SUPER MUD

for Deep Foundation Construction

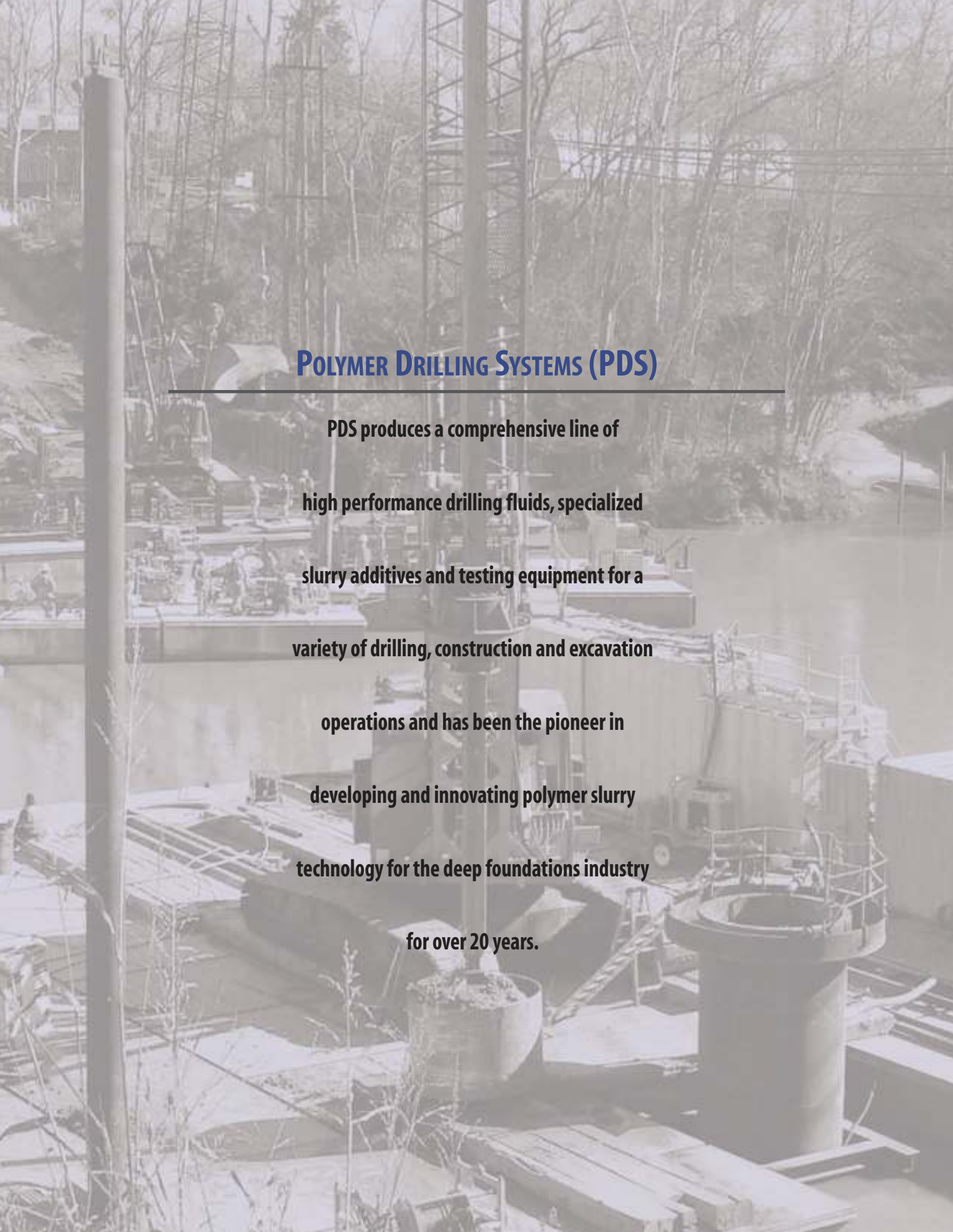
Polymer Slurry & Additives

Slurry Testing Equipment

Technical Services

www.pdscoinc.com

PDS



Polymer Drilling Systems (PDS)

PDS produces a comprehensive line of high performance drilling fluids, specialized slurry additives and testing equipment for a variety of drilling, construction and excavation operations and has been the pioneer in developing and innovating polymer slurry technology for the deep foundations industry for over 20 years.

