Via email:

June 27, 2006

RE: Bentonite Vs Cement

BENTONITE GROUT vs. CEMENT GROUT

COST COMPARISON

Volclay Grout vs. Cement

	Portland Cement Grout	Volclay High Solids Bentonite Grout
Description	94 lb. bag mixed with 6 gal. water	50 lb. bag mixed with 18 gal. water
Yield	1.2 ft^3	3.0 ft^3
Cost	$5.50 - $7.00	$10.00 - $11.00
Formation Loss	30% - 40%	5% - 10%

Cost Calculations

Grouting the annulus of a 10" boring with a 6" id casing in a 250' deep well.
Volume to be grouted: .349 ft^3/ft of well x 250 ft = 87.25 or 87 ft^3.

Cement Grout

Volume + formation loss = total volume needed
87 ft^3 + (87 ft^3 x 40%) = 121.8 or 122 ft^3

Total volume / yield = bags needed x bag cost = total cost
122 ft^3 / 1.2 ft^3/bag = 101.6 or 102 bags x $7.00/bag = $714.00

Volclay Grout

Volume + formation loss = total volume needed
87 ft^3 + (87 ft^3 x 10%) = 95.7 or 96 ft^3

Total volume / yield = bags needed x bag cost = total cost
96 ft^3 / 3.0 ft^3/bag = 32 bags x $11.00/bag = $352.00

Cost savings when using Volclay Grout: $362.00

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BENTONITE GROUT vs. CEMENT GROUT

ADDITIONAL COMPARISONS

High Solids Bentonite	**Description**	**Cement**
32 bags x 50 lbs = 1,600 lbs.	Weight Material Handling	102 bags x 96 lbs = 9,792 lbs
96 ft^3 x 7.48 gal = 718 seven 100 gallon batches	Mixing and Pumping	122 ft^3 x 7.48 gal = 912 nine 100 gallon batches
Will not start setting until mixing is stopped. Remains pumpable for hours	Tremie Pipe Placement	Starts to set when mixing. Flash setting.
No hurry, just rinse with fresh water. Saves time.	Ease of Use/Clean Up	Must be cleaned prior to setting. Abrasives can damage equipment.
Neutral, will not harm skin or affect water quality. pH = 6-7	pH	High, can cause skin damage, corrode equipment and affect water quality. pH = 13
Remains flexible, will not crack. Sticks to well casing. Reseals itself.	Sealing Characteristics	Rigid, cracks and shrinks away from casing.
No heat is generated when curing.	Heat of Hydration	Generates heat upon curing, potentially causing damage to PVC casing.
Allows for removal of casing and screen for resetting or redrilling.	Reconstruction	Cannot be done.
Certified Safe by NSF. Natural occurring organic bentonite	Environmental Safety	No standard mixture; unknown objectionable ingredients.

High Solids Grouts

There are several high solids bentonite grouts on the market today. These products differ in yield mixing ratio, solids content, and ingredients.

From a yield standpoint, the higher the yield the lower the percent of solids. Most of these products have between a 20% and 30% solids content. A 30% solids material will yield approximately 2.2 cubic feet per 50 pound bag when mixed with 14 gallons of water. A 20% solids material will yield 3.5 cubic feet of grout when mixed with 23 gallons of water. High solids grouts are manufactured to perform at a specific solids content (i.e. 20% or 30%). Use of additional water will increase yield, but will also

increase formation loss and reduce the grout's sealing ability. Due to the increased yield a 20% solids material will have a lower usage cost in comparison with a 30% solids material.

The basic ingredient difference in the high-solids grouts is the fact that some of the grouts may have polymers to decrease hydration and set time. This may make the products unacceptable for use as grouting materials in monitoring well construction. The addition of polymers is not reflective of the solids content of a bentonite grout. Whether or not a high-solids bentonite grout contains polymers is dependent strictly on the manufacturer's formulation of the product.

The fact that there are several grouts on the market that seem to be similar while actually having numerous differences can cause confusion. To determine the best grout for a particular job, the driller must consider the type of well being constructed, the acceptable solids content of the grout, any objectionable ingredients the grout might contain, the ease and/or difficulty associated with mixing and placement of the grout, and the usage cost (not per bag cost) associated with the product. Once it has been determined which grout is to be used, the driller should request a certificate of analysis and a product specification sheet to make sure the grout meets the specifications required of the job.

