Drop Test of Ca p Material Blended with Two Forms of Activated Carbon

TEST REPORT #16
Drop Test of Cap Material Blended With Two Forms of Activated Carbon

Background and Purpose of Testing

Stokes Law states that solids of varying size and density will fall at varying speeds through a liquid of a constant viscosity (water). This law suggests that placing a blended granular cap material through a water column will result in a layering effect of the material at the bottom of the column based on the size and density of the particles.
A series of column drop tests were done in order to illustrate the relative difficulty, as predicted by Stokes Law, of achieving a uniform mixture of materials within an as-placed capping layer. The drop tests were performed using an existing specification for blending carbon materials into a granular cap.
The cap specification used was the current Hudson River Project “Type 2 Granular Cap” , outlined below, which calls for the addition of 2% Total Organic Carbon (TOC) by weight. For these tests, Activated Carbon (AC) in various forms was substituted for TOC materials called out in the actual Hudson River specification.

Backfill Type 2 Gradation Table (by weight)	
Percent (%) Passing	Sieve Size
100	3 inch
85-100	1 inch
50-75	No. 4
30-65	No. 10
10-45	No. 40
3-35	No. 100
0-12	No. 200

The four different forms of AC tested are dry Granular Activated Carbon (GAC), saturated GAC, Graded AquaGate®+PAC, and AquaGate+PAC. The goal of this testing is to illustrate the effect of Stokes Law on “Type 2 Granular Cap” blended with these four forms of Activated Carbon.

Methods

Water columns of 5-feet in depth and 4-inches in diameter were used for all tests. The blended samples were dropped into the water columns through a funnel with a five and one half inch opening; the material falls 12 inches prior to entering the water.
The quantity of AC required to achieve the 2% specification was calculated based on bulk density and percent weight and does not take into account relative sorption rates of the powder versus granular form.
It was determined that 0.144 lbs of AC was required to meet an equivalent active loading of 2% within the 9-inch thick AC isolation layer. As GAC is 100% AC, 0.144 lbs satisfies the 2% requirement. Both AquaGate+PAC and Graded AquaGate+PAC contain 5% PAC and therefore 2.88 lbs of each is required in order to get 0.144 lbs of AC.
The Graded AquaGate+PAC includes a range of particle sizes from sand-sized material up through the larger particles of the more uniform AquaGate+PAC material. The saturated GAC was soaked in water for 24 hours prior to testing.

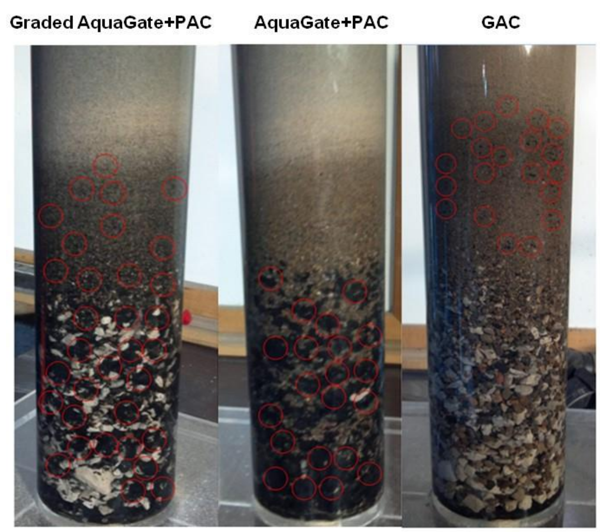
Observations and Results

For every drop test, the water column became very cloudy (high turbidity). At a point no less than 18 inches below the surface of the water, the blended material began to separate. The largest particles separated almost immediately upon hitting the water. Smaller particles became suspended in the water column, descending at a slower velocity.

Over the first two minutes, some of the suspended material could be observed settling to the bottom on top of the larger particles. Within 5 minutes, the water began to regain transparency.
There is a clear separation of the size ranges, appearing as if they were added in sequence as opposed to dropped as a blended mixture. The photo on the right shows how evident the separation of large and small particles is during descent.
There is no significant difference observed between the dry and saturated GAC drop test results. Neither dry nor saturated GAC remain evenly distributed throughout the capping layer and end up in the top half of the amended/reactive capping layer.
The graded AquaGate+PAC exhibited the widest dispersion, with particles mixed throughout the amended/reactive capping layer. The AquaGate+PAC settled into the bottom half of the column leaving very few particles incorporated with the fine-grained material at the top of the capping layer.

Conclusions

The column tests demonstrate that the materials in the amended/reactive capping layer proposed in the Hudson River project separate almost immediately upon entering the water column leading to distinct layering according to grain size. It appears as if the mixture was added in sequence as opposed to being dropped as a blended mixture
The GAC behaved similarly to the smaller particles from the Type 2 Granular Capping material. In addition as GAC has a lower specific gravity, it is more susceptible to being affected by current or wave action.
While the AquaGate+PAC was not fully uniformly distributed within the distributed throughout the entire thickness of the amended/reactive capping layer.
Of the drop tests performed, AquaGate+PAC enabled the placement of the highest percentage of AC near the bottom half of the amended/reactive capping layer.



Red circles indicate relative location of particles within the as-placed cap.
They do not denote the number of particles in a given location.

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