Synthetic Polymers

SUPER MUD™ Liquid Polymer

SUPER MUD DRY™ Dry Granular Polymer

Super Mud and **Super Mud Dry** are highly concentrated synthetic polymers that are primarily used to create high viscosity slurries which stabilize excavations, maintain hole cleanliness and promote stronger load capacities. **Super Mud** slurries also simplify the process of slurry mixing, excavating, concrete placement and disposal. These slurries are environmentally friendly and recyclable.

ADVANTAGES

- Easy to mix and requires little or no mixing equipment
- Mixes in either fresh or saltwater
- Increases speed of production
- Reduces wear on tools and equipment
- Controls fluid loss
- Recyclable and reusable
- Lowers disposal costs
- Environmentally friendly

Performance Characteristics

Sand & Gravel – The polymer molecules form a matrix, binding these granular soil particles together.

Clay – Super Mud encapsulates clay preventing water from hydrating the clay plates and inhibits swelling.

Shale – Super Mud slurries are designed to prevent slaking in shales.

*Unlike mineral slurries that leave seams of wall cake between concrete and soil, **Super Mud** slurries are instantly degraded upon contact with concrete creating a direct bond between existing soil and concrete providing greater friction bearing capacity.*

***Super Mud** binds the soil together making excavating easy.*

Technical Services

- On-Site Technical Assistance
- Free Slurry Cost Estimation
- Slurry Training Seminars
- Free Site Specific Slurry System Programs

Slurry technicians are available for on-site technical support and training.

Water Treatment

Most slurries are sensitive to various water characteristics that should be treated prior to initial mixing and controlled during excavating for best slurry performance. Water conditions such as water hardness, acidity, and alkalinity occur in city water, ground water, or can be caused by contamination from soil or cement.

The remedy is **Water Treat™**, a pH conditioner from PDSCo. See page 10 of this brochure for additional information regarding the usage of **Water Treat**. **Water Treat** or soda ash is recommended for pH buffering and softening of makeup water and preventing contamination from calcium and magnesium ions.

A good estimate for correction of **Super Mud** slurry is 1lb **Water Treat** to 200 gallons freshwater (1 kg : 1.6 m^3) or 1lb **Water Treat** to 100 gallons (1 kg : 0.8 m^3) of salt or brackish water. In cases of extreme acidic soil conditions, the use of sodium or potassium hydroxide as a water conditioner may be necessary. However, extra precautions should be taken if these materials are used.

Mixing

Mixing in Surface Tanks

Simply pour **Super Mud** through a venturi type mixer or pour slowly directly into a rapid, turbulent moving stream of water filling the tank.

For mixing **Super Mud Dry**, slowly sift the granular directly into a stream of running water.

Surface tank mixing is recommended, especially on large scale projects, because properties of the slurry are more easily controlled.

Avoid the use of shear mixers or centrifugal pumps if at all possible as over shearing will reduce viscosity.

Mixing Directly into the Excavation

Pour **Super Mud** slowly and directly into the stream of water allowing the stream of **Super Mud** to enter the water at the most turbulent point.

If **Super Mud Dry** is used, add slowly to avoid lumping and wastage.

The drilling tool should then be slowly raised and lowered into the slurry column to distribute and homogenize the slurry with slow rotation.

