AquaBlok® HoleBlok™ – Use in Borehole and Well Construction and Abandonment

TEST REPORT #1 HB AQUABLOK® HOLEBLOK™ GROUT PARTICLES

Technology Overview

AquaBlok® is a patented, composite-aggregate technology resembling small stones and typically comprised of a dense aggregate core, clay or clay sized materials, and polymers (Figure 1). For typical formulations, AquaBlok's clay (sealant) component consists largely of bentonite clay. However, other clay minerals can be incorporated to meet specific needs. Other technology parameters (particle size, relative clay content, etc.) can also be modified, as appropriate.

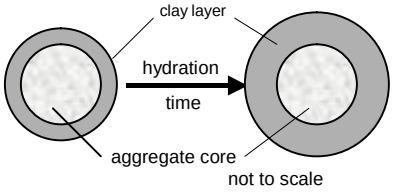


Figure 1. Configuration of Typical AquaBlok Particle.

AquaBlok particles expand when hydrated, with the degree of net vertical expansion determined largely by the formulation, application thickness, and the hardness and salinity of the hydrating water. When a mass of particles is hydrated, the mass coalesces into a continuous body of material. Once developed, the hydrated AquaBlok can act as an effective physical, hydraulic, and chemical barrier by virtue of its relatively cohesive and homogeneous character, and low permeability to water.

Problem Statement

A low-permeability, hydraulic seal is often required during construction of monitoring and other types of wells for a variety of industry processes to minimize the potential for vertical transfer of contaminated ground water or oil along the well's annular space. Such transfers pose a risk in that pollutant migration can contaminate adjacent aquifers.

Current Approach

Current practice for creating a hydraulic seal above a well's screened interval generally involves installation of a low-permeability cap directly over a well screen sand pack or other granular material previously placed into the well's annular space, adjacent to the well screen (Figure 2). The cap is typically created by pouring an adequate quantity of pure, dry bentonite pellets or chips down the annular space and across the surface of the granular component.

Water present in the formation hydrates the pellets, thus affecting material expansion and sealing of the annular space. Finally, bentonite chips or a bentonite or concrete/bentonite slurry, also known as "grout" and typically characterized by a low bearing capacity, is tremie-piped over the top of the semi-solid cap. Well construction is then typically completed through application of a surficial concrete cap.

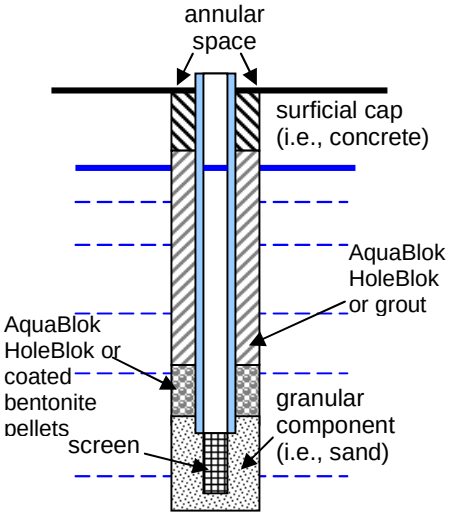


Figure 2. Schematic of common well construction.

Construction of an effective bentonite cap directly over the top of (and contiguous with) the underlying granular unit can be complicated by a phenomenon known as "bridging." Bridging generally involves a "clogging" of bentonite material within upper reaches of the annular space during its application and descent through the annular space, and can result in gaps.

Such a hydraulic gap could create pathways for release or the uncontrolled transfer of contaminated ground waters from one aquifer to another.

Why AquaBlok Is Better

Use of a relatively dense, bentonite-bearing product for sealing annular spaces in wells minimizes bridging during descent through the annular space, enabling more effective placement of the reactive bentonite component directly overtop the sand unit – thus resulting in formation of a continuous and effective well seal. The settling velocity of dry AquaBlok particles through a water column within the annular space equals that of bentonite coated pellets and is faster than that of pure chips (see Figure 6, page 2).

