EFFECT OF WATER SCRUBBING ON AMMONIA EMISSIONS FROM A GESTATING SOWS BUILDING IN THE SOUTH OF EUROPE

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1 INTRODUCTION

Ammonia, greenhouse gases, odour and dust are major sources of air pollution from animal husbandry (Ni et al., 2000; Melse, 2009). Most attention has been paid to the emission of ammonia from animal housing, as it is considered an important compound for the acidification of soils and water (European Commission, 2003).

Several regulations have been developed in order to reduce the environmental impact of intensive livestock farming. The European Directive on Integrated Pollution Prevention and Control (IPPC) aims to reach acceptable levels of environmental performance through the use of Best Available Techniques (BAT).

Wet scrubbers are considered an end-of-pipe technique for the reduction of air emissions, in which the exhaust air from livestock buildings is passed into a trickling bed filter where certain pollutants, such as ammonia, dust and odours, are retained. For a given compound, the mass transfer from gas to liquid phase is determined by the concentration gradient, the size of the contact area between gas and water phase, and the contact time of gas phase and liquid phase (Melse and Ogink, 2005).

Previous studies carried out in other European countries have shown a large variability (from 45 to 90%) in ammonia removal efficiencies (Hahne et al., 2004; Guingand and Grainer, 1996; Guingand, 2008; Arends et al., 2008; Melse and Ogink, 2005). The predominant climate on the Iberian Peninsula is Mediterranean, whose characteristics are very different from those of the Central European Continental climate, where most of the available information on emissions has been generated. Specifically, the scrubbing technique has not been studied under Spanish conditions so far.

The objective of this research was to determine the ammonia removal efficiency of a water scrubber under Spanish production conditions in the Mediterranean region.

2 MATERIALS AND METHODS

The study was conducted at a pig farm located in Navarra (Spain) where 800 gestating sows were housed. The building was equipped with two water scrubbers. The specifications of the scrubbers are shown in Table 1.

The duration of the study was 68 days, from November 2008 to January 2009. Measurements were carried out in one of the scrubbers. Air-ammonia concentration, before and after the scrubber, was measured continuously, using an infra red photoacoustic gas analyzer (INNOVA 1312, Lumasense, Denmark). Four sampling points were placed before the scrubber and the other four were placed after it, as shown in Figure 1. Every 15 minutes the concentration was measured in each point. Parameters of the water, such as pH, conductivity and ammonium content, were analyzed weekly. Electricity and water consumption were also recorded.

The data were processed using summary statistics and t-test by means of the program SPSS 8.0.

TABLE 1 **Specifications of the scrubber**

Packing type	Inorganic material
Measurements of the scrubber (length x width x high) (m)	2.40 x 4.50 x 1.8
Volume of the filter bed package (m^3)	19.44
Specific contact filter surface ($m^2/m^{3)}$	80
Total contact surface of the contact filter package (m^2)	1,555
Maximum load on the contact surface (air flow rate: 100%) ($m^3/(m^2\ h)$)	43
Maximum exhaust air volume flow (100% air flow rate) (m^3/h)	67,582
Speed in the contact bed (air flow rate: 100%) (m/s)	1.74
Dwell time of the exhaust air in the contact bed (air flow rate: 100%) (s)	1.04
Flow configuration	Counter-current
Water recirculation	Continuous
Volume of the scrubbing water tank (m^3)	3.45
Recirculation pump flow (m^3/h)	25
Sprinkling density ($m^3/(m^2\ h)$)	2.3
Discharge water control	Time