Usage Tables

Super Mud™

Formation Type	Super Mud Dosage or Concentration				Marsh Funnel Viscosity
	vol/ vol ratio	lbs/ cu yd	gal/1000 gal or liter/m³	kg/m³	
Clay & Shale	1/800	2.19	1.25	1.30	35-45
Silt & Fine to Medium Sand	1/600	3.3	1.87	1.87	45-60
Coarse Sand to Pea Gravel	1/400	4.4	2.5	2.6	60+

Super Mud Dry™

Formation Type	Super Mud Dosage or Concentration			Marsh Funnel Viscosity sec/quart
	lbs/ cu yd	lbs/ 1000 gal	kg/m³	
Clay & Shale	0.3 – 0.8	1.5 - 4.2	0.2 – 0.5	40 -50
Silt & Fine to Medium Sand	0.8 – 1.7	4.2 – 8.3	0.5 – 1.0	50 – 60
Coarse Sand to Pea Gravel	1.7 - 2.5	8.3 – 12.5	1.0 – 1.5	60 -80
Gravel to Cobbles	2.5 – 3.4	12.5 -16.7	1.5 - 2.0	80+

These values are not specifications. They should be used as guidelines in matching slurry to soil. In applications where brackish, salt, or seawater contaminates slurry or is used in slurry makeup, dosage should be near top of given ranges, and developed viscosities may be lower. Treatment of makeup water and /or slurry with pH conditioners such as **Water Treat** or soda ash may be required.

Volume of Water in Drilled Shaft/ Bored Pile

Diameter Feet	Diameter Inches	Gallons per Foot of Depth
0	0	0.00
	3	0.37
	6	1.50
	9	3.37
1	0	5.91
	3	9.35
	6	13.24
	9	18.18
2	0	23.49
	3	29.99
	6	36.73
	9	44.73
3	0	52.88
	3	62.38
	6	71.96
	9	83.03
4	0	93.95
	3	106.59
	6	118.93
	9	133.07
5	0	146.83
	3	162.47
	6	177.65
	9	194.78
6	0	211.38
	3	230.08
	6	248.11
	9	268.31
7	0	287.76
	3	309.52
	6	330.32
	9	353.58
8	0	375.80
	3	400.63
	6	424.27
	9	450.60
9	0	475.65
	3	503.48
	6	529.96
	9	559.35
10	0	587.18
	3	618.15
	6	647.39
	9	679.86

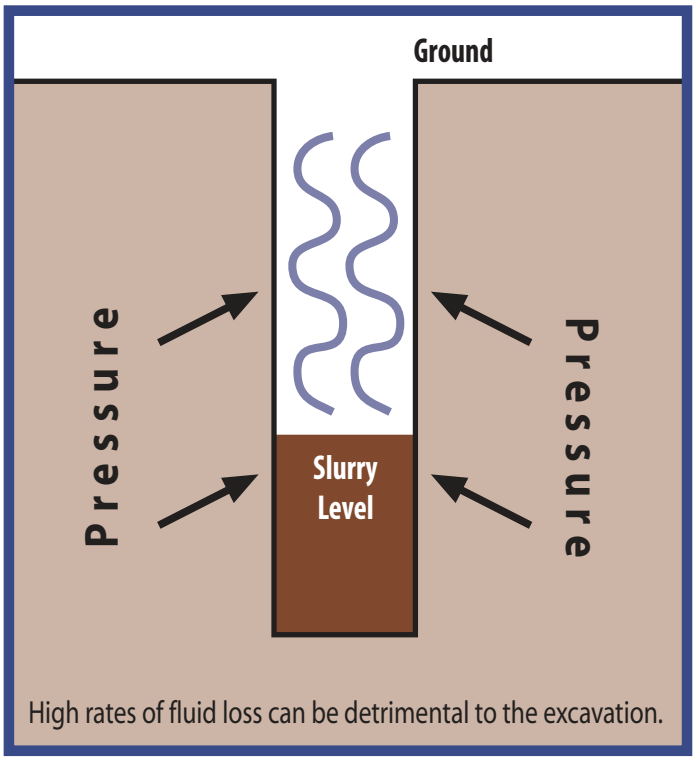
The volume can be calculated with a simple formula:

Radius² x Depth x π

Radius = $^1/_2$ Diameter
π = 3.14

Maintenance

FLUID LOSS – High rates of fluid loss can be detrimental to the excavation stability because migration of fluid through the side walls of the excavation can reduce cohesion of the surrounding soil, equalize pressure between the hole and the soil, increase potential for hydration of swellable clays and shales, and cause sloughing or collapse of the hole.

