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Ammonia air stripping from pig slurry: influence of previous mesophilic anaerobic digestion process

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SUMMARY

The solution to environmental problems associated with livestock wastes requires a broad integrated approach. The recovery of valuable products as nitrogen, has become a need in geographical areas with high animal farming density. Ammonia air stripping, combined with absorption, can remove and recover ammonia from liquid wastes. The objective of the present paper is to study the pH effect on ammonia air stripping from pig slurry and its performance when fresh and anaerobic digested slurry is used. Depending on the pig slurry type, treatment performances are different. In any case, ammonia removal rates are pH dependent, the higher the pH, the higher the removal rates are. When fresh pig slurry is used, a high initial pH is required (large addition of alkali is needed). For digested pig slurry, pH adjustment is still necessary but not critical for achieving high removal efficiencies. Whit digested slurry, a complete ammonia removal without pH modification was possible, at 80ºC.

KEYWORDS

Ammonia stripping, post-treatment, anaerobic digestion, pig slurry.

INTRODUCTION

The inclusion of anaerobic digestion in pig slurry treatment strategy reports some advantages. The generated biogas can be used as an energy source. When cogeneration is applied, the feasibility of the treatment is often determined by the use of the surplus thermal energy.

The recovery of valuable products as nitrogen, has become a need in geographical areas with high animal farming density. Ammonia air stripping, combined with absorption, can remove and recover ammonia from liquid wastes. Moreover, ammonia removal as a pre-treatment of anaerobic digestion could be a good way to improve its performance, since it has a high inhibitor effect on methanogenic bacteria (Angelidaki y Ahring, 1993; Bonmatí, 1998). Although this method has largely been used for treating industrial wastes (Janus and van der Roest, 1996; Schiweck and Nahle, 1990; González and Garcia, 1996; Cheung et al., 1997), few works has been done with complex water matrices like pig slurry.

Ammonia equilibrium in aqueous solution is pH and temperature dependent, higher the pH and temperature, the higher free ammonia fraction is. When pH modification is required, large amounts of alkali are needed, due to the high buffering capacity of pig slurry. Otherwise, if air stripping is performed at high temperature, its high buffering capacity can maintain pH at the needed value.

The aim of the present investigation is to evaluate pH effect on ammonia air striping from pig slurry at high temperatures (80ºC), and to study the feasibility of the process when fresh and anaerobic treated pig slurry are used.

METHODS

The tests performed to achieve the objectives of this work and the methods used are described bellow.

Row material

Two types of filtered pig slurry were used: fresh slurry from a piggery farm, and the effluent of a lab scale mesophilic anaerobic CSTR fed with similar pig slurry. Main averaged characteristics of the filtered wastes are shown in Table 1.

Table 1.- Characterisation of the filtered pig slurry (average of three samples)

	pH	TS (g/kg)	VS (g/kg)	COD (g/kg)	NH_4^+-N (g/kg)	TKN (g/kg)	TALK mgCaCO$_3$/L	PALK mgCaCO$_3$/L	RALK
Filtered Fresh Slurry	7.68	49.9	31.4	68.03	3.65	5.79	13.20	5.95	0.55
Filtered Digested Slurry	8.45	30.0	15.2	26.46	2.74	3.77	13.29	10.39	0.22

Air stripping test

For the air stripping tests, an isothermal wet wall glass column was used (97,5 cm height x 5 cm internal diameter) in semi-batch conditions. Four litres of pig slurry were used for each experiment. The effluent was collected at the bottom of the column and recycled to the top with a peristaltic pump. Air was supplied with an air blower. Pig slurry stream and air were preheated to 80ºC in a thermostatic bath. Air charged with ammonia was bubbled into a strong acid solution. Three different initial pH of the waste stream were tested (non-modified pH; 9,5 and 11,5). pH adjustment was done with calcium hydroxide. After 12h sedimentation, pH of the clarified stream was re-adjusted to the desired value. Three replications were done.

Analytical methods

Total Kjeldahl-N (TKN), NH_4^+-N, pH, total solids (TS), volatile solids (VS), and COD were analysed by standard methods (APHA, 1995). Partial and total alkalinities (PALK, TALK) were analysed by titration with HCl to pH 5,75 and 4,3 respectively. Alkalinity ratio (RALK) was calculated according to Iza (1995).

RESULTS AND DISCUSSION

Ammonia removal (%) and pH evolutions for experiments with fresh pig slurry are shown in Fig.1a. A higher initial pH resulted in higher removal efficiency. A removal efficiency above 98% was achieved when initial pH was 11,5. When initial pH was adjusted to 9,5 or non-modified, 69% and 65% removal efficiency were reached respectively. The loss of alkalinity (see Fig. 1b) involves a simultaneous pH decrease. When pH<8, ammonia stripping rates became practically zero.