Smaller-diameter, relatively dense AquaBlok HoleBlok™ particles can also be formulated to accommodate particularly narrow annular spaces. AquaBlok can also be used in lieu of, or in combination with, typical grouting material to affect a hydraulic seal elsewhere within a well, as dictated by site-specific conditions.

AquaBlok HoleBlok™+™ Reactive Sealant for Pollution Prevention

By adding reactive media or catalysts to AquaBlok, such as Zero Valent Iron, hydratable composite particles quickly form subsurface seals around targeted objects such as well casings, caissons, pillars, piping, or other engineered structures that will also provide treatment of residual pollution. The reactive nature of the amended sealant is such that organic compounds that partition into the sealant can be destroyed. Inorganic compounds, which tend to migrate along the preferred path of the boreholes or engineered structures, will also be effectively sequestered, thereby minimizing extended or cross-contamination of sub-aqueous environments.

The use of reactive AquaBlok HoleBlok™+™ helps ensure that cross contamination of aquifers does not occur during site investigation, delineation and remedial actions. In addition, the potential for rebound of contaminants of concern, which may be attributed to the sorptive nature of conventional sealants, can be minimized (PATENTS PENDING).

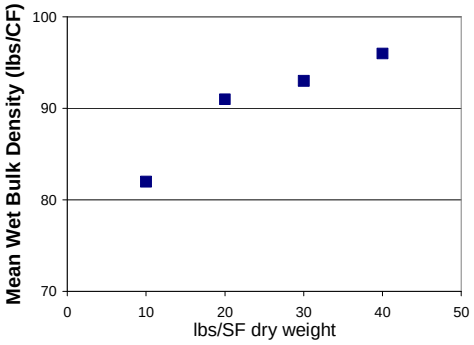
Figure 3. AquaBlok HoleBlok™ and HoleBlok+™ grout particles are easy to handle and place. No mixing or special equipment is required.

Figure 4. Permeability.

AquaBlok HoleBlok™ Formulation	Hydraulic Conductivity Values (cm/sec)
4060 FW	3.94×10^{-9}

Representative samples of freshwater AquaBlok (4060 FW) were used to determine saturated hydraulic conductivity in general conformance with ASTM Method D 5084.

Figure 5. Mean Wet Bulk Density and Percent Moisture of Hydrated Product.



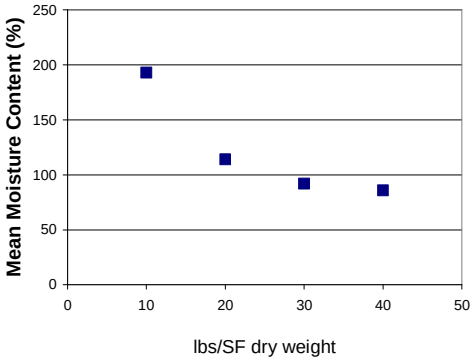


Figure 6. Particle Size Distribution.

Sieve Size (inches)	4060 FW No. 9 Percent Finer	4060 FW No. 8 Percent Finer
0.75	100.0	100.0
0.375	98.9	61.3
#4 – 0.187	52.7	0.0
#10 – 0.078	1.7	0.0
#20 – 0.033	0.0	0.0

Figure 9. Typical Dry Bulk Density for Standard AquaBlok HoleBlok

Product Formulation	Aggregate Core	Dry Bulk Density, Typical Range (lbs/ft^3) 75 80 85
4060 FW	No. 8	

Representative samples of freshwater AquaBlok (4060 FW) were used for the quantitative determination of the distribution of particle sizes in general conformance with ASTM D422.

