Analysis on the Performance Evaluation of a High-Speed Filtering Apparatus for the Treatment of Combined Sewer Overflows (CSOs)

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Abstract. In this study, the generation characteristics of the Combined Sewer Overflows (CSOs) that occur in urban areas were investigated. In addition, performance evaluation of the CSO treatment efficiency was conducted through the field application of a high-speed filtering apparatus using a fibrous filter media for the treatment of the CSOs that occurred in an urban area. The study site, a city located in Seoul, South Korea, was one that included the typical residential and commercial districts. The results of the field application of a high-speed filtering apparatus using a fibrous filter media showed that the average treatment efficiency of SS was 63.7% during the dry season. The average treatment efficiency of SS during rainfall was 84.2% (1st), 88.0% (2nd), 87.5% (3rd), 85.8% (4th), 75.8% (5th), 75.5% (6th), and 90.3% (7th), and exhibiting more than 80% treatment efficiency.

Keywords: Combined Sewer Overflows (CSOs), Fibrous Filter Media, Runoff First Flush, High-Speed Filtering Apparatus

1 Introduction

The degree of water pollution caused by the water pollutants discharged during rainfall gradually increases with the increasing flow rate [1], and the water pollutants respond to rainfall very sensitively [2,3]. In addition, rainfall runoff has a characteristic of increasing the degree of water pollution due to the initial rainfall [4], and the discharged water pollutants are reported to vary depending on the regional and temporal characteristics. Even in the United States, there was a great difference in water quality fluctuations during rainfall. According to the USEPA report, CSOs contain all the contaminants, such as organic matter, bacteria, nutrients, ammonia, turbidity, TSS, and toxic substances other than acidic wastewater. A huge amount of these pollutants are discharged through the overflow outlet in a short time, adding to the water body contamination [5]. At present, South Korea is greatly expanding its facilities for treating non-point pollution sources in the city sewage treatment and
industrial waste treatment plants, but the water quality of the rivers and lakes has not yet been improved. One of the reasons for this is that a great volume of non-point pollutants other than the point pollution sources are flowing into the rivers and lakes. The effects of the non-point pollution source loads discharged during rainfall on the water quality are greater as the sewage treatment ratio is improved, and as the level of economic activity increases. In South Korea, where there is high-density land use, more than 50% of the water pollution loads caused by suspended solids, and more than 80% of the nutrients in the case of closed waters, are due to non-point pollution sources. This study was designed to investigate the characteristics of the CSOs that occur in urban areas, and to promote the field application of the high-speed filtering apparatus for the treatment of overflows occurring in the study site.

2 Contents of research

2.1 Fibrous filter media

This filter media was found to be smaller than other media made with a single material, such as Polypropylene (PP or PETE), and boasts higher pollutant removal efficiency. Table 1 shows the characteristics of the fibrous filter media.

<table>
<thead>
<tr>
<th>Item</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size and shape</td>
<td>5×3mm(thickness)</td>
</tr>
<tr>
<td>Material</td>
<td>Polypropylene (PP)</td>
</tr>
<tr>
<td>Diameter (㎛)</td>
<td>10-100</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>90-94%</td>
</tr>
<tr>
<td>Specific surface area (㎡/㎥)</td>
<td>8000</td>
</tr>
</tbody>
</table>

2.2 High-speed filtering apparatus for CSOs treatment

The high-speed filtering apparatus for CSOs treatment (EcoTreat) is designed to carry the overflows occurring in the early stage to the sewage treatment plant through the intercepting sewer, to treat them up to an advanced or highly advanced level, and to discharge them to the public water system (Fig.1). The apparatus is composed of an inlet, an outlet, and a filtration unit. In the outlet and the filtration unit, there is a non-powered discharge regulator (NPDR) for flow rate control and backwashing. The inlet allows sewage to be introduced without delay into the intercepting pipe during the dry season, through the inflow and runoff channels at the bottom of the treatment facilities.
3 Conclusion

In this study, the generation characteristics of the combined sewer overflows (CSOs) that occur in urban areas were investigated. In addition, performance evaluation of the CSO treatment efficiency was conducted through the field application of a high-speed filtering apparatus using a fibrous filter media for the treatment of the CSOs that occurred in an urban area.

The results of the field application of a high-speed filtering apparatus using a three-dimensional fibrous filter media showed that the average treatment efficiency of SS was 63.7% during the dry season. The average treatment efficiency of SS during rainfall was 84.2% (1st), 88.0% (2nd), 87.5% (3rd), 85.8% (4th), 75.8% (5th), 75.5% (6th), and 90.3% (7th), which indicates more than 80% treatment efficiency. The treatment effects of particulate materials, however, turned out to be consistently significantly high, without huge constraints on the filtering linear velocity and influent concentrations. Gromarie-Merz et al. (1998) conducted a comparative analysis of the pollutant loads on the surface runoff and the sewer effluent at the tip of the drainage basin and deduced that in the case of surface runoff, the particulate fraction was 30-80% whereas the sewer effluent fraction was 70-90%, which is due to the effects of the erosion of the sediments during rainfall [6]. In this regard, it is concluded that among the overflows that occur during rainfall, the particulate contaminants can be blocked from being directly discharged into the rivers.

Acknowledgments. This research was financially supported by Korea Institute of Civil Engineering and Building Technology (KICT), project No. 2014-109.

References