Performance Evaluation Using a Perlite Filter for TPH Removal

Aqua-Tech Report 1.1[a]

Background Information

AquaShield™ utilizes various filter media for the treatment of stormwater and industrial runoff in the Aqua-Filter™ Stormwater Filtration System, the Go-Filter™ Mobile Treatment System, and the Aqua-Guardian™ Catch Basin Insert. The media is packaged in flexible cartridges that are fixed within the different patented technology devices. While each of these systems are custom-engineered facilities, the Aqua-Filter™ and Go-Filter™ systems utilize a two stage treatment train configuration. Treatment begins with the removal of gross pollutants and free-floating oil by the swirl concentrator (Aqua-Swirl™), followed by the removal of fine sediments and other waterborne pollutants by the filtration chamber. The Aqua-Guardian™ does not rely on a treatment train approach.

Perlite is the most common filter media used in the AquaShield™ stormwater treatment systems. Perlite (CAS: 93763-70-3) is an amorphous, hydrated glassy volcanic rock of rhyolitic composition, consisting primarily of fused sodium potassium aluminum silicate. Perlite has long been recognized as an effective filter medium for the removal of sediment and hydrocarbons contained in stormwater runoff.

Purpose of Performance Evaluation

In order to evaluate the performance level of a perlite filter medium to treat stormwater runoff, a laboratory simulation was performed using a known concentration of total petroleum hydrocarbons (TPH).

Laboratory Methods

Independent laboratory testing was performed on behalf of AquaShield™ by Analytical Industrial Research Laboratories, Inc. (AIRL) of Cleveland, Tennessee.[b] AIRL is accredited with the National Environmental Laboratory Accreditation Program (NELAP).

A 10 gallon stock solution of laboratory reagent water containing 160 mg/L of a 50-50 blend of #2 diesel fuel and motor oil was gravity fed from a 40-gallon sterile polypropylene holding tank. The container was gently stirred with an electric motor turning a paddle at approximately 25°C (77°F). The container was fitted at the base with a manually operated PVC flow discharge nozzle. An open ended, tube shaped, PVC filtration cartridge was held in place below the discharge nozzle by the use of standard laboratory clamp devices. A 10 inch head space was maintained between the discharge nozzle and the top of the filtration cartridge. The filtration cartridge dimensions were 1.5 inches in diameter and eight inches in length, and occupied a volume of 14.13 cubic inches. Both ends of the cartridge were covered with a thin flexible nylon screen having one millimeter (0.0394 inch) square openings to retain the perlite filter media.

Water passed through the filtration cartridge at an assigned flow, or loading rate of approximately 41.1 gpm/ft^2. Prior to testing, the filtration cartridge was rinsed with three gallons of reagent water to establish background levels.

One gallon effluent (filtered) water samples were collected at one gallon intervals in new, sterile polypropylene containers at the (bottom) terminus of the filtration cartridge. Each one gallon effluent water sample was analyzed for TPH by EPA Method 418.1.

Simulated Test Parameters

The use of simulated test parameters allows for the laboratory test parameters to be extrapolated in order to evaluate removal efficiency for a larger scale filtration cartridge. By using the laboratory test parameters of test gallons (10 gallons), test cartridge volume (14.13 in^3) and loading rate (41.1 gpm/ft^2), the extrapolated flow rate over a 24 hour period using a larger simulated filtration cartridge can be calculated.

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Based on the laboratory test parameters cited above and a simulated filtration cartridge measuring 2 feet x 2 feet x 1 foot thick (4 ft^2, 4 ft^3, or 6,912 in^3), the laboratory test simulated almost 236,300 gallons of TPH-contaminated water continuously passing through a 4 ft^3 filtration cartridge over a 24 hour period.

Analytical Results

Table 1 summarizes the average influent and effluent concentrations of TPH, and the calculated removal efficiencies that were achieved during the performance test. Removal efficiency (RE, %) is calculated as follows:

$$RE = 100 \times \frac{\text{Influent Concentration} - \text{Effluent Concentration}}{\text{Influent Concentration}}$$

Table 1:
Perlite Filter Performance for TPH Removal

Gallon #	Influent (mg/L)	Effluent (mg/L)	Removal Efficiency (%)
1	160	7	95.6
2	160	13	91.9
3	160	16	90.0
4	160	11	93.1
5	160	11	93.1
6	160	9	94.4
7	160	14	91.3
8	160	10	93.8
9	160	13	91.9
10	160	23	85.6
Average	**160**	**12.7**	**92.1**

Conclusions

- Laboratory performance testing using over 236,000 gallons of simulated stormwater passing through a 4 ft^3 filtration cartridge in a 24 hour period demonstrates that the perlite filter medium provides outstanding water quality treatment against TPH.
- The average TPH removal efficiency is calculated to be 92.1%.
- Similar results can be expected when using this filter medium in the Aqua-Filter™ Stormwater Filtration system, the Go-Filter™ Mobile Treatment System, and the Aqua-Guardian™ Catch Basin Insert.
- The use of perlite filter medium can be applied to a wide variety of sites for the removal of TPH contamination by filtration.

[a] April 2001, Updated July 2008.

[b] AIRL, 1550 37th Street, NE, Cleveland, TN 37312, (423) 476-7766.