OUKA
The University of Osaka
Institutional Knowledge Archive

| | |
|---|---|
| Title | AMMONIA REMOVAL FROM SWINE WASTEWATER USING AN AEROBIC, ANOXIC FILTER AT A PILOT-SCALE IN THANH LOC BIOSTATION |
| Author(s) | Nguyen, Huu Phuc; Nguyen, Duc Canh; Le, Cong Nhat Phuong et al. |
| Citation | Annual Report of FY 2001, The Core University Program between Japan Society for the Promotion of Science(JSPS) and National Centre for Natural Science and Technology(NCST). 2003, p. 229-233 |
| Version Type | VoR |
| URL | https://hdl.handle.net/11094/13044 |
| rights | |
| Note | |

*The University of Osaka Institutional Knowledge Archive : OUKA*

https://ir.library.osaka-u.ac.jp/

The University of Osaka

# AMMONIA REMOVAL FROM SWINE WASTEWATER USING AN AEROBIC, ANOXIC FILTER AT A PILOT-SCALE IN THANH LOC BIOSTATION

**Nguyen Huu Phuc, Nguyen Duc Canh, Le Cong Nhat Phuong, Ngo Ke Suong, Nguyen Tien Thang**
*Institute of Tropical Biology*
*National Center For Natural Science and Technology Research*
*Add: 01 Mac Dinh Chi Street, District 1, Hochiminh City, Vietnam*
*Tel.: 84-8-8241346; 84-8-8978798, Fax: 84-8-8241346*
*Email: iotb@hcmc.netnam.vn*

## Introduction

The wastewater from a pig farm after an anaerobic treatment contains a high ammonium concentration (400 – 1000 mg/l) which does not reach the B degee for wastewater by the Vietnamese Standard. There are different methods for solving this problem: using an anaerobic treatment together with bioponds (1); anaerobic treatment in UASB, sand filter and bioponds with aquarium plants (2)(3); using zeolit for ammonium reduction before the treatment in UASB (4) or anaerobic filter (5); anaerobic filter and bioponds with aquarium plants ; reducing nitrate in USB pilot (6) and using SBR technology (7).

This report presents the pilot-scale in treating swine wastewater as a combination of both aerobic and anoxic filtration methods in Thanh Loc Biostation, located in Dist. 12, Hochiminh City.

## Materials and methods

The mixture of the nitrating microorganisms was selected from the activated sludge from the aeroten by screening through 1-2 mm sieve and incubating in the selective medium, which contained $(NH_4)_2 SO_4$ 2 g, $K_2HPO_4$ 1g, $MgSO_4.7H_2O$ 0.5 g, NaCl 2 g, $FeSO_4$ 0.4 g, $CaCO_3$ 1 g for *Nitrosomonas* cultivation. The selective medium contained $NaNO_2$ 1 g, $Na_2CO_3$ 1 g, NaCl 0.5 g, $K_2HPO_4$ 0.5 g, $MgSO_4.7H_2O$ 0.3 g, $FeSO_4$ 0.4 g at pH of 8,3-8,8 for *Nitrobacter* cultivation. The denitrating microorganisms were cultured in the selective medium containing $KNO_3$ 2 g, Potassium Citrate 5 g, $K_2HPO_4$ 1g, $KH_2PO_4$ 1 g, $MgSO_4.7H_2O$ 1 g at pH of 7-7,2.

The nitrating and denitrating microorganisms were attached to 2 kinds of the carrier materials: polymer carrier material Pol-01 and inoganic Voc-01 carrier material, packing in the aerobic and anoxic columns. The parameters COD, total N by Kjedahl (TNK), $N\text{-}NH_4^+$, $N\text{-}NO_3^-$, $N\text{-}NO_2^-$ and pH were analysed according to Standard methods for the water and wastewater examination.

## Results and discussion

### *Ammonium reduction in the wastewater from pig farm by the aerobic filter*

Table 1 and 2 show the results of ammonium reduction in the aerobic filter containing Pol-01 and Voc-01. Both carrier materials had the same efficiency of ammonium reduction at 3 different loadings. At the loading 0.93 kg $NH_4/m^3$/day, the efficiency of ammonium removal was 97.3% and the increase of nitrate was 1467.5% for Pol-01. For Voc-01 the results were 96.8% and 1402.7% respectively.

