

Principal Research Results

Simplified denitrification system using alcohol released from non-porous polyethylene-film bag

Background

Nitrogen compounds are a cause of eutrophication in lakes and coastal waters. We are conducting study on a novel bioreactor for nitrogen removal. Current available systems for nitrogen removal require facilities (pumps and tanks) for adding alcohol as an electron donor for denitrification into wastewater with little or no organic compounds. Surplus alcohol has to be added to the wastewater, since a part of the added alcohol is used for purposes other than denitrification. It results in waste of the added alcohol and production of surplus sludge. Thus an effective electron donor supplier for denitrification is effective to simplify the current available systems, since it can omit the need for additional facilities and a complicated sequence of operations.

Objectives

Controlled release of electron donor for denitrification is examined by using polyethylene-film bag. Novel nitrogen-removal bioreactor using the polyethylene-film bag is developed to apply the wastewater treatment in various fields of industrial plants.

Principal Results

1. Controlled release of electron donors for denitrification from polyethylene-film bag

An ethanol-filled holding bag fabricated using non-porous polyethylene-film could release ethanol slowly. The amount of ethanol released from the bag could be controlled by changing the film thickness. Denitrifier, *Paracoccus denitrificans* cells could use 99.5% ethanol released from the film bag effectively, though their denitrifying activity was inhibited by using 5% or higher ethanol. Thus the polyethylene-film bag could release ethanol to *P. denitrificans* cells slowly without diluting 99.5% ethanol. It would be effective to construct a simplified denitrification system.

2. Nitrification and denitrification using ethanol released from polyethylene-film bag

We constructed a dual bag comprised of an outer bag, on which ammonia-oxidizer, *Nitrosomonas europaea* cells and denitrifier, *P. denitrificans* cell were immobilized, and an inner polyethylene-film bag filled with ethanol (Fig.1). The dual bag could remove ammonia as nitrogen gas from the wastewater in a single step (Fig.2). It suggests that the dual bag can omit additional facilities for adding ethanol and eliminating surplus organic compounds. Efficiency of released ethanol used by *P. denitrificans* cells for denitrification was over 86%, though that of the current available system using free *P. denitrificans* cells was about 33%. The effective use of the ethanol would decrease the production of surplus sludge.

A simplified denitrification module was made by the concept of the dual bag. The module (3 mm thick) was comprised of three non-woven polyethylene fabrics and two non-porous polyethylene films (Fig.3). The thin module can also remove ammonia from wastewater in a single step. Thus the dual bags and the modules would be extremely effective as an additional denitrification system because they can be easily installed in the vacant spaces of preinstalled water treatment systems.

Future Developments

Modify the simplified denitrification system using the dual bags and the modules in order to apply a practical treatment system in coal thermal power plants. The durability of the system is examined in actual wastewater of power plants.

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Reference

H. Uemoto, et al., 2007, "Nitrogen removal using ethanol derived from polyethylene film," CRIEPI Report V06023 (in Japanese)