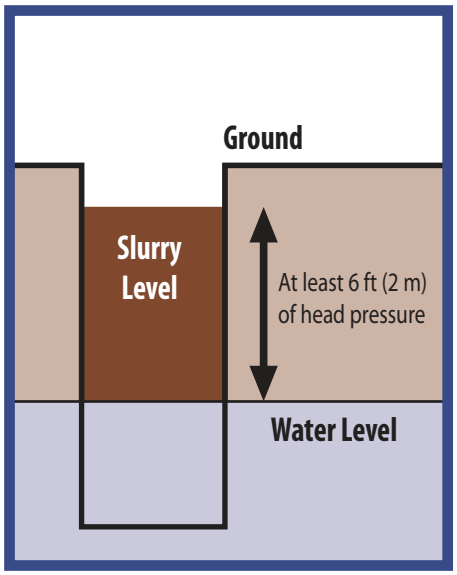


High rates of fluid loss can be detrimental to the excavation.

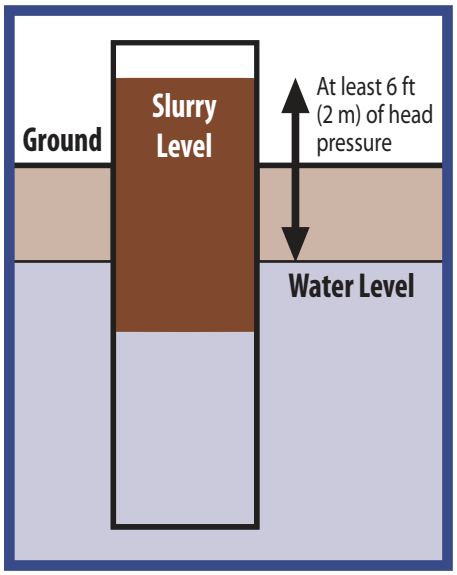
OPTIONS

- Increase the polymer dosage and viscosity of the slurry by adding **Super Mud** or **Super Mud Dry** directly into the hole with water.
- Transfer premixed high viscosity polymer slurry to the hole from storage tank.
- Fluid loss control agents such as **Aquasorb** or **Granular Bentonite** may be added to the existing slurry. (Use only additives developed for compatibility with the fluid in use). See page 9 for additional information on fluid loss control additives.
- Natural silts that have already been removed from the excavation can be added directly into the top of the excavation or can be applied directly to the fluid loss zone by placing the natural silt on the auger. The auger should be rotated so as to spin the material off against the sidewalls of the excavation just above the loss zone.

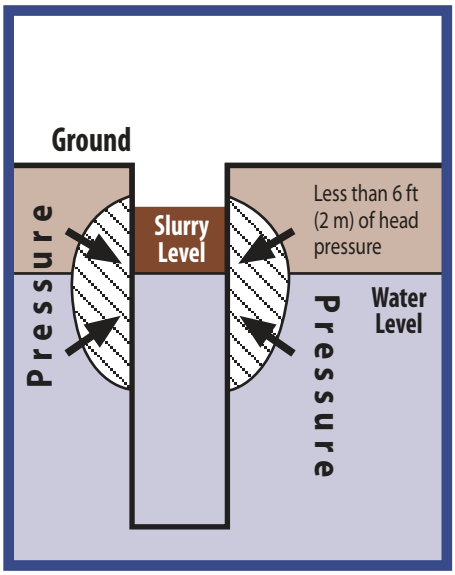
WATER TABLE – The slurry level should be maintained at least 6 feet (2 m) above the water table to balance hydrostatic pressure and to prevent collapse of unstable formations. If the slurry drops below this level, the operation should be paused and the proper slurry level reestablished by adding fresh water and polymer directly to the hole or by transferring premixed slurry from a holding tank to the hole. Surface casing use is always recommended.