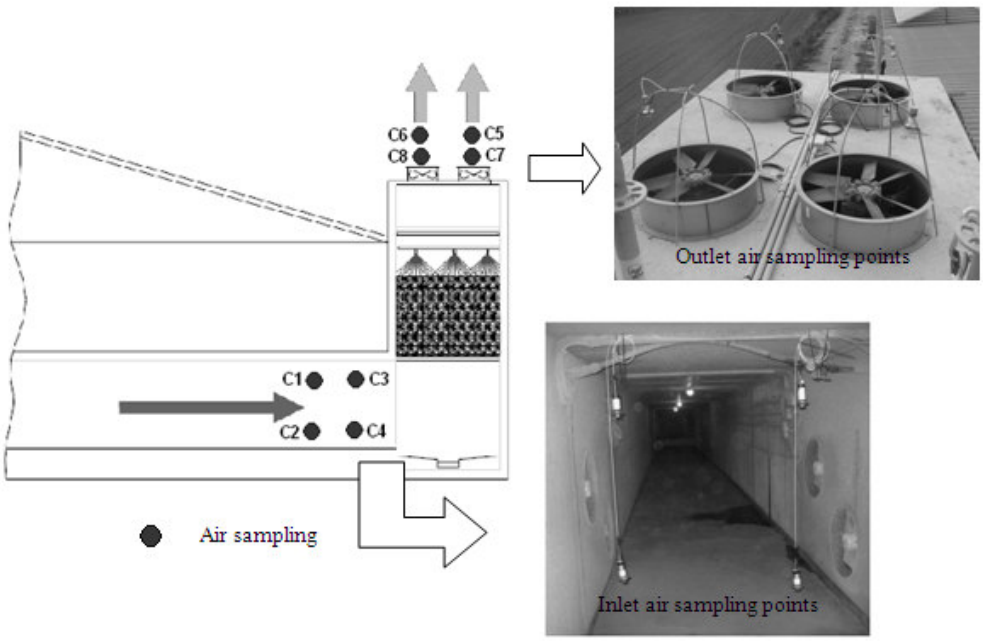

FIGURE 1 **Location of measuring points**

3 RESULTS AND DISCUSSION

Table 2 shows the main results of this study. The average ammonia concentrations before and after washing were 7,771 and 2,278 µg/m^3, respectively, representing an average ammonia removal efficiency of 70%, which agrees with the values found by other authors (Melse and Ogink, 2005). Paired sample t-test showed that the washing treatment significantly reduced the ammonia concentration in the air. Figure 2 shows the evolution of the average ammonia concentration before and after the scrubber over the period of study.

In addition, a positive significant relationship ($p<0.001$) was shown between ammonia concentration in the inlet air and the removal efficiency (Figure 3), as expected with increasing the concentration difference between gas and liquid phase (Melse, 2009).

The average values of pH, conductivity and ammonium concentration in the washing liquid were 7.1, 32.4 mS/cm and 4.22 kg NH_4/m^3, respectively.

TABLE 2 **Summary of results**

	Before treatment	After treatment	Significance level[1]
Average ammonia concentration (µg/m^3)	7,771	2,278	***
Std. Deviation (µg/m^3)	2,936	969	
Sample size (N)	3,160	3,160	
Removal efficiency (%)	70		
Average outside temperature (ºC)	13		
Average inside temperature (ºC)	22		
Fresh water consumption (m^3/year and animal place)	0.42		
Electricity consumption (kWh/year and animal place)	29		
Wastewater production (m^3/year and animal place)	0.13		
Duration (days)	68		
Average number of animals housed	993		
Measurement period	22/11/08 to 28/01/2009		