The purpose of this correspondence is to offer an opinion on the use of bentonite in the construction of monitoring wells as recommended by C

A monitoring well measures the physical and chemical properties of ambient ground water without adversely affecting its quality. The cleanliness of well construction and the collection of discrete data are the goals of properly installed monitoring wells.

Bentonite as an Annular Sealant

Because of its unique swelling characteristics and large surface area, sodium bentonite provides a highly effective annular seal in wells. Its function for wells is to provide a low-permeability seal that will not adversely affect ambient groundwater quality, will seal discrete sample zones, and will prevent the mixing of aquifers and the vertical migration of surface water.

The design of the annular seal varies from well to well: however, the American Society for Testing and Materials (ASTM) has established standards on groundwater and vadose zone investigations (ASTM,1991). ASTM D5092 (*Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers)* promotes (1) durable and reliable construction, (2) extraction of representative groundwater samples and (3) efficient and site hydrogeologic characterizations (ASTM, 1992).

In a typical single-cased well, a 2-4 ft bentonite layer is placed above the filter pack. This layer (typically bentonite chips or tablets) forms a low permeability seal to prevent the infiltration of grout into the filter pack. Following installation of the bentonite seal, a high-solids bentonite grout is commonly installed. In certain instances bentonite chips and tablets may not be able to be placed effectively above the filter pack (i.e. the material may bridge, or it is a deep well installation, etc.). In this case a secondary filter pack of a finer-grained material is installed which allows for a high-solids bentonite grout to be placed directly on top of the filter pack. Bentonite platelets will form a filter cake at the interface with the finer-grained, low porosity, secondary filter pack. This mechanism prevents the migration of grouting fluids into the sampling zone. Cement based grouts do not have the ability to form a filter cake and subsequently should not be installed directly on top of the filter pack. To ensure that there will be no mixing and migration of interaquifer and surface fluids into the screened area, the entire annular space should be sealed.

High-solids bentonite grout

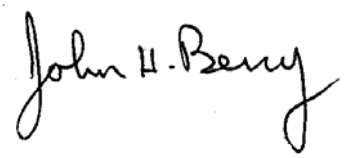
High solids bentonite grouts are products specifically engineered for use as borehole sealants. The grouts consist of a blend of powered bentonite and fresh water mixed to a pumpable slurry containing a minimum of 20% solids (ASTM, 1992). For example, mixing 24-gal (6.35 L) of water and 50 lb (22.6-kg) forms grout with a minimum of 20% solids of bentonite. The higher the solids content, the lower the porosity and therefore the lower the permeability. The solids content should only reflect the weight of bentonite used in the slurry, not inactive filler materials (i.e. sand, drill cuttings, etc.). To determine the percentage of solids of a grout mixture, the weight of the material is divided by the weight of the material and water [(i.e. weight of dry material/weight of material + weight of water) x 100]. Following is a list of functions for a high-solids bentonite grout.

- Permeability. Grout material should have a permeability equal to or lower than the least permeable formation layer present.
- Reactivity. Grout should not react with formation material or water nor be capable of contaminating the aquifer.
- Placeability. Grout must be in a form which can positively and accurately be placed to fill voids.
- Flowability. Grout should be self-leveling in the annulus, should not bridge and should be uniform in consistency.
- Settlement. Grout should have minimal penetration into a permeable formation zone.
- Stability. Grout should provide an element of structural stability when set.
- Bonding/shrinkage. Grout should be capable of bonding to a well casing and borehole wall to provide a watertight seal.

Alternatively, Portland cements and cement/bentonite mixtures are also often used to seal boreholes. These materials have both advantages and disadvantages. Shrinkage generally occurs with the cement, causing it to pull away from the borehole wall and/or casing. Because of its chemical nature cement is a highly alkaline substance (pH from 10 to 13), and thus introduces the potential for altering the pH of water with which it comes in contact. Cement also produces heat when curing, (170-190º F). This heat, coupled with the weight of the material typically, (14-15 lb/gal) can deform or collapse PVC casing. Bentonite grouts, however, are less dense, (9-10 lb/gal) and do not generate heat while hydrating.

If I can be of further assistance do not hesitate to contact me at (847) 818-7935 or (847) 910-4334.

Sincerely,
Colloid Environmental Technologies Company



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