Tab.1. Efficiency of the wastewater treatment on the carrier materials Pol-01

| Parameter ppm | Loading 0.93 kg $NH_4/m^3$/day | | | Loading 0.63 kg $NH_4/m^3$/day | | | Loading 0.33 kg $NH_4/m^3$/day | | |
|---|---|---|---|---|---|---|---|---|---|
| | Influent | Effluent | Efficiency % | Influent | Effluent | Efficiency % | Influent | Effluent | Efficiency % |
| COD | 430.0 | 130.5 | - 69.9 | 300.0 | 110.3 | - 63.3 | 209.0 | 80.9 | - 61.3 |
| $NH_4^+$ | 310.0 | 8.5 | - 97.3 | 210.0 | 4.2 | - 98.9 | 112.0 | 3.05 | - 97.3 |
| $NO_2^-$ | 1.53 | 20.5 | +1239.8 | 1.3 | 15.3 | +1076.9 | 0.96 | 9.85 | +926 |
| $NO_3^-$ | 1.85 | 29.0 | +1467.5 | 1.05 | 20.9 | +1890.4 | 0.32 | 19.5 | +5993.7 |
| pH | 8.40 | 8.10 | | 8.40 | 7.60 | | 8.40 | 7.60 | |

Tab.2. Efficiency of the wastewater treatment on the carrier materials Voc-01

| Parameter ppm | Loading 0.93 kg $NH_4/m^3$/day | | | Loading 0.63 kg $NH_4/m^3$/day | | | Loading 0,33 kg $NH_4/m^3$/day | | |
|---|---|---|---|---|---|---|---|---|---|
| | Influent | Effluent | Efficiency% | Influent | Effluent | Efficiency% | Influent | Effluent | Efficiency% |
| COD | 430.0 | 128.7 | - 70.1 | 300.0 | 108.7 | - 63.7 | 209.0 | 82.6 | - 60.6 |
| $NH_4^+$ | 310.0 | 9.9 | - 96.8 | 210.0 | 4.9 | - 96.7 | 112.0 | 2.9 | - 97.4 |
| $NO_2^-$ | 1.53 | 19.9 | +1200 | 1.3 | 14.6 | +1023 | 0.96 | 8.9 | +830 |
| $NO_3$ | 1.85 | 27.8 | +1402.7 | 1.5 | 19.5 | +1200 | 1.32 | 18.9 | +1331.8 |
| pH | 8.40 | 7.90 | | 8.40 | 8.10 | | 8.00 | 7.81 | |

**Efficiency of the nitrate and nitrite reduction in the anoxic filter**

Tab.3. Efficiency of the nitrate and nitrite reduction in the anoxic filter

| Loading | Parameter | Influent, ppm | Effluent, ppm | Efficiency, % |
|---|---|---|---|---|
| 0,481 kg$NO_3^-/m^3$/day | COD | 98.57 | 65.54 | 33.51 |
| | $NH_4^+$ | 5.15 | 1.58 | 69.32 |
| | $NO_3^-$ | 80.20 | 2.96 | 96.31 |
| | $NO_2^-$ | 50.20 | 2.56 | 94.90 |
| | pH | 8.52 | 8.54 | |
| 0,244 kg $NO_3^-/m^3$/day | COD | 82.50 | 61.56 | 25.38 |
| | $NH_4^+$ | 4.48 | 1.25 | 72.10 |
| | $NO_3^-$ | 40.60 | 0.81 | 98.00 |
| | $NO_2^-$ | 20.50 | 0.20 | 99.02 |
| | pH | 8.21 | 8.42 | |
| 0,129 kg $NO_3^-/m^3$/day | COD | 81.50 | 57.13 | 29.90 |
| | $NH_4^+$ | 4.98 | 1.23 | 75.30 |
| | $NO_3^-$ | 21.60 | 0.39 | 98.19 |
| | $NO_2^-$ | 10.08 | 0.08 | 99.2 |
| | pH | 8.15 | 8.30 | |
| 0,055 kg $NO_3^-/m^3$/day | COD | 72.5 | 58.74 | 19.17 |
| | $NH_4^+$ | 4.58 | 1.11 | 75.76 |
| | $NO_3^-$ | 9.25 | 0.19 | 97.94 |
| | $NO_2^-$ | 4.21 | 0.04 | 99.00 |
| | pH | 8.09 | 8.17 | |

The carrier material Voc-01 was chosen for the nitrate reduction in the anoxic condition. The results of the nitrate reduction at 4 different loadings showed in Tab. 3. At the loading of 0.481 kg/m$^3$/day the nitrate reduction was 96.31%. At a lower loading, the results were higher – 97-98%.