[1]*p* * < 0.05, ** < 0.01; *** < 0.001

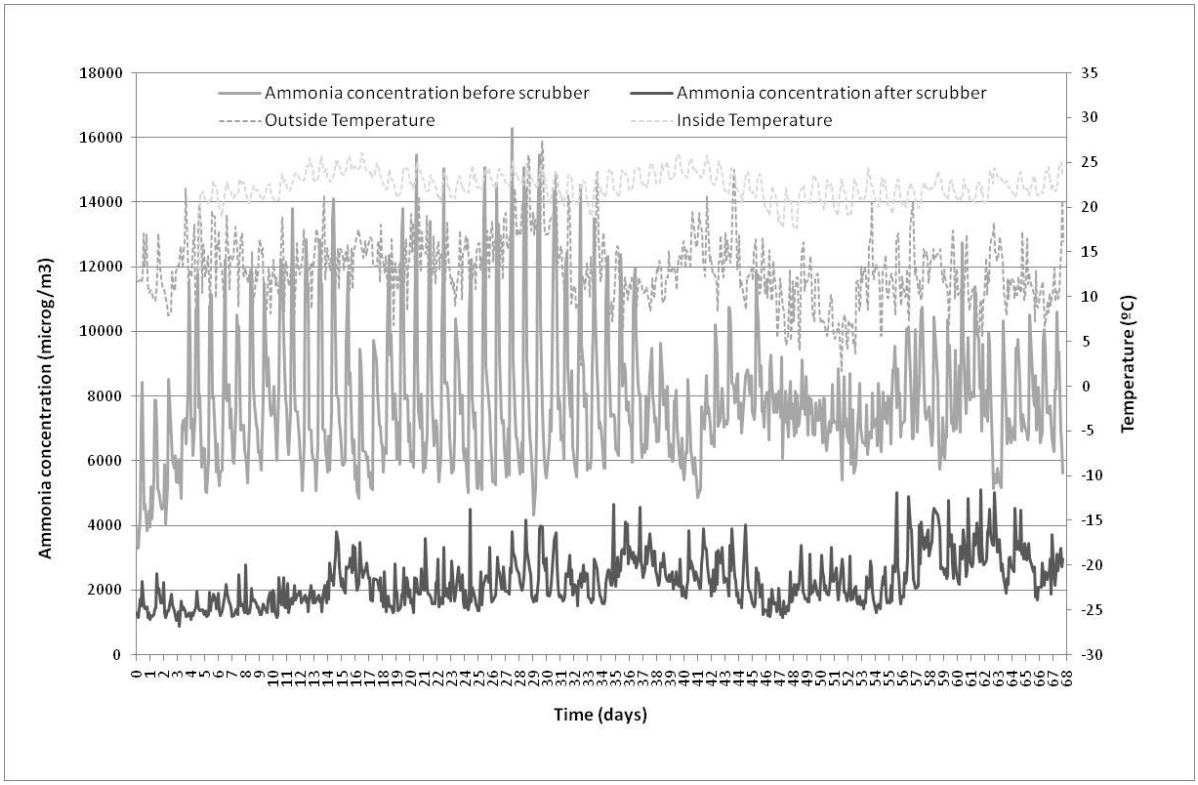

FIGURE 2 **Evolution of ammonia concentration**

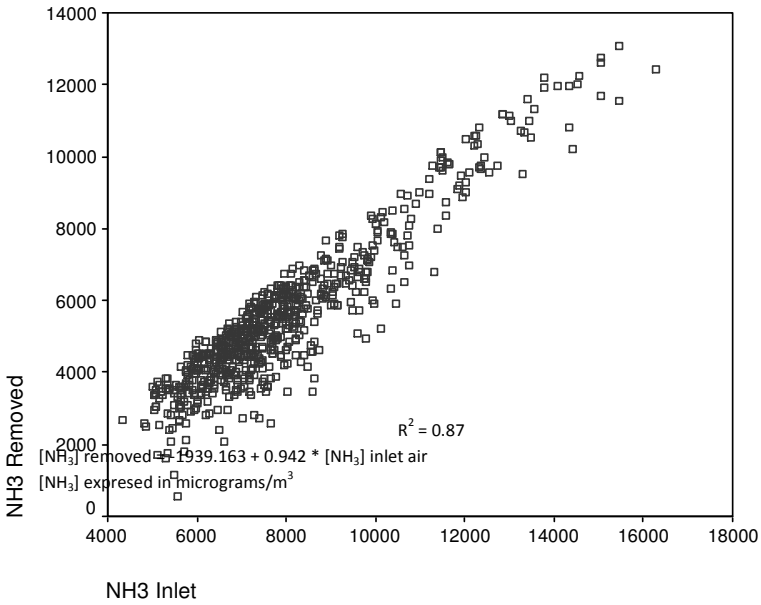

FIGURE 3 **Relation between ammonia concentration in the inlet air and the removal efficiency**

4 CONCLUSIONS

Water scrubbing significantly reduces the ammonia concentration in the exhaust air in livestock houses in winter with an efficiency of 70%. This removal efficiency seems to be higher when the concentration gradient between the gas phase and the liquid phase increases. Further research is necessary to optimize the system performance.

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