Nitrogen Removal in a High-efficiency Denitrification/Oxic Filter treatment System for Advanced Treatment of Municipal Wastewater

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Abstract—Biological treatment of secondary effluent wastewater by two combined denitrification/oxic filtration systems packed with Lock type (denitrification filter) and ceramic ball (oxic filter) has been studied for 5 months. Two phases of operating conditions were carried out with an influent nitrate and ammonia concentrations varied from 5.8 to 11.7 mg/L and 5.4 to 12.4 mg/L, respectively. Denitrification/oxic filter treatment system were operated under an EBCT (Empty Bed Contact Time) of 4h at system recirculation ratio in the range from 0 to 300% (Linear Velocity increased 19.5 m/d to 78 m/d). The system efficiency of denitrification, nitrification over the range from 0 to 300% (Linear Velocity increased 19.5 m/d to 78 m/d). The system efficiency of denitrification, nitrification over 95% respectively. Total nitrogen and COD removal range from 54.6% (recirculation 0%) to 92.3% (recirculation 300%) and 10% to 62.5%, respectively.

Keywords—Advanced treatment, Biofilter, Nitrogen removal, Two combined denitrification/oxic filter

I. INTRODUCTION

CONTINUED population growth, contamination of the both surface water and groundwater, uneven distributions of water resource, and peridious droughts have forced water agencies to search for new sources of water supply. Use of highly treated wastewater effluent, now discharged to the environment from municipal wastewater treatment plants, is receiving more attention as a reliable water source. In many parts of the country, wastewater advanced treatment is already an important element in water resources planning and implementation. While water advanced treatment is viable option, water conservation, efficient use of existing water supplies, and new water resources development and management are other alternatives that must be evaluated. As a result of increasingly strict regulation on treated effluent quality, many existing wastewater treatment works need to be upgraded, especially with regard to nitrogen removal. The European Directive recommends an enhanced nitrogen treatment for discharging water to protected areas, which means an average annual nitrogen removal of at least 70%. When compared to the post-denitrification, pre-denitrification using the organic carbon of the municipal wastewater is more attractive from both an economic and environment point of view: less sludge production, less air consumption, no need or reduced need of an external carbon source, improvement if alkalinity balance. Furthermore, biofiltration nowadays represents a well-proven and robust process. It is particularly suited to sites where a compact or modular design is required e.g. urban, coastal or mountain areas. Denitrification in tertiary filtration can be realised quickly and is a cost-effective alternative to extended denitrification in a biofilter system. Denitrification in tertiary filtration with the addition of methanol has been successfully practised in U.S.A for more than 15 years. Aerated biofilters are a compact wastewater treatment process with a high flexibility with regard to the combination with other wastewater processes. Biodegradation of organics [6,7,10], denitrification and also biological phosphorous removal are possible applications. Some researcher have developed biological filtration processes for tertiary nitrification [2,9,11], biological filtration processes can be also effective for denitrification by combination of control systems with on-line sensors of nitrate and dissolved oxygen [3,4,5,9,12]. However, further optimization is required, especially with regard to automatic control of denitrification process.

II. MATERIALS AND METHODS

The sewer system is a type of combined sewer collection one, and a conventional activated sludge process is adopted for treatment. In this experiment, the effluent from the secondary sedimentation tank was used as the target water of treatment. The experimental devices consisted of two up-flow filter systems, denitrification filter and oxic filter. The diameter and the height of denitrification filter were 350mm and 2050mm respectively, and those of oxic filter were 350mm and 1250mm respectively. The denitrification filter filtration media used Lock type and made Vinylidene chloride with a relative Specific gravity of 1.62, diameter of 12.2~19.8mm and Porosity of 95% respectively. And the oxic filter filtration media used ceramic ball type and made Ceramic with a relative Specific gravity of 2.35, diameter of 7.5~8.5mm and Porosity of 56% respectively. The media were packed at 2000mm and 1200mm height from the bottom of denitrification filter and oxic filter, respectively. The empty bed volumes of the
The denitrification/oxic system achieved average removals of total COD, ammonia, and nitrate of up 39.2, 98.5, and 97.9 respectively, at a recirculation ratio of all. Total nitrogen removal efficiencies by post-denitrification and pre-nitrification were over 95% at effluent recirculation ratios of all, whereas its removal was only 2-5% when effluent recirculation was not applied to the system. No apparent effect of temperature on the overall removals was observed at 21.5-26.9.
The denitrification/oxic system achieved average removals of pre-nitrification but also an advanced treatment of organics. The upflow denitrification filter packed lock media contributed not only the complete denitrification, and the following upflow nitrification filter to the substantial reduction in nitrate as well as to the treatment efficiency is expected. Denitrification filter is also little effect on the denitrification rate of linear velocity 19.5 m/d to the 78 m/d to the increased recirculation flow rate was accompanied by the improved system removal of nitrogen.

![Denitrification Efficiency](image1)

![Nitrification Efficiency](image2)

During operation of 0-300% by increasing the recirculation rate of linear velocity 19.5 m/d to the 78 m/d to the increased denitrification and nitrification are shown in Figure 1 and 2. Denitrification filter is also little effect on the denitrification efficiency but, in the oxic filter linear velocity increased respectively, at a recirculation ratio of all. The increase in recirculation flow rate was accompanied by the improved system removal of nitrogen.

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**REFERENCES**


