# STORMWATER SOLIDS REDUCTION FOR NPDES PERMITS

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NPDES, filtration, automatic filters, stormwater, solids, TSS.

## INTRODUCTION

Finally obtaining a National Pollution Discharge Elimination System (NPDES) Permit is often a relief but is by far not the end of the story. Meeting the requirements of that permit often proves to be quite difficult and stiff fines are freely doled out to those who fail to meet regulatory limits. For one Midwest jet propulsion manufacturing facility, the issue of total daily solids discharge limitations has been a major concern. Parking lots, roof tops and other impermeable surfaces result in a lot of stormwater runoff for any large manufacturing facility. In addition, this plant adds blow-down water from a series of large cooling towers as well as blow-down water from several boilers to the stormwater mix. Stormwater is carried underground through a large pipeline for about 300 meters (approximately 1000 feet) before terminating in a one-acre stormwater detention pond. Water is then discharged from this pond through a 91.5 cm (36 inch) manual valve into an underground concrete conduit for nearly 400 meters (approximately ¼ mile) before discharging to a natural stream. The Indiana Department of Environmental Management (IDEM) is responsible for administration and enforcement of most federal Environmental Protection Agency (EPA) permits within the state. The facility has a real-time nephelometer with chart recorder installed in the concrete conduit at the detention pond discharge site along with a recording flowmeter and flow-proportional automatic sampler. IDEM personnel empirically converted nephelometric turbidity unit (NTU) values to total suspended solids (TSS) concentrations in parts per million (ppm) then devised a table that combines flow rate readings with turbidity readings to get the approximate daily solids discharge. As turbidity values (therefore TSS concentrations) increased, personnel had to manually close down the discharge valve to decrease the flow, thereby decreasing the total solids discharge. This labor-intensive method was far from foolproof.

Facility personnel began an investigation to see if an automatic self-cleaning filter system could improve total solids concentrations in the discharge. A pilot installation was started in the summer months of 2002 to test performance during the peak algae season. Previous laboratory tests had shown the solids in question to be predominantly algae and sand. Other than problems with keeping the portable pump primed during intermittent use, the pilot test was quite successful in reducing the amount of total solids in the final discharge. The following spring a skid-mounted filtration system was purchased and installed consisting of a pump, 6" Amiad SAF -6000 automatic self-cleaning filter, isolation valves, flow meter, pressure sustaining valve, flow control valve and a fully integrated PLC controller. Thoughts were put into interfacing the controls of two variable frequency drive (VFD) pumps with the flow meter and nephelometer outputs. This interface could be used to automatically increase the flow rate when the turbidity was low downstream of the filter system and decrease the flow rate when the turbidity was high. This type of feedback control is quite valid but the cost was prohibitive. Therefore, the installed system is operated automatically at a manually set discharge rate.

## METHODOLOGY

Various types of filtration systems were considered for this application. Sand media pressure filters, cyclonic separators, automatic disc filters and automatic self-cleaning screen filters were all evaluated. All but the automatic self-cleaning screen filters were eliminated during the preliminary review for reasons sited under "DISCUSSION."

A portable pump and automatic screen filter was temporarily installed during the early spring of 2002. It was readily apparent that the filter could not clean itself and was quickly removed. Another automatic self-cleaning screen filter complete with skid, pump, flowmeter and appropriate valves was later rented from another manufacturer and set on the bank of the stormwater detention pond. Screens with filtration degrees of 80, 100 and 130 microns were interchanged during that summer to determine the degree of filtration that afforded optimum flow/turbidity conditions without undue automatic cleaning cycle frequency. The filtration system had to meet the following conditions.

- Stay within the limits of the electric service available
- Maintain sustained flow to prevent the stormwater detention pond from overtopping its emergency spillway
- Be automatic and labor-free
- Eliminate the threat of exceeding permit limits
- Be within the allocated budget
- Be totally self-contained and skid mounted with easy installation

The second system was observed for the summer months of 2002 by powerhouse personnel and found to meet all the establishing requirements.

