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 kgNO_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*).

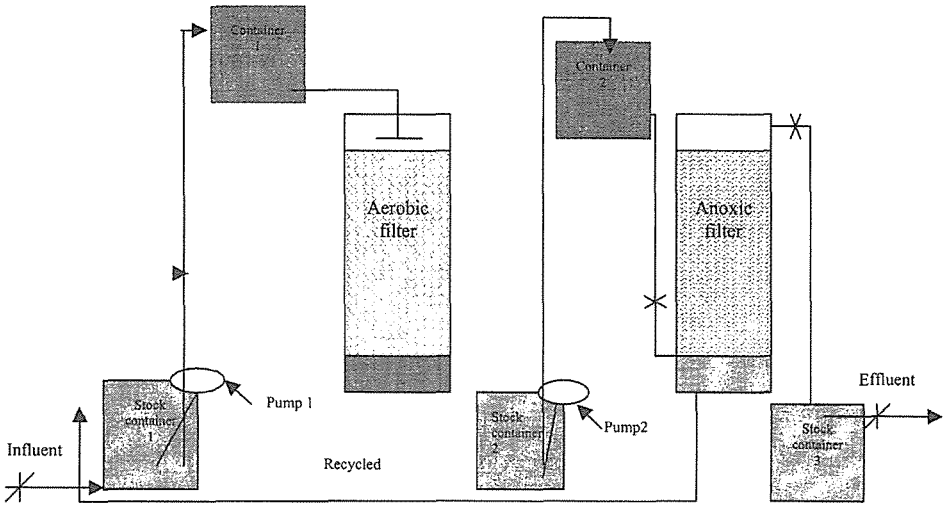

Fig.1. The working scheme of the pilot-scale

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, $N\text{-}NH_4^+$ 2.687kg/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.

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