A head pressure must be maintained at a level of 6 feet (2 m) above the static water level at all times.



If water table is at grade, extend surface casing above grade to allow sufficient head pressure.



Failing to do so will result in the collapse of the wall from near the water level.

Preparing for Concrete Placement

TYPICAL CLEANUP – When design depth is reached, the hole bottom should be cleaned with a cleanout bucket, submersible pump or an airlift system.

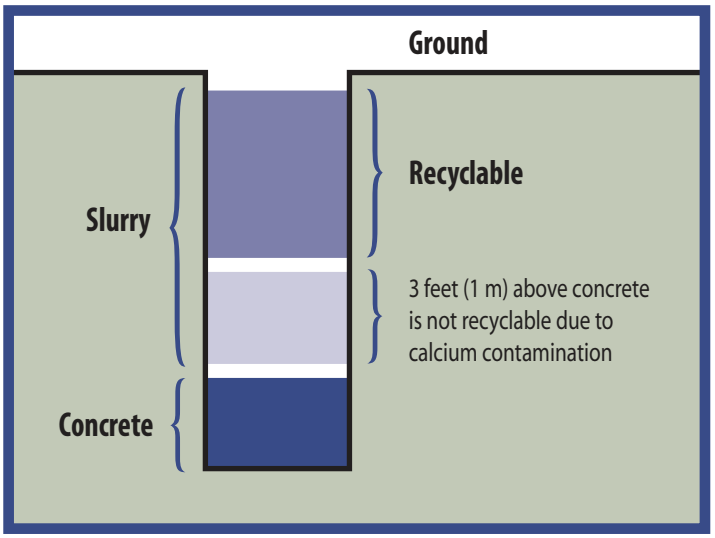
If required, slurry samples should subsequently be taken from within 2 feet or ½ meter from the bottom of the hole to determine viscosity, sand content, pH and density. After the bottom of the hole is cleaned, placement of the rebar and concrete may proceed.

Recycling

Care should be taken not to pump any slurry back to the holding tanks that have become contaminated from contact with the concrete. Contamination can be very visible as it looks very much like clabbered milk or oatmeal.

The last 3 feet (1 m) of slurry above the concrete interface shall be diverted to a waste tank or pit.

The slurry collected in a holding tank should be tested for pH and viscosity, and adjusted by the addition of **Water Treat** or **Super Mud** for reuse in the next excavation.



Breakdown of Super Mud Slurry for Disposal

Upon completion of a job, any remaining **Super Mud** slurries can be broken down with a chemical oxidizer. The most common oxidizer for this purpose is 5% Sodium Hypochlorite solution (household bleach); 3% Hydrogen Peroxide (household use concentration) can also be used.

The Hypochlorite solution should be added to the **Super Mud** slurry at a rate of 1 gallon to 800 gallons of slurry to be treated. After the breaker is added, the entire system should be circulated to insure complete oxidation of all polymer molecules.

When breakdown is complete, all that remains is acrylate molecules and water. This is often safely discharged into sewer systems, percolated into the ground, or simply left to evaporate. Always check local regulations before disposal.

Slurry Additives

QUIK FLOC™ (Flocculent/Settling Agent) – A selective mud flocculent in liquid form that aids in the settlement of solids. **Quik Floc** reduces the time required for settlement by rapidly agglomerating silt and other micron size particles that are suspended within the slurry and settles them to the bottom of the excavation allowing for easy removal by cleanout bucket or airlift system. Flocculation time will vary depending upon concentration of suspended fines.

