ORGANOCLAY for Hydrocarbon Contaminants

AquaBlok®

TEST REPORT #13: AquaGate+ ORGANOCLAY

Proven Remediation Performance of Organoclay Delivered in an Aquatic Setting

Background

AquaBlok is a patented, composite aggregate technology resembling small stones and typically comprised of a dense aggregate core. In this application of the technology an organoclay coating is utilized with polymers (Figure 1). In other AquaGate+™ applications various alternative treatment materials can be incorporated to meet project-specific needs.

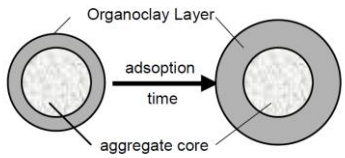


Figure 1. Configuration of an Organoclay Coated Particle

AquaGate+ORGANOCLAY particles adsorb oil and a wide range of hydrocarbon-based contaminants when contact is made in sediments. As the particles chemically bind the contaminants, the clay layer will expand. At a point when the full mass of the organoclay is achieved the particles coalesce into a continuous and relatively soft body of material, decreasing the permeability of the layer. The AquaGate+ORGANOCLAY layer can also be used in conjunction with a standard AquaBlok cap layer to form an even lower permeability barrier layer above the sediment, if desired.

Organoclays are organically modified clays, typically produced by blending surfactants and clay minerals. This blend creates a new product, a surfactant with a solid base. By means of a partition process, the modified clays will fix non-polar organic compounds. In contrast to activated carbon, by which organic compounds are adsorbed into pores in the carbon and quickly become fouled, the partitioning phenomena takes place outside of the clay particles, minimizing the fouling problem.

Applications of AquaGate+ORGANOCLAY Technology

Organoclays are a proven remediation technology that addresses a wide range of hydrocarbon-based contamination. The following is a partial list of typical sites and/or contaminants where AquaGate+ORGANOCLAY cap can be a cost-effective solution:

- **MGP Plants**
- **Wood Treating Facilities**
- **Creosote**
- **Coal Tar (BTEX)**
- **PCBs**
- **PAHs/NAPL**

Although it has been established that similar weight of organoclay materials will remove, by means of partitioning, up to 7 times the rate of activated carbon, activated carbon can provide further absorption of trace amounts that may not be fully removed by organoclay. Thus, the materials can be used in series in a complimentary manner in some applications requiring very low levels of treatment.

Photo 1. Example Design Mix – 300g of AquaGate+ORGANOCLAY 4060 blend sample (120g of Active Organoclay), 3 weeks after addition of 185ml motor oil.

Generally, AquaGate+ ORGANOCLAY is expected to adsorb between 50-100% of the total weight of the organoclay present in the particle. This percentage of organoclay can vary from 20-40% depending on the desired cap / treatment design and contaminant material and concentration.

Additionally, by varying aggregate particle size, control over various properties of the cap can be obtained, thus creating a more versatile cap that can be easily engineered for project specific applications.

Use of AquaGate+ ORGANOCLAY

For many projects, use of the product will generally involve applying dry masses of the material through the water and across the surface of contaminated sediments or directly onto pools of free product. The material can also be placed below other more permeable capping materials such as sand or directly on soil/sediments in the dry if an area has been dewatered.

The use of organoclay in an AquaBlok matrix provides for an efficient delivery and placement option for materials that may otherwise be subjected to erosion by stream flow, wave action, or tidal fluctuations.

A variety of application methods have been implemented for similar materials, such as: barges, clamshells, stone slingers, conveyors, and many more. The ease of placement and ability to place AquaGate+ORGANOCLAY through a water column creates a practical method for addressing sediments contaminated by oils, PCBs or other difficult hydrocarbon based COCs.

Funnel & Gate Approach

An AquaGate+ORGANOCLAY cap can be configured as a “gate” with a “funnel and gate” system to selectively capture discharges from submerged seeps of upland plume related discharges. Should breakthrough eventually occur, the gate material can be effectively removed and the gate replaced with fresh material. By capturing the product at the seep source, relatively modest volumes of material need to be handled as opposed to using oil sorbent booms and pads, etc. to capture and cleanup seeps that discharge through the water and rise to the surface.

AquaGate+ORGANOCLAY Compatible Product Manufacturers

AquaGate+ORGANOCLAY has been produced and tested with organoclay product available from the following manufacturers:

- **Aqua Technologies of Wyoming, Inc.**
- **Biomin, Inc.**
- **CETCO (Div. of Amcol, Intl.)**
- **Polymer Ventures, Inc.**

In addition, AquaGate+ ORGANOCLAY material can be manufactured with other amendments, such as Adventus Group's ZVI or EHC products (see www.adventusgroup.com), to be used to deliver a treatment "train" approach for complex sediments with multiple contaminants.

Bench-Scale Testing & Application and Modeling

While organoclays were originally developed as a water treatment medium, they have more recently received consideration for sediment remediation applications, and when delivered to the sediment water interface as an AquaGate+ amendment, the range of applications increases. In addition, when used in the manufacture of AquaGate+ORGANOCLAY, cost efficiencies can be realized as a result of the more effective placement option.

Although other variations exist, the typical applications of AquaGate+ ORGANOCLAYs would be one of the following:

- A composite cap with AquaGate+ORGANOCLAY overlain by sand or other non-reactive material can be an effective remedy where contaminated sediments were transplanted to a deposition area that is not related to a continuous upland source.
- A composite cap with AquaGate+ORGANOCLAY used to consolidate semi-suspended sediments (especially those with petrochemical components) prior to the application of a low permeability standard AquaBlok cap layer.
- As a treatment gate material in a "funnel and gate" configuration with standard AquaBlok or other low permeable capping material to direct flow through the AquaGate+ ORGANOCLAY treatment media, either through gate columns set at specific intervals, or laterally under a complete cap for capture along the entire cap length, essentially creating a long, thin horizontal column with significant residence times.