Settling Characteristics

To obtain a comparison of the rate of descent of AquaBlok to alternative products, two formulas of AquaBlok were used: a 4060 No. 9 AquaBlok HoleBlok™, having an average particle size of ~1/4"; and a 4060 uniform No. 8 AquaBlok HoleBlok™, having an average particle size of ~3/8". The two formulations of AquaBlok were compared to bentonite chips, 1/4" coated tablets, and 3/8" coated tablets. To perform the comparison, an 8.5'x11"x11" acrylic testing apparatus was used. The 8.5- foot column was filled to six-inches from the top of the column to obtain an eight-foot water column. A dropping apparatus was then utilized to consistently drop approximately 200 cm^3 of each product. The rate of descent was timed from the moment of opening the dropping apparatus until the majority of the product had reached the floor of the testing column. A total of ten repetitions were completed for each product. As shown on Figure 6, the average drop rates for the AquaBlok HoleBlok™ grout particles are equivalent to the coated bentonite pellets.

Figure 7. Comparative Drop Test Results.

TEST #	Bentonite Chips	1/4" Coated Bentonite Pellets	AquaBlok 4060 No.9's	3/8" Coated Bentonite Pellets	AquaBlok 4060 No. 8's
	Time (sec)	Time (sec)	Time (sec)	Time (sec)	Time (sec)
AVG	*11.46*	*10.44*	*10.46*	*8.22*	*8.31*

Figure 8. Hole Size Application Rates.
D1 = Bore Hole Diameter (Inches)
V1 = Entire Bore Hole Volume (Cu.Ft.)
LF1 = Linear Feet per 50# of HoleBlok
D2 = Well Casing Diameter (Inches)
V2 = Annular Space Volume (Cu.Ft.)
LF2 = Linear Feet per 50# of HoleBlok

D_1	V_1	LF_1	D_2	V_2	LF_2
24	3.142	0.20	16	1.745	0.36
			12	2.356	0.27
18	1.767	0.35	8	1.418	0.44
			6	1.571	0.40
16	1.396	0.45	8	1.047	0.60
			6	1.200	0.52
			4	1.309	0.48
14	1.069	0.58	8	0.720	0.87
			6	0.873	0.72
			4	0.982	0.64
12	0.785	0.80	6	0.589	1.06
			4	0.698	0.90
10	0.545	1.15	4	0.458	1.36
			2	0.524	1.19
8	0.349	1.79	2	0.327	1.91
7	0.267	2.34	2	0.245	2.55
6	0.196	3.18	2	0.175	3.58
			1	0.191	3.27
4	0.087	7.16	2	0.065	9.55
			1	0.082	7.64
3	0.049	12.73	1 1/2	0.037	16.98
			1	0.044	14.32
2	0.022	28.65	1 1/2	0.010	65.48
			1	0.016	38.20
			3/4	0.019	33.34
1 3/4	0.017	37.42	1 1/4	0.008	76.39
1 1/2	0.012	50.93	1	0.007	91.67
1 1/4	0.009	73.34	1	0.003	203.72
1	0.005	114.59	3/4	0.002	261.92

Figure 8 is based on an AquaBlok HoleBlok™ bulk density of 85 lbs/ft^3. AquaBlok HoleBlok™+ reactive sealants bulk density will vary. The table accounts for typical borehole diameters and well riser/screen sizes that can be accommodated by a particular auger inside diameter (lower diameters such as 3" and 2" boreholes are accomplished with direct push technology for shallow applications. All dimensions are nominal and adjustments to material requirements need to consider formation loss and other site-specific applications.

Available Sizes / Quantity

AquaBlok can supply HoleBlok™ in 50lb plastic pails or bags for typical applications. However, for larger projects HoleBlok™ can be packaged in approximately one ton super sacks (bulk bags). Bulk packaging also provides significant savings on per pound material costs.

Contact AquaBlok Today

For more information, call AquaBlok, Ltd. at (800) 688-2649, fax us at (419) 385-2990, or email us at services@aquablokinfo.com.

The test reports are also available on our web site at: www.aquablokinfo.com.

AquaBlok® Composite Particle System