***Efficiency of the nitrogen reduction in the pilot-scale***

After separate tests of nitrogen reduction using the aerobic and anoxic filter we combined them together into a pilot-scale working one after other as followed:

- The primary treated wastewater from anaerobic container was collected in the stock container 1, from which it was pumping into a container 1 laying higher than an aerobic filter-column. From the container 1, the wastewater was dropping into the aerobic filter-column. The aerobic filter was 1250 mm high, and 300 mm in diameter, was containing filter material Pol-01 consisting of flat pieces (100x10 mm). The filter material bed was 950 mm high.

- From the aerobic filter the treated wastewater was continuously collected in the stock container 2, from which it was pumping into the container 2 laying higher than the anoxic filter-column. From the container 2 the wastewater was running up from the bottom of the anoxic filter-column. The anoxic filter-column was 2200 mm high, and 300 mm in diameter containing filter material Voc-01 consisting of flat pieces (25x28x4 mm). The filter material bed was 1800 mm high.

The influent of wastewater was 530 l/day, the COD loading was 3.439 kg/m$^3$/day, the N-$NH_4$ loading was 2.687 kg/m$^3$/day. The results are shown in Table 4.

Tab.4. Efficiency of the nitrogen reduction in the pilot-scale

| Parameter, | Aerobic Filter | | | Anoxic Filter | | | Efficiency, % |
|---|---|---|---|---|---|---|---|
| ppm | Influent | Effluent | Efficiency,% | Influent | Effluent | Efficiency,% | |
| DO | 0.0 | 2.19 | | 2.19 | 0.0 | | |
| $NO_2^-$ | 3.93 | 30.81 | 87.2 | 30.81 | 6.21 | 79.85 | 36.71 |
| $NO3^-$ | 6.32 | 70.4 | 91.02 | 70.4 | 16.47 | 76.6 | 61.6 |
| $NH_4^+$ | 358 | 51.6 | 85.58 | 51.6 | 1.3 | 97.48 | 99.63 |
| COD | 458.19 | 233.54 | 51.2 | 233.54 | 48.48 | 79.2 | 89.42 |
| pH | 7.41 | 7.63 | | 7.63 | 7.99 | | |

The COD loading was 3.439 kg/m$^3$day, N-$NH_4$ 2.687 kg/m$^3$day the efficiency of the ammonium and COD reduction in the aerobic filter-column were 85.58% and 51.2%, respectively. The efficiency of the nitrate and COD reduction in anoxic filter-column were 76.6% and 79.2%, respectively. The effluent wastewater went into the bioponds after the processing in the pilot-scale and reached B degree.

Primary test of the efficiency of different aquarium plants growing in the treated wastewater gave good results: The COD, N-$NH_4^+$ and P in the wastewater after treated in the pilot-scale had been reduced continuously in the lab-scale biopond which contained the floating aquarium plant Beo Cam - *Spirodela polyrrhiza* (*Lemnaceae*), Beo Tai Chuot – *Salvinia cucullata* (*Salviniaceae*), Beo Cai – *Pistia stratiotes* (*Araceae*) and Beo Luc Binh - *Eichhornia crassipes* (*Pontederiaceae*).