- Can be premixed with **Super Mud** slurries or can be mixed directly in the excavation prior to cleanout.
- **Quik Floc** is salt tolerant and meets the same rigorous environmental standards as **Super Mud.**
- 1 to 2 quarts **Quik Floc** : 4000 gallons of slurry to be cleaned (1 to 2 liters : 15 m^3).
- **Quik Floc** can also be used in flocculating water, without the presence of polymer or bentonite slurry.

WATER TREAT™ (pH Conditioner) – A pH conditioning and water-hardness reducing additive that is designed to enhance the performance of the slurry. **Water Treat** is especially useful and necessary when acidic water is used, acidic soil or groundwater is encountered, or when brackish or saltwater conditions exist.

For use with **Super Mud** and **Super Mud Dry**, we recommend maintaining the pH level between 8 and 10 in fresh water and a pH of at least 10 in saltwater. **Water Treat** should be added to the makeup water prior to mixing of the other slurry materials.

Recommended Usage		
Fresh Water	1 lb : 200 gallons of water	1 kg : 1.6 m^3
Brackish/Saltwater	1 lb : 100 gallons of water	1 kg : 0.8 m^3

To mix, slowly sift into the makeup water or slurry. pH of the slurry should be monitored throughout the drilling operation and **Water Treat** should be added as necessary to maintain proper pH level and buffer against contaminants. **Water Treat** can be added directly to the hole, in the slurry tank, or mud pit.

AQUASORB™ (Fluid Loss Control Additive) – A water absorbent polymer, is a crosslinked, modified polyacrylamide which absorbs many hundreds of times its own weight in water and swells to form a durable crystalline gel. These gel particles do not dissolve, but continue to swell with time, making a seal in the pore spaces of the formation; thus, eliminating fluid loss.
For maximum results, every pound (0.45 kg) of **Aquasorb** should be prehydrated with three gallons (11.36 liters) of water for about 10-15 minutes before introducing to the excavation. Upon hydration, pour into the excavation allowing hydrated polymer to migrate into the loss zone. Repeat as necessary. Generally, one pound (0.45 kg) of **Aquasorb** per foot (0.30 meter) of diameter of hole will control moderate losses. For severe losses, this amount will require doubling to achieve complete seal.

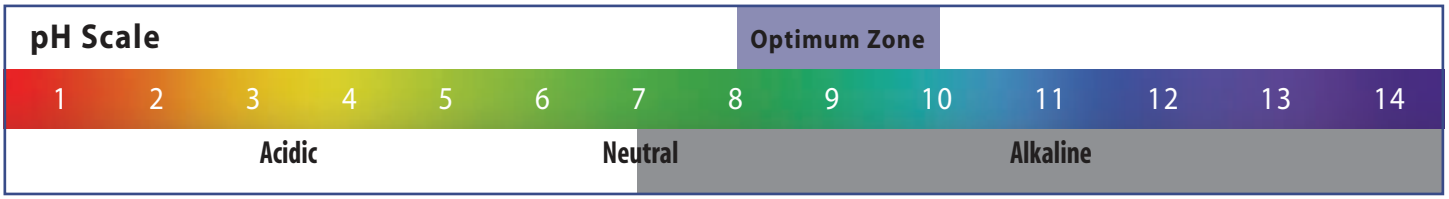
GRANULAR SEAL™ (Mineral Fluid Loss Control Additive) – A dry, granular fluid loss control additive for use with **Super Mud** polymer slurries. **Granular Seal** helps to control fluid loss in porous soil conditions.

Slurry Testing Equipment

TESTING SLURRY PROPERTIES – There are four main properties that require testing during use:

pH – This test is performed by dipping a piece of litmus paper (pH paper) into the slurry and comparing the color change to a chart. The result is reported in a number from 1 to 14, 1 to 6 acidic, 7 is neutral, and 8 to 14 is alkaline; 1 is the most acidic, 14 the most alkaline.

