Hydrodynamic Separator MP-51

Description

Hydrodynamic separators: (alternatively, gravity separator, oil and grit separators, swirl concentrators or vortex separators) are typically manhole or vault based systems employing flow shaping features to enhance gravitational separation of floating and sinking pollutants. Compared to conventional wet vaults, hydrodynamic separators can typically provide the desired pollutant removal performance within a more compact system. Unlike a rectangular wet vault a hydrodynamic separator is round and directs incoming stormwater in a circular fashion, separating suspended sediments, trash and attached pollutants with centrifugal force. There are practical limitations to performance of most designs, where a certain minimum flow rate must be maintained, below which flow shaping features are ineffective and the system operates more as a simple gravity separator. In practice hydrodynamic separators are usually not designed to target sediment particles finer than about 50 microns.

Design Considerations

- Service Area
- Settling Velocity
- Appropriate Sizing
- Inlet Pipe Diameter

Targeted Constituent	Removal
Sediment	Med/High
Nutrients	Low
Trash	High
Metals	Low/Med
Bacteria	Low
Oil and Grease	Med
Organics	Low

California Experience

There are currently over 5,000 installations in California.

Advantages

- May provide the desired sediment and oil removal performance in a smaller footprint compared to conventional wet vaults.
- Scalable designs can treat a wide range of flow rates from <1 cfs to >100 cfs.
- Functions as a cost effective pre-treatment device.
- May provide significant spill protection.
- Captures and holds solids, oil and trash out of public view and out of contact with wildlife, native soils and groundwater.
- Subsurface design allows overlying land to be used for pedestrian or vehicular traffic or for landscaping.

Limitations

- As some of the systems have standing water that remains between storms, there is concern about mosquito breeding.
- It is likely that vortex separators are not as effective as wet vaults at removing fine sediments, on the order 50 to 100 microns in diameter and less.
- Does not remove dissolved pollutants.

- An export of dissolved pollutants may occur as accumulated organic matter (e.g., leaves) decomposes in the units.

Design and Sizing Guidelines

Stormwater enters the separator, typically below the effluent line, tangentially into the basin, thereby imparting a circular motion in the system (Figure 1). Due to centrifugal forces created by the circular motion, the suspended particles move to the wall of the device, and fall along the wall to the bottom. Trash accumulates in the low pressure area of the center of the vortex.

Figure 1. Looking down a hydrodynamic separator from the top where stormwater tangentially enters the unit.

There are a wide variety of system designs commercially available with treatment capacities ranging from less than 1 cfs to more than 100 cfs. Some designs include internal screens suitable for capturing neutrally buoyant materials. Some incorporate internal bypass features that direct peak flows exceeding the design water quality flow rate around the separation zone. Many systems can accommodate multiple inlet pipes, grate inlets or curb inlets. Most systems are designed within standard manhole or utility vaults and can support HS20 loading, with additional reinforcement for greater loads available as an option.

Design of hydrodynamic separators is flow-based with the system size increasing as the design water quality flow rate increases. Some hydrodynamic separators have a characteristic hydraulic loading rate expressed as flow rate per system volume or separation chamber surface area that is associated with a specific targeted pollutant concentration reduction or effluent concentration. Sizing most commonly entails dividing the design water quality flow rate by the hydraulic loading rate to get a minimum system size.

Most, if not all commercially available systems also have sizing tables available for standard models listing the maximum treatment flow rate for a particular model and target performance level. It should be noted that the default target particle diameter and removal rate varies widely between manufactured systems so direct comparison of different models can be difficult. In most cases, a specific system can also be scaled larger or smaller to achieve a greater or lesser performance target at a particular flow rate. Results of full scale field monitoring or standardized laboratory testing with a standard sediment gradation are available for many hydrodynamic separators and should be the basis for selection and sizing decisions.

Construction/Inspection Considerations

No special considerations.

Performance

The primary mechanism of pollutant removal is gravitational separation for all hydrodynamic separators, with some models also employing screens to capture neutrally buoyant materials such as trash. There are numerous hydrodynamic separator design variations commercially available with performance of a particular design depending primarily on the residence time within the system.

Protocols for testing and verifying the performance of innovative stormwater treatment systems have been developed by the Washington State Department of Ecology and the New Jersey Department of Environmental Protection. Both programs provide certification or approval of treatment systems following independent verification that those systems meet certain performance targets. Both programs have been endorsed by numerous states and public agencies including EPA and the Water Environment Federation (WEF) and have been supported by the Stormwater Equipment Manufacturers Association (SWEMA).

The Technology Assessment Protocol – Ecology (TAPE) from the Washington State Department of Ecology program has a "Pretreatment" standard that is applicable to hydrodynamic separators. It is intended to achieve 50% removal of fine (50 micron-mean size) and 80% removal of coarse (125-micron-mean size) total suspended solids.

A list of technologies, including several hydrodynamic separators that have met this treatment standard can be found on the Ecology web page for emerging technologies at:
http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html

The New Jersey DEP laboratory protocol for hydrodynamic separators requires 50% removal of a TSS gradation with a mean particle diameter of 75 microns. A list of technologies, including several hydrodynamic separators that have met this standard can be found on the NJ DEP web page for Stormwater Manufactured Treatment Devices at:
http://www.njstormwater.org/treatment.html

To ensure acceptable hydrodynamic separator performance and operational feasibility, selection of systems that have been verified by the Ecology and/or NJ DEP programs is recommended. Furthermore, design and sizing should be consistent with approvals issued by those programs.

Siting Criteria

Hydrodynamic separators can be configured to receive runoff from the surface through a curb inlet, grate inlet, or through one or more inlet pipes. They can be installed under vehicular or pedestrian traffic areas or under landscaped areas. Maintenance typically requires a vacuum truck so hydrodynamic separators should be located where they can be accessed without unduly disrupting traffic flow or site operations.

Additional Design Guidelines

Hydrodynamic separators may be susceptible to washout if flows significantly higher than the design treatment capacity are directed through the separation chamber or the sediment storage zone. Therefore, it is important that the system either be designed in an off-line configuration

where peak flows are routed around the treatment system, or that the peak flow rate does not exceed the rate at which significant resuspension of previously captured materials will occur. For most designs, the maximum flow rate that the system can handle without resuspension is significantly higher than the design treatment flow rate for particles in the range of 100 microns. The New Jersey DEP protocol for hydrodynamic separator testing includes scour testing which is used to establish the maximum allowable hydraulic loading rate prior to bypass.

Maintenance

Maintenance consists of the removal of accumulated material with a vacuum truck which should be performed annually unless experience indicates the need for more or less frequent maintenance. It may be necessary to remove and dispose of the floatables separately due to the presence of petroleum product.

Cost

Manufacturers provide costs for the units including delivery. Installation costs are generally on the order of 25 to 50% of the manufacturer's cost. For most sites the units are cleaned annually.

Cost Considerations

- Treatment with one larger systems is typically more cost effective than using multiple smaller systems.

References and Sources of Additional Information

Field, R., D. Averill, T.P. O'Connor, and P. Steel, 1997, Vortex separation technology, Water Qual. Res. J. Canada, 32, 1, 185

New Jersey manufactured stormwater devices' performance verification: http://www.njcat.org/verification-process/technology-verification-database.html

New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device: http://www.njstormwater.org/pdf/hds-protocol-1-25-13.pdf

Washington State manufactured stormwater devices' performance verification: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html