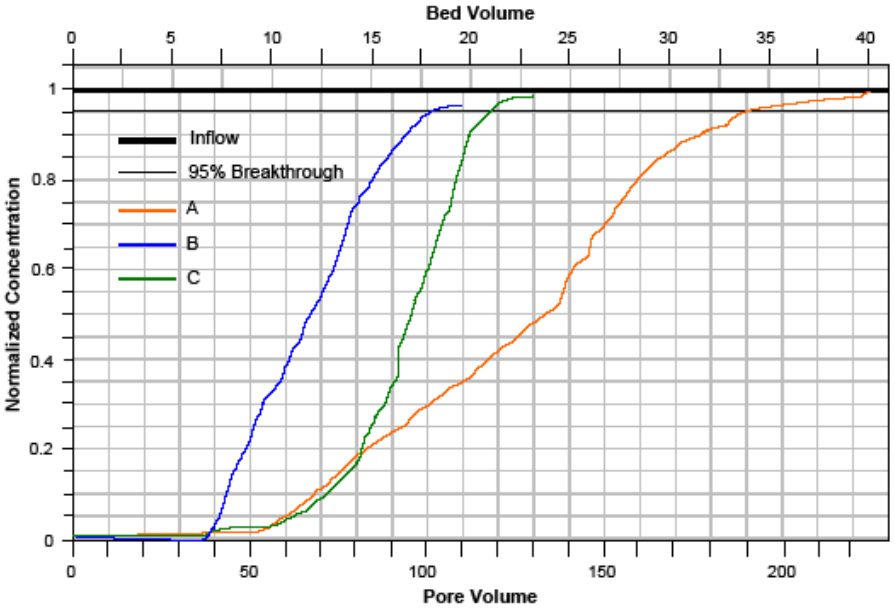
There are multiple manufacturers of organically modified clays and the individual products demonstrate different performance attributes as the chemicals of concern, levels of contamination, and salinity of the application area vary. In addition, different organoclays demonstrate varying swell factors, which are an important design consideration. AquaGate+ORGANOCLAY has been successfully manufactured using a variety of organoclays from multiple vendors. **Tables 1 & 2** demonstrate the relative efficiency of one such product (manufactured by Biomin, Inc.) at removing a surrogate vegetable oil in a series of three small column tests designed to demonstrate the effect of varying particle size (and resulting pore size and volume) and residence time, (which is a function of flow-through rates and column length). **Figure 2** graphically demonstrates this relationship between particle size (a 1/4" particle size vs. 3/8" particle size) and, in the case of the duplicate 3/8" particles, runs at different flow-through rates and how these variables affect the removal

Table 1 (*)

Sorbent	Mass Sorbent		Porosity	Flowrate		Residence
	(kg)	(lb)		(mL/min)	(gal/hr)	(min)
A	0.16	0.34	0.19	2.4	0.038	30
B	0.155	0.341	0.21	7.0	0.114	10
C	0.157	0.345	0.20	3.8	0.061	21

Table 2 (*)

Sorbent	Breakthrough			Mass Sorbent		Mass Sorbed/Mass Sorbent		
	PV	BV	min	(kg)	(lb)	(mg/kg)	(lb/lb)	(% by sorbent)
A	207.7	39.5	6471	35687	0.079	223043	0.223	22.3
B	101.9	20.4	4256	15702	0.035	98139	0.098	9.8
C	117	23.6	9526	24518	0.054	156163	0.156	15.6



A - AquaBlok+ORGANOCLAY (30/70 Blend), 1/4" size, 30 min. residence and 3,810 mg/L Vegetable Oil.
B - AquaBlok+ORGANOCLAY (30/70 Blend), 3/8" size, 10 min. residence and ~3,400 mg/L Vegetable Oil.
C - AquaBlok+ORGANOCLAY (30/70 Blend), 3/8" size, 21 min. residence and ~3,400 mg/L Vegetable Oil.

(*) Independent testing completed by Vinka Cramer, Ph.D. and James Smith, Ph.D. for Biomin, Inc. on sample AquaBlok+ORGANOCLAY material, manufactured by AquaBlok, Ltd. using a Biomin, Inc. supplied Organoclay.

efficiency and the ultimate time (and pore volumes) for significant contaminant breakthrough.

The use of specifically designed bench scale tests can be very effective at selecting specific organoclays for particular applications (see Reible et al, University of Texas at Austin, Organoclay Laboratory Study – McCormick & Baxter, September 2005) and the selection of the appropriate AquaGate+ particle size and layer thickness. Similarly, simple bench scale testing can also determine the appropriate application rates of specific AquaGate+ORGANOCLAY applications for use as a flocculant to consolidate free-product layers and semi-suspended sediments to facilitate more efficient removal by dredging or excavation, or to create a stable base prior to the installation of a clean cap to meet restoration goals.

The results of bench scale testing can be used in conjunction with flow models to design composite systems that meet long-term risk assessment goals and subsequent targeted remediation goals, while minimizing overall project costs.

AquaBlok®
Composite Particle System

For more information, contact AquaBlok, Ltd. at:

175 Woodland Ave., Swanton, OH 43558

Phone: (419) 825-1325
Email: services@aquablok.com
Website: www.aquablok.com

Last Revised: June 2016