Oil Removal Efficiency of the Aqua-Swirl® Stormwater Treatment System

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Purpose and Background Information

The purpose of this report is to demonstrate the results of a full scale field simulation to determine the oil removal efficiency of an Aqua-Swirl® Stormwater Treatment System using an AS-4 model.

Aqua-Swirl® Technology

The Aqua-Swirl® is known to be an effective manufactured BMP capable of consistently providing high levels of water quality treatment. The performance of the Aqua-Swirl® system has been independently verified by the New Jersey Corporation for Advanced Technology (NJCAT), a widely recognized technology evaluation authority. The Aqua-Swirl® is a custom-engineered, patented treatment system designed to remove sediment, free-floating oil and floating debris using swirl technology, or hydrodynamic vortex-enhanced sedimentation separation. Aqua-Swirl® technology is a rapid or high flow rate device that has no moving parts and operates on gravity flow or movement of the stormwater runoff entering the structure.

Operation begins when stormwater enters the Aqua-Swirl® by means of its tangential inlet pipe, which induces a circular (swirl or vortex) flow pattern. Dynamic separation occurs during each storm event, while quiescent separation takes place between successive storms. A combination of gravitational and hydrodynamic drag forces results in solids dropping out of the flow and migrating to the center of the swirl chamber where velocities are the lowest. The treated flow exits the Aqua-Swirl® behind the arched inner baffle, which also serves to retain the free-floating oil and debris. The top of the baffle is sealed across the treatment channel to eliminate floatable pollutants from escaping the system. A vent pipe is extended up the riser to expose the backside of the baffle to atmospheric conditions, preventing a siphon from forming at the bottom of the baffle.

Testing Methods

A 600-gallon run was performed to establish the oil removal efficiency of the Aqua-Swirl®. A flow rate of 300 gpm (21.1 gpm/ft^2) was used for the run. Five gallons of waste oil was manually poured into the influent stream. Influent samples were manually collected at the opening of the inlet pipe to the swirl chamber. Given the inability to feasibly collect effluent samples behind the arched baffle in the swirl chamber, effluent samples were manually collected at the opening of the inlet to the effluent holding tank located four feet downstream of the Aqua-Swirl®.

Results

Laboratory analyses were performed by EPA Method 418.1 to determine the concentration of total petroleum hydrocarbons (TPH) in the influent and effluent grab samples. All analyses were performed independently by a NELAP certified laboratory. This cited analytical method was used since it applies to the waste oil spectrum. Table 1 summarizes the TPH concentrations and the oil removal efficiency for the run.

Table 1
Aqua-Swirl® AS-4 Oil Removal Efficiency

Influent TPH (mg/L)	Effluent TPH (mg/L)	Oil Removal Efficiency (%)
600 gal water + 5 gallons waste oil @ 21.1 gpm/ft^2		
789.2	15.0	98.1

A TPH removal rate of 98.1% was recorded for the test run at a loading rate that compares favorably to those rates where 80% TSS removal are also achieved. That is, a high level of oil removal can occur at loading rates consistent with higher flows; and the need to reduce flows significantly to allow for high levels of oil removal are not indicated.

Conclusions

The Aqua-Swirl® AS-4 demonstrated a high oil removal efficiency at an operating rate of 21 gpm/ft^2, or 300 gpm. It is important to consider that greater than 80% of storms exhibit loading rates less than 25 gpm/ft^2; hence, it is considered that this test reasonably reflects the majority of field operating conditions that would be encountered. It is evident that the Aqua-Swirl® can serve as an effective stormwater BMP in the presence of varying levels of oil concentrations.

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