The Effect of Landfill Leachate on Nitrification Inhibition of Activated Sludge

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Abstract

While increasing complex wastewater produced in modern society, the technology of treatment is demanded improvement to be suitable sustainable development, especially in nitrification processes, which plays an important role in wastewater treatment plant. However, microorganism, nitrification process relied, is sensitive to some toxicant affecting quality of outlet water. The main objective of this study is collection and conclusion of literature about NI (nitrification inhibition), and controlled experiment on landfill leachate causing NI degree by assay type - ammonia conversion rate. The controlled experiment on ATU (N-Allylthiourea) is to prove the effectivity of this assay method. In literature review, it's considered sources of NI, assay types and nitrifier resistance. They showed this batch of landfill leachate couldn't cause NI. It's suggestion that classification and limitation of wastewater sources guarantee security of microorganism.

Introduction

Environmental pollution is a serious issue in modern life. The discharge of untreated wastewater contributes significantly to pollution, particularly due to the presence of toxic substances. This pollution disrupts ecosystem balance and poses risks to human health. To support sustainable societal development, wastewater treatment is essential.

The biological treatment process plays a crucial role in nutrient removal, directly affecting effluent quality. Microorganisms, particularly nitrifiers, are essential for this process and are among the most important bacteria in wastewater treatment. However, nitrifiers are at the same time the most sensitive group of organism in a treatment plant. Besides, excessive toxicity in raw wastewater can inactivate or even kill microorganisms. The landfill leachate is considered as one of serious toxicants. When nitrifiers lose their activity, ammonia accumulates in the effluent. Therefore, studying the causes and mechanisms of NI is a critical for nitrifiers protection. Moreover, it has significance for raising the levels of application and operation in WWTPs.

Objectives

The objectives of this research is to determine whether landfill leachate causes NI and analyze experimental results. To achieve this objectives, it is essential to demonstrate the effectiveness of the method. Additionally, literature review of NI theory is significant for results analysis.

Methods

The method of this study is quantitative analysis - controlled experiment about NI caused by landfill leachate in activated sludge with only substrate and substrate and landfill leachate. The assay type is **ammonia conversion rate**. In order to prove the effectiveness of this assay type, the other controlled experiment about NI caused by ATU is conducted. ATU is a common biological nitrification inhibitor.

Materials:
Activated Sludge – From aerator in Renseanlæg Vest (domestic WWTP)
Landfill Leachate – From Rærup Deponi (construction and demolition waste landfill)
Substrate – Ammonia chloride at 20mg/L

Fig. 1 The aerator in Renseanlæg Vest

Controlled experiments:
Controlled experiment I
Toxicant: ATU at 0.125, 0.25, 0.5, 1.0 and 2.0mg/L
Controlled experiment II
Toxicant: landfill leachate at 100, 200 and 300mL

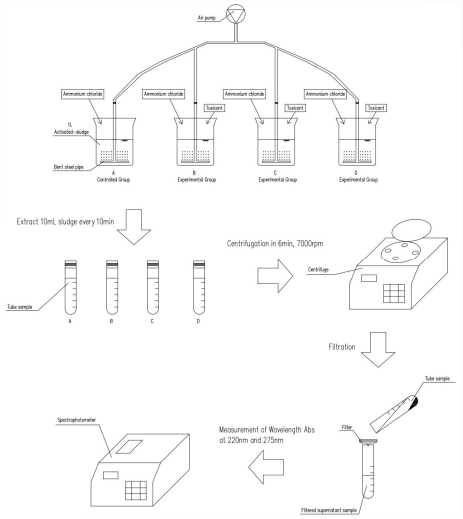

Fig. 2 The draft of controlled experiment processes

Results & Discussion

Controlled experiment I (ATU)

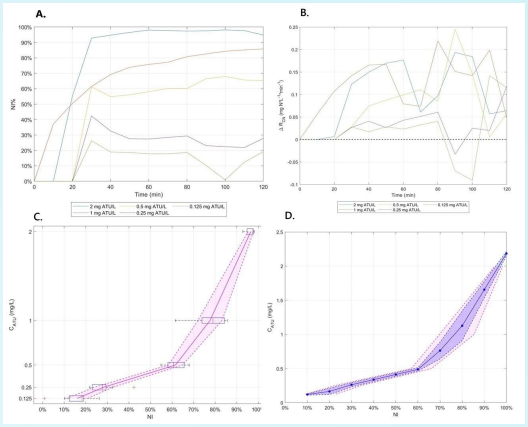

Fig. 3 The Results of Controlled Experiment I (A. The curves of NI% by the time; B. The curves of differences for ammonia conversion rate by the time; C. The box and line plot of NI% by ATU concentration; D. The curves of ATU effective concentrations with error)

The results demonstrated that NI effects caused by ATU were distinct and exhibited a clear dose. EC_{50} of ATU in this study was 0.41±0.03mg/L, and the total inhibition was at 2.18±0.03mg/L. Some studies found that EC_{50} of ATU was 0.15-1.2mg/L [Iizumi et al., 1998; Hockenbury et al., 1997; Hooper et al., 1973], and the total inhibition was at 2mg/L [Young et al., 1973]. The results of controlled experiment I are in the expectant range. Therefore, the assay type – ammonia conversion rate is an effective method.

Controlled experiment II (landfill leachate)

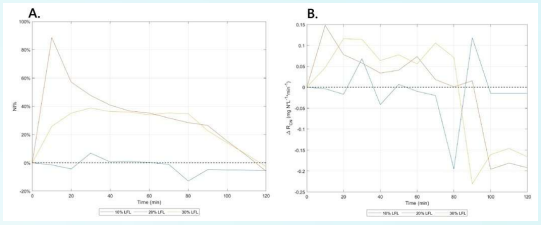

Fig. 4 The Results of Controlled Experiment II (A. The curves of NI% by the time; B. The curves of differences for ammonia conversion rate by the time)

The results demonstrated that NI effects caused by landfill leachate couldn't be stable as ATU. The 10% landfill leachate couldn't cause any NI. The 20% and 30% landfill leachate caused NI in 80 minutes, but nitrification rate accelerated sharply after 80 minutes.

Conclusion

The assay type – ammonia conversion rate is available for NI effect test. However, this batch of landfill leachate couldn't cause stable NI. The 20% and 30% landfill leachate caused NI in 80 minutes, but nitrification rate accelerated sharply after 80 minutes. In Literature Review, construction and demolition landfill leachate is high pH (above 6.5) and contains abundant heavy metal ions [Weber et al., 2002]. The limitation of this study is that multiple batches of landfill leachate should be tested.

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