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Influence of salinity on partial nitrification in a submerged biofilter

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HIGHLIGHTS

- The highest NO_2–N/NO_x–N ratio was achieved under operational condition.
- The stimulatory and inhibition concentration of NaCl was determined.
- The average nitrification rates was determined with the batch tests.
- The ammonium oxidation and nitrite production rate was obtained.

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ABSTRACT

Partial nitrification under various concentrations of NaCl (0–40 g/l) at a constant operational condition was investigated in a submerged biofilter reactor. The highest NO_2–N/NO_x–N ratio (0.76) was achieved at the NLR of 830 g NH_4–N/m^3 day with salt free wastewater. Small increase the salt content led to higher activities and the NH_4–N removal efficiency increased from 92% to 95% at 1 g/l NaCl concentration. Over this concentration, each NaCl addition provoked the NH_4–N oxidation and a sharp increase of inhibition was observed. The total oxidized NH_4–N was achieved at the nitrogen loading rate (NLR) and surface loading rate (SLR) of 0.754 kg/m^3 day and 3.23 g/m^2 day, respectively without salt in the feed wastewater and it was decreased to 0.322 kg/m^3 day and 1.38 g/m^2 day at the salinity of 40 g/l in the PNBR.

1. Introduction

Discharge of untreated industrial and municipal wastewaters are the main factor on deterioration of the water body because of the presence of nutrients such as nitrogen which is one of the pollutants responsible for dissolved oxygen (DO) depletion. Because of negative affects, nitrogen compounds (NH_4–N, NO_x–N) should be removed from the wastewater before it is discharged to the environment.

Recent researches on the nitrogen removal are mainly oriented either towards improvement of efficiencies and energy saving in traditional nitrification and denitrification or towards identification of new processes. Partial oxidation (short-cut, nitritation) of NH_4–N to NO_2–N and subsequent reduction of the latter to molecular nitrogen was seen as a favorable shortcut nitrification–denitrification (Sun et al., 2010). In the partial nitrification, the accumulation of NO_2–N is determined without affecting the ammonia oxidizing bacteria (AOB) while the activity of nitrite oxidizing bacteria (NOB) is inhibited by operating the reactor at low DO concentration, alkaline conditions, high temperature and varying sludge retention times (SRT) and hydraulic retention times (HRT) (Aslan et al., 2009).

High nitrogen concentrated streams can also contain large amount of other ions like chloride and it is well known that high saline concentrations in wastewater have negative effects on nitrogen removal (Windey et al., 2005). Nowadays salt is considered as a common stress factor in wastewater treatment plant (WWTPs), especially in the industrial sector. High or low level inorganic salt concentrations in the wastewater was discharged from industries like pickling, cheese manufacturing, seafood processing, tanning, chemicals and pharmaceuticals, oil and gas recovery and infiltration of subsurface water in the coastal areas, landfill leachates and contaminated groundwater. Waste minimization practices are expected to generate brines in future via effective water reuse and recycling schemes. Also the use of saline water for flushing due to the scarcity of fresh water will increase the wastewater salinity that reaches the treatment plant (Moussa et al., 2006). In comparison with fresh water available, seawater is considered to be an inexhaustible water resource and has been used widely as flushing toilet water in the coastal cities (Sun et al., 2010).

Salinity influences the life strategies of bacteria which are able to survive in environments with high salinity by keeping their cytoplasm at the same osmotic level as that of the surrounding environment (Bollmann and Laanbroek, 2002). High salt concentration (>%1 salt) causes plasmolysis and loss of activity of the cells (Kargı and Uygur, 1996).

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