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Treatment of combined sewer overflows by ballasted flocculation: Removal study of a large broad spectrum of pollutants

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HIGHLIGHTS

- Fifty-seven substances were detected in CSOs.
- BFU is a suitable to remove particles, carbonaceous and phosphorous pollution.
- Hydrophobic compounds are well removed (>80%).
- Hydrophilic compounds are from poorly (<20%) to moderately (<50%) removed.
- BFU is sensitive for the accurate adjustments of chemical doses and sand injection.

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ABSTRACT

This study aims at examining the performance of the ballasted flocculation unit (BFU) on treating combined sewer overflows (CSOs) and the evaluation depends on the values obtained of routine wastewater parameters and on the contents of a large broad spectrum of pollutants. Accordingly, the full-scale BFU at the largest wastewater treatment plant in Europe (*Seine Aval* plant near Paris, France) is investigated during three sampling campaigns. Of the 97 molecules targeted, 57 substances including 18 priority substances and 11 priority hazardous substances were detected in the BFU influents confirming that wet weather flow (WWF) treatment has definitively proven to be necessary. The WWF treatment by ballasted flocculation appears as a promising but not a fully adapted technology for use in densely urbanized areas to considerably mitigate the CSO impacts. On operating at the optimal chemical and sand doses, this process appears to be a suitable technology to remove particles, carbonaceous and phosphorous pollutants, particulate metals and most of hydrophobic organic compounds whilst nitrogenous pollutants and most of hydrophilic compounds are from poorly (<20%) to moderately (<50%) removed. The BFU appeared less sensitive to the influent concentration fluctuations and hydraulic peak load (at the scale of the campaigns considered) than to the adjustments of chemical doses and sand injection. Investigating the performance of such process, could serve to develop management strategies that enable mitigating the impacts of CSOs on receiving water in compliance with the Water Framework Directive objectives.

1. Introduction

Historically speaking, older town centers are drained by combined sewer systems and this for many metropolitan cities in the US and Europe (New York, Washington, Paris, London, etc.) raises concerns regarding the combined sewer overflows (CSOs). The magnitude of CSO pollutant loads [1–4] and their subsequent acute impact on receiving waters [5,6] have been extensively studied since 1970. One major reason for the long-term persistence of low-quality water is the continued existence of uncontrolled or poorly-controlled discharges from both CSO and surface water runoff [7]. Because of their impact, many regulations have been implemented to address CSO concerns. In Europe, the Water Framework Directives required EU Member States to ensure a "good ecological and chemical status" of surface water by 2015. This proposal has therefore mandated a gradual reduction in emissions, losses and discharges in receiving waters of 41 priority substances that present a significant risk to the aquatic environment. Thus, one of the main priority actions is to reduce CSO discharges into receiving water to pursuit the WFD objectives.

For the last decades, different practices for storm water management have been proposed to mitigate the CSO impact by reducing runoff volume and by enhancing the storm water quality

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