Optimum Zone (pH 8 – 10) / Problematic Acidic Conditions (pH below 7)
At this level, polymer molecules can fully hydrate and extend, creating more viscosity. The carbonate ion present in alkaline solutions also buffers the slurry against calcium and magnesium contamination. Acidic soil and groundwater can be extremely detrimental to a slurry and should be corrected by additions of a safe pH conditioner such as **Water Treat** or soda ash (Na_2CO_3). In extreme cases potassium or sodium hydroxide may be used, however extreme caution should be taken; for further details contact PDS.



MARSH FUNNEL VISCOSITY – Viscosity is the measure of slurry thickness, polymer concentration and the slurry's ability to stabilize surrounding soils. This test should be performed both initially and at frequent intervals during use of the slurry. The time in seconds for one quart of slurry to pass through the funnel is reported as viscosity in seconds per volume. At standard mixing rates, **Super Mud** slurries will yield a viscosity of 40+ seconds per quart (0.95 liter).

Procedure – The test requires a Marsh Funnel and Viscosity Cup.

While holding a finger over the tip of the Marsh Funnel, fill the funnel by pouring the slurry sample through the screen located in the top of the funnel. The screen will filter out any particles that may clog the tip of the funnel. The funnel should be filled to the bottom of the screen. Place the Viscosity Cup on a level surface and while holding the funnel over the cup, remove your finger allowing the fluid to flow into the cup. Using a stop watch or wrist watch, time the number of seconds it takes to fill the cup to the top line marked 32 oz. (1 quart). MFV is reported in seconds per quart.

DENSITY TEST – This test determines the weight of the slurry and is performed with a standard mud balance, also known as a mud scale or density scale. **Super Mud** slurries, regardless of viscosity, have the same density as water, specific gravity of one (8.3 lbs/gal).

Procedure – Fill the reservoir of the mud balance with the slurry sample and replace the lid. Wipe off any excess mud from the reservoir and place the balance on the fulcrum or knife edge. Slide the weight along the balance arm while using the level located on the arm just behind the reservoir to determine when the balance is level. Once the balance is leveled, the result can be read and reported in specific gravity, pounds per gallon, pounds per cubic foot, or pounds per square inch.

Slurry Testing Equipment

SAND CONTENT – This test measures the amount of sand suspended within the slurry and is performed with a standard sand content kit. The results are reported as percent sand. Testing is normally performed at the completion of excavation and just prior to placing concrete. When using **Super Mud** slurries, the sand content will rarely test over 1.0% sand. Due to **Super Mud's** flocculation ability, it drops sand very quickly; therefore, the slurry remains nearly sand free.

Procedure – This test requires the glass and content tube, the 200 mesh sieve with funnel, and the wash bottle. Due to the binding effect the polymer has on the mesh sieve, the wash bottle should be filled with water containing 10% regular household bleach.

Fill the glass and content tube with the slurry sample to the point marked MUD TO HERE. Then fill tube with clean water to the point marked WATER TO HERE. While holding your finger over the tip of the tube, shake the tube for several seconds, mixing the water and slurry sample.

Pour the diluted slurry sample on top of the sieve, invert the sieve and with the wash bottle (containing clean water) wash the sand particles that were trapped in the screen back into the glass sand content tube. When all the sand particles have dropped to the bottom of the tube, the result can be read and reported in percent sand.

FLUID SAMPLER – The Fluid Sampler permits its user to sample at any depth of the excavation for accurate analysis.

The Fluid Sampler is 3.5 inches in diameter and it is constructed of schedule 40 PVC. It is equipped with a double ball check valve allowing for fluid extraction from desired depths and also features a threaded midsection for easy cleaning and storage.

PDS TESTING EQUIPMENT KIT

- Marsh Funnel & Viscocity Cup
- Mud Balance
- pH Test Paper
- Sand Content Kit
- Fluid Sampler
- Stop Watch
- Durable Carrying Case

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