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PE22) A Compact Modified Bio-Scrubber System for the Simultaneous Ammonia Gas Absorption and Nitrification Process

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1. INTRODUCTION

Malodorous gases could be generated from several sources such as sewage biodegradation or wastewater treatment plants [1]. Among these gases, ammonia and hydrogen sulfide are infamous due to the negative environmental impact they are related to. Ammonia gas is known to be highly soluble in water. Therefore, the simplest and most economic way of treatment ammonia emissions is through non-reactive absorption system.

In the field of biological gas removal, bio-scrubber is the least investigated. Bio-scrubber is comprised of two zones: the absorbing tower and a separated bioreactor for the degradation of the absorbed gases [2]. Some of the disadvantages of bio-scrubber system compared to biofiltration and bio-trickling includes the requirement of another bioreactor which contains the microorganisms, in biofilm or suspended culture forms, for the biodegradation of the absorbed gas. Another problem associated with bio-scrubber is the control of excess microbial growth which could contribute to excess sludge production.

This study is thereby conducted in order to resolve or minimize the above-mentioned drawbacks of bio-scrubber particularly in the application of ammonia gas emission treatment. An innovated system was tested for its efficiency in terms of simultaneous ammonia gas absorption and nitrification process. Also the system features a small footprint, which is in fact a hybrid system of absorbing tower and packed bed biofilm system of slowly-growing but active nitrifiers.

2. MATERIALS AND METHODS

Two columns of modified bio-scrubber systems were installed. Previous bubble column optimization study was used as the basis for the bubble column dimensions of 20-cm bed height and 10-cm diameter. A month old enriched activated sludge with nitrifying media was inoculated and allowed to attach onto poly-urethane foam for 2-3 weeks. The immobilized activated sludge-poly-urethane foam media was then packed in a 1.75 L bed which is located below the bubble column reactor (see figure 1). The parameters tested in this study are summarized in table 1.

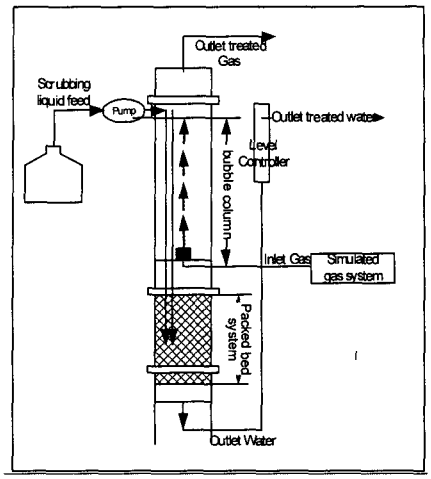

Fig. 1. The modified bio-scrubber setup for simultaneous ammonia gas absorption and nitrification process.

Table 1. General parameters tested in the study

Parameters	Pertinent Information
Liquid HRT (hours)	36 (column 1) 48 (column 2)
Inlet gas concentration (ppmV)	25, 50
Media in packed system	poly-urethane foam
Microbial system	activated sludge
MLSS concentration	3000 mg/L

3. DISCUSSIONS

The bio-scrubber efficiency can be assessed into two ways: the efficiency of bubble column tower and the ability of packed system to degrade ammonia into nitrite and/or nitrate.

Hydraulic retention time affects the system in two ways: it dictates the volume of scrubbing liquid that could remove ammonia gas over a period time and it affects the efficiency of ammonia biodegradation at the packed bed system. Inlet gas concentration also affects the system in terms of the inlet ammonia concentration at the packed bed system and the efficiency of bubble column in absorbing the gas.

Bubble column efficiency

Figure 1 illustrates the ammonia removal efficiency of the two systems with different operating scrubbing liquid HRTs. At constant inlet gas concentrations (25 and 50 ppmV), column which was operated at 36-hour HRT revealed a slightly higher removal efficiency than the 48-hour HRT system This indicate that due to the higher volume of scrubbing liquid, the ammonia gas was more easily absorbed under this operation condition. However, in terms of elimination capacity, system with 48-hour HRT would give a higher result. In terms of increasing inlet gas concentration, both systems showed a slight decrease in removal efficiency. But since ammonia gas is highly soluble in

water, doubling up the inlet gas concentration resulted to a minimal efficiency reduction on both systems.