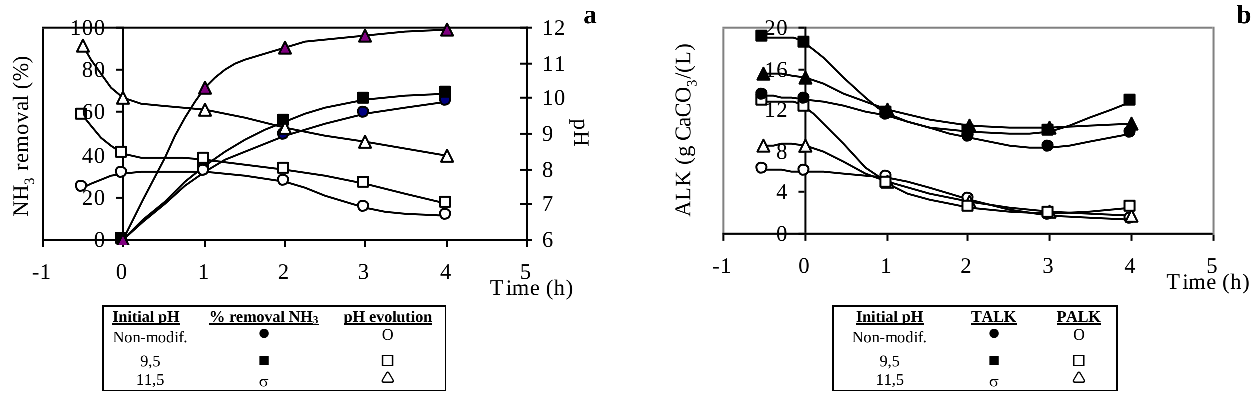

Fig. 1 Ammonia removal, pH evolution, partial and total alkalinity in experiments with filtered fresh pig slurry (average of three replications)

Results from experiments with digested pig slurry are shown in Fig 2. In these experiments pH evolution is completely different: after an initial decrease in the preheating step, its value remains stable, with a slight increase or decrease (Fig 2a). This fact can be explained with the higher partial alkalinity (due to bicarbonate), and its lower VFA contents (see RALK in Table 1). Removal efficiency above 96% is achieved in all experiments. Otherwise, above pH 9,5, ammonia removal efficiency was not greatly influenced by pH, as suggested by results from Liao (1995).

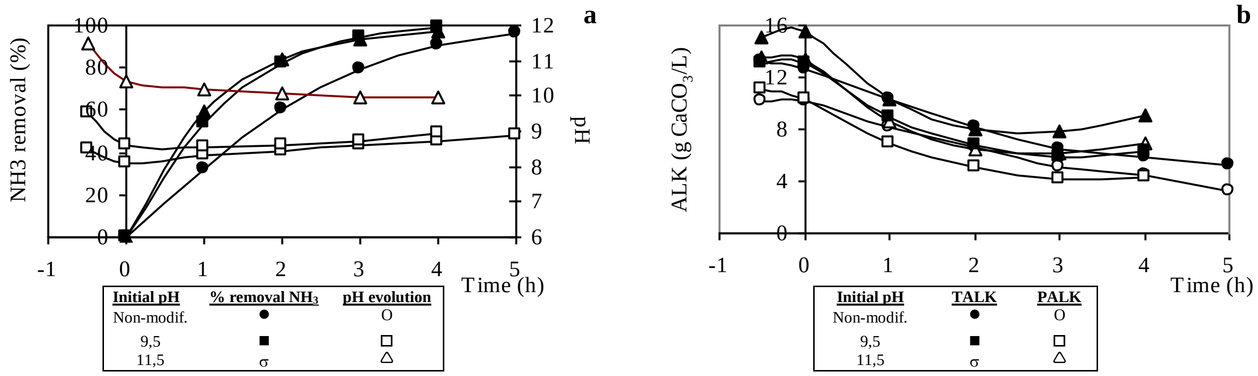

Fig. 2. Ammonia removal, pH evolution, partial and total alkalinity in experiments with filtered digested pig slurryb (average of three replications)

CONCLUSIONS

Air-stripping presents high ammonia removal efficiency at 80ºC. Depending on the pig slurry type, treatment performances are different. In any case, ammonia removal rates are pH dependent, the higher the pH, the higher removal rates are. When fresh pig slurry is used, a high pH is required (large addition of alkali is needed). For digested pig slurry, pH adjustment is still necessary but not critical for achieving high removal efficiencies. In this case, a complete ammonia removal without pH modification was possible.

REFERENCES

Angelidaki, I., Ahring, B.K. (1993). Thermophilic anaerobic digesiton of livestock waste: the effect of ammonia. *Appl. Microbiol. Biotechnol.*, **38** (3), 560-564.

Bonmatí, A. (1998). *Digestió anaeròbia de purins amb altres residus orgànics*. Pagès Editors, Lleida.

Cheung, K.C.; Chu, L.M.; Wong, M.H. (1997). Ammonia stripping as a pretreatment for landfill leachate. *Water, Air, and Soil Pollution,* **94**, 209-221.

Gonzalez Benito, G.; Garcia Cubero, M.T. (1996*).* Ammonia elimination from beet sugar factory condensate streams by a stripping-reabsorption system. *Zuckerindustre*, **9**, 721-726.

Iza, J. (1995). Control del proceso anaerobio. In: *1r Curs d'Enginyeria Ambiental, Universitat de Lleida*, X.Flotats (ed.), Paperkite edn., Spain.

Janus,H.M. and van der Roest, F. (1997) Don't reject the idea of treating reject water. *Wat. Sci. Tech.*, **35** (10), 27-34.

Liao, P.H.; Chen, A.; Lo, K.V. (1995). Removal of nitrogen from swine manure wastewaters by ammonia stripping. *Bioresource Technology,* **54,** 17-20.

Schiweck H.; Nahle, C. (1990*).* Removal of ammonia from condensates and surplus condenser water by stripping with air. *Zuckerindustre*, **115**, 639-647.

Standard methods for the examination of water and waste water (1995),19th edn., American Public Health Association/American Water Works Association/Water Environment Federation, Washington DC, USA.