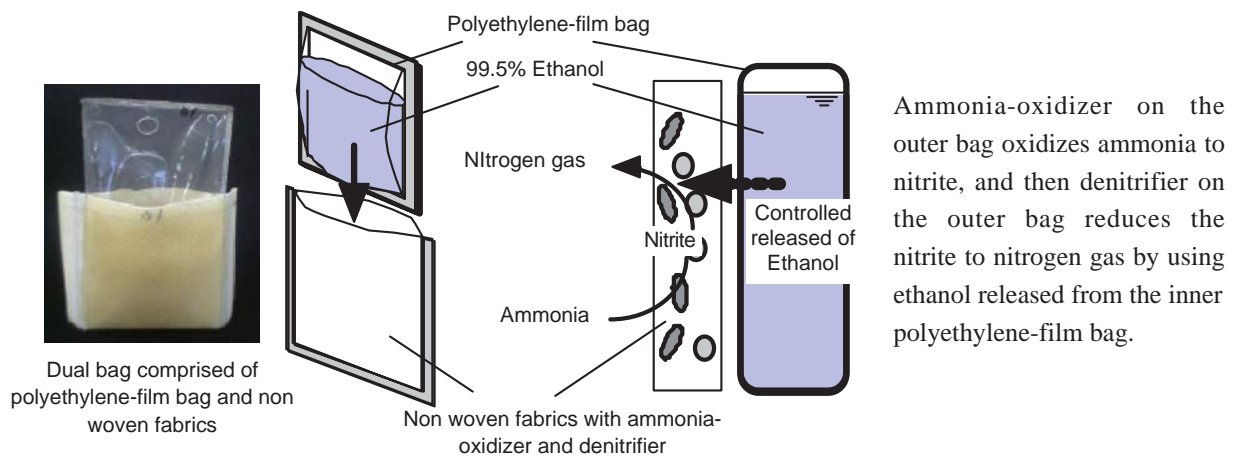


Fig.1 Schematic diagrams of dual bag comprised of outer bag and inner polyethylene-film bag

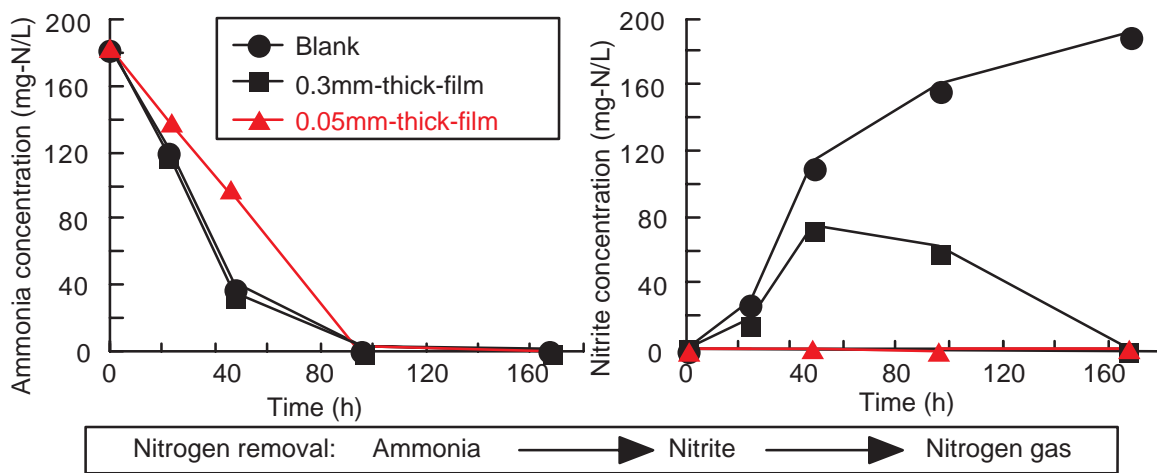


Fig.2 Time-dependent changes in the ammonia and nitrite concentrations in the batch system using dual bag

When ammonia solution was treated by the dual bag without the inner bag (Blank) or with 0.3 mm-thick film bag, ammonia decreased and nitrite was accumulated in the solution. When using the dual bag with 0.05 mm-thick film bag, ammonia was removed without accumulation of nitrite.

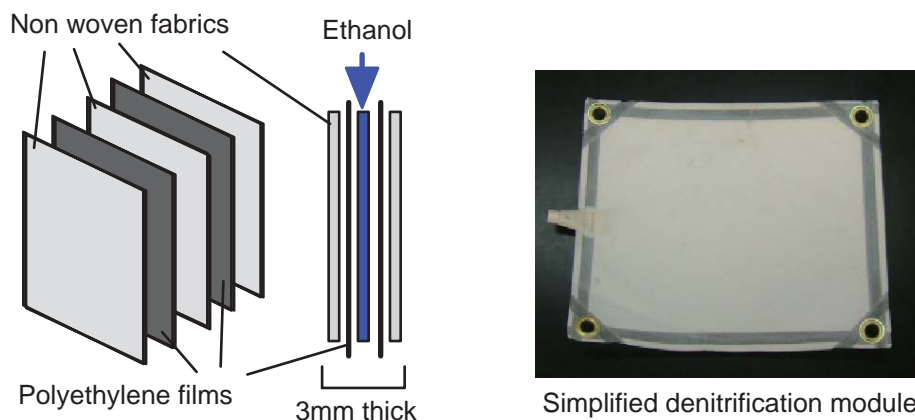


Fig.3 Simplified denitrification module using the concept of dual bag

The simplified denitrification module (3 mm thick) was made of three non-woven polyethylene fabrics and two non-porous polyethylene films.