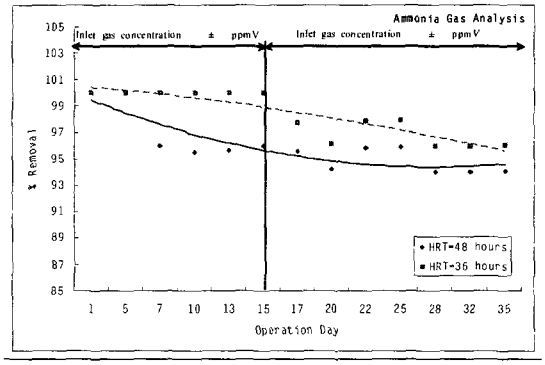

Fig. 3. Ammonia gas removal efficiency at the bubble column section.

Packed bed system efficiency

In figure 4a, dissolved ammonia nitrogen from bubble column at 48-hour HRT was around 100 mg/L at 25 ppmV of inlet gas concentration, average value that is almost double with that at HRT 36 hours (figure 4b). At higher inlet gas concentration of 50 ppmV, the dissolved ammonia nitrogen was also almost doubled in both systems.

In terms of nitrification efficiency, nitrite conversion was higher than nitrate, nitrite conversion occurs first and nitrate conversion depends on the available nitrite compounds. Between two HRT at 25 ppmV inlet gas concentration, ammonia conversion was found more effective at lower HRT (36 hours). However, at higher inlet gas concentration of 50 ppmV, ammonia conversion was lower in system with HRT 36 hours though the inlet dissolved ammonia is lower. This result indicates that HRT is a more critical parameter than inlet dissolved ammonia concentration. At 36-hour HRT, the packed system converts less incoming dissolved ammonia than that with system at higher HRT of 48 hours.

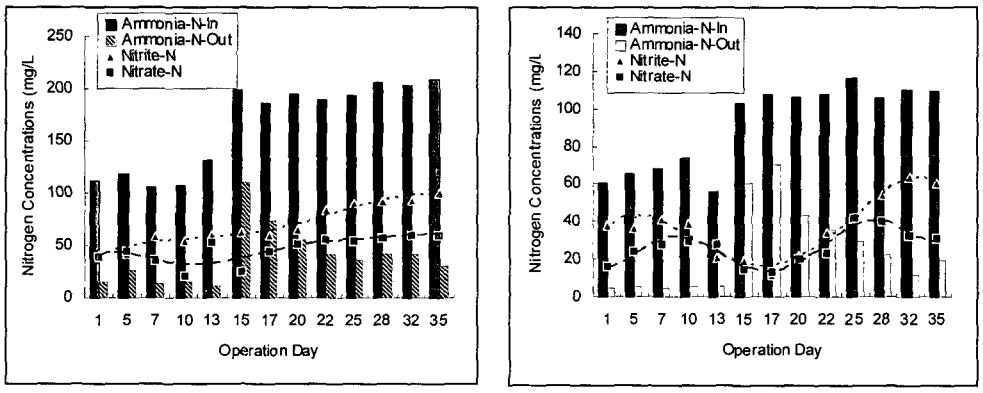

Fig. 4. Ammonia nitrification efficiency in packed bed system.

A- column operated under 48-hour HRT B- column operated under 36-hour HRT.

4. CONCLUSIONS

The study was able to conclude that the modified bio-scrubber system is effective for the treatment of ammonia gas emissions in terms of simultaneous ammonia gas absorption and nitrification. Results revealed that HRT and inlet gas concentration slightly affected the bubble column scrubbing efficiency due to the high solubility of ammonia into water. However, in terms of nitrification process, HRT was found to be a more critical parameter since it significantly affected the ammonia conversion to nitrite and nitrate.

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