocity must be kept above this critical carrying velocity.

Slurry guidelines can be followed when there is critical carrying velocities with pressure gradients of solid mixtures. The slurry acts as a Newtonian liquid - when the pressure loss is the same as the water friction - when the slurry contains particles under 150 microns and the concentration of the particles is low with the fluid velocity high enough to ensure uniform particle distribution.

Friction loss is dependent on pipe roughness. A rough pipe design will yield a higher pressure loss capability. For example, when using a “C” factor pipe of 100, this will result in a pressure loss capability of about 100% greater than design with a clean-steel pipe.

Although slurry-pipe friction can be higher than water or Newtonian fluids, many slurries have negligible head correction and can be treated with a correction almost the same as clear water.

SEDIMENT TERMINOLOGY

TYPE SCREEN MESH/INCH	US STANDARD MESH/INCH	INCHES	MICRONS	CLASS
		1.3-2.5	33,000-63,500	Very Coarse Gravel
		.6-1.3	15,200-33,000	Coarse Gravel
2.5		.321	8,000	Medium Gravel
5	5	.157	4,000	Fine Gravel
9	10	.079	2,000	Very Fine Gravel
16	18	.039	1,000	Very Coarse Sand
32	35	.0197	500	Coarse Sand
60	60	.0098	250	Medium Sand
115	120	.0049	125	Fine Sand
250	230	.0024	62	Very Fine Sand
400		.0015	37	Coarse Silt
		.0006-.0012	16-31	Medium Silt
			8-16	Fine Silt
			4-8	Very Fine Silt
			2-4	Coarse Clay
			1-2	Medium Clay
			.51-1	Fine Clay