## RESULTS

The filter type that was permanently installed was an automatic self-cleaning screen filter with focused back-flush cleaning technology. The motor driven suction scanner performed as described by the manufacturer. These filters were shown to be very efficient, causing only 1 psi loss across the system when the screen was clean and going into a 20-second cleaning cycle when the differential pressure (DP) across the screen reached 7 psi. It was determined that if the filtration degree of the screen was too low, excessive solids were being trapped by the screen causing the filter to automatically flush too often. The 100-micron screen proved to be the most effective at keeping the TSS low enough to stay within the limits of the permit without cycling into its cleaning mode too often.

No samples were collected for laboratory analysis but the chart recorder on the nephelometer gave graphic proof that the filter with a 100-micron screen reduced TSS and maintained a value that allowed a discharge rate of up to 500 gpm over 24 hours without exceeding the NPDES Permit maximum daily average total solids discharge limit.

The final system was installed midsummer of 2003. The skid mounted system with 500 gpm pump, 6” automatic self-cleaning filter, isolation valves, flowmeter, pressure sustaining valve, flow control valve and a fully integrated PLC controller are shown in Figures 1 and 2.

**Figure 1 – Stormwater Treatment System (Front View)**


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**Figure 2 - Stormwater Treatment System (Back View)**

**DISCUSSION**

While sand media pressure filters are quite adept at removing algae and other organic substances, they accumulate contaminants with high specific gravities such as sand. In addition, they are generally not mobile. They generally require a concrete pad for support and they are voracious energy consumers. Electric service at the remote site was limited to 30 amperes (amps) and the utility company wanted more than $100,000 to run a 60 amp service to the site. Winters at this latitude preclude algae growth five months out of the year making system mobility desirable; thus, avoiding the cost of protecting the system from freezing.

Cyclonic separators are passive in nature and have no moving parts. This type of machinery provides a very economical solid/liquid separator at a fixed flow rate. However, cyclonic separators can only remove solid particles that have a specific gravity significantly greater than water. This property lends them to removing sand very efficiently but at the same time, makes them unproductive at removing algae and other organic matter.

Automatic disc filters are very adept at removing organic material and, to a reasonable but lesser extent, inorganic matter from pressurized water flow. Expense is an issue with this type of filter and the cleaning mechanism is quite intricate. Because the installation is remote from the main plant, daily observation is out of the question. Materials like filamentous algae or twigs can get between stacked discs during the cleaning cycle, wedging the discs apart. This obviously compromises the integrity of the filtration element allowing solids to pass through the system thereby, risking the chance of exceeding permit limits.

Most automatic self-cleaning screen filters on the market have a cleaning cycle where the filter is taken off-line and the flow reversed through the filter body, thus flowing backward through the screen. This back-flow breaks the debris loose from the screen surface and carries it through a flush-line to the outside of the filter body for discharge. In this cleaning method, velocities are low and energy to remove debris from the screen surface is very limited. This method is referred to as *simple back-flushing* and rarely works well except under ideal conditions.

Another method to clean an automatic self-cleaning screen filter is *focused back-flushing* technology. Such filters have a series of small nozzles that, when connected to atmospheric pressure, create a differential pressure that causes very high velocity flow to "vacuum" the debris off the screen surface. Velocities of 30 to 50 feet per second normally occur at the nozzle openings. All combined, these nozzles clean less than two square inches of screen surface at any one time. The nozzles are then slowly moved across the screen surface by a ½ horsepower electric motor to clean all of the debris from the filter system. This cleaning method usually takes 20–30 seconds and is initiated by a 7-psi differential pressure between the inside and outside of the cylindrical screen element as sensed by a pressure differential switch. A preset timer in the control box can also be used to initiate the cleaning cycle.

## CONCLUSION

Although various types of filtration systems could be used to limit solids at an NPDES outfall, focused back-flush suction scanning automatic self-cleaning screen filters appear to have a distinct advantage. This study also showed that not all automatic self-cleaning screen filters are of equal performance. Choosing a manufacturer with a proven reputation and then testing their system on-site are a must. Unless the pump inlet is continuously submerged, a self-priming pump is recommended. The owners have been shown first-hand that suction-line foot valves cannot be depended upon under such harsh conditions. To-date solids limits have been maintained when run at a steady 70 $m^3$/hr (300+ gpm). Additionally, the filter has maintained its ability to clean itself in 20 seconds when required.

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