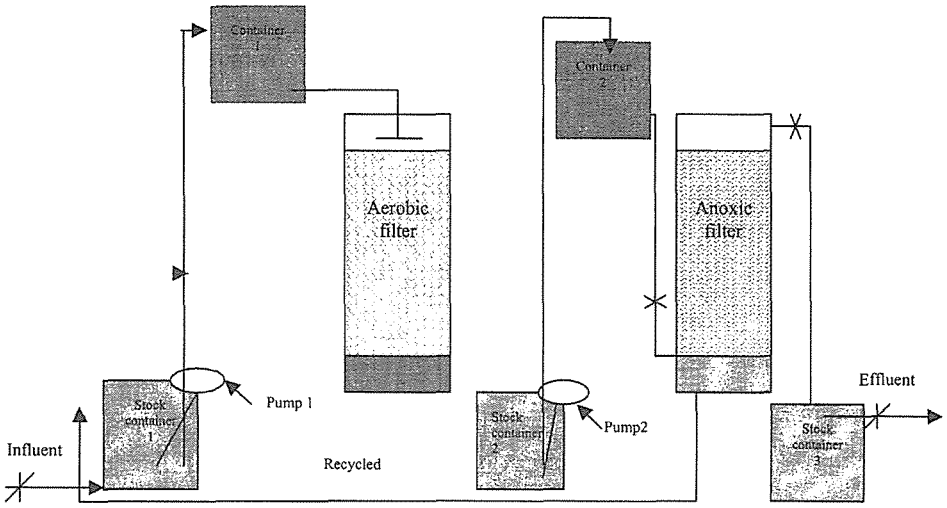


Fig.1. The working scheme of the pilot-scale

## Conclusion

Were chosen 2 kinds of the material Pol-01 and Voc-01, which had been used in the aerobic and anoxic filters for the treatment of the wastewater from pig farm. The efficiency of ammonium, N-total and COD reduction in the wastewater from pig farm at the loading 0.8739 kg $NH_4/m^3$/day were 99.65%, 98.4% and 89.65%, respectively.

The treatment tests on pilot-scale gave the results as followed: at the COD loading 3.439 $kg/m^3$/day, $N\text{-}NH_4^+$ 2.687$kg/m^3$/day the efficiency of $NH_4^+$ reduction was 99.63%, COD reduction – 89.42%. The effluent fllows into the biopond reached B degree, according to Vietnam Standard of the wastewater, TCVN-5945-1995.

## Summary

This paper presents the laboratory pilot-scale treating swine wastewater combined both aerobic and anoxic filtration. Two kinds of the carrier materials Pol-01 and Voc-01 were used for attached microorganisms. Ammonia eliminable result has attained 99,65%. An eliminable COD has attained 89,65%, TNK has removed 98,4% at loading 0,873 $NH_4^+/m^3$/day.

## References

1. Do Hong Lan Chi, T.T.Phuong, M.T.M.Hanh, Lam minh Triet, 1997. *The treatment of the wastewater from pig farm Dong Hiep*. The report at Seminar on "The Enviromental Technology and Management in HCMC" 28-29/5/1997, 136-147.
2. Nirandoru Poticanond, Ulrich Stoehr Gbowski, Weerapan Kiarpakdee, Piyawa Boonlong and Kendrich Logedon J.R., 1996. *Aerobic wastewater treatment system of the national dissemination progam for the medium and large scale pig farms in Thailand*. Proceedings of the regional seminar for South-East Asia on " Anaerobic technology for waste and wastewater manegement and its economic, social and ecological impacts" HCMC 9-13/9/1996, p. 300-319.

3. Tanticharoen M. and S. Bhumiratana, 1996. *Thailand's opportunities for environmental biotechnology*. Proceedings of the regional seminar for South-East Asia on " Anaerobic technology for waste and wastewater manegement and its economic, social and ecological impacts" HCMC 9-13/9/1996, p. 103-123.
4. Cintoli R., B. Di Sabatino, L. Galeoti and Bruno, 1996. *Ammonium uptake by zeolite and treatment in UASB reactor of piggery wastewater*. Wat. Sci.Tech. Vol.32(12), p.73-81.
5. Ngo ke Suong, Nguyen huu Phuc, Pham ngoc Lien, Vo thi Kieu Thanh and Le Cong Nhat Phuong, 2000 "*Using anaerobic-disc filter for the treatment of the wastewater form pig farm*. Sci. Report at DoSTE HCMC.
6. Metcalt and Eddy, 1991. *Wastewater engineering*. Mc Gow Hill International Editions.
7. Tilche A., Bacilieri E., Bortone G., Malaspina F., Piecinini S. and Stante L. 1996. *Biological phosphorus and nitrogen removal in full scale sequencing bach reactor treating piggery wastewater*. Wat. Sci. Tech. Vol.32(12)p 199-206.