Gaseous emissions from systems for pig slurry treatment

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ABSTRACT: In the Netherlands manure treatment is applied because of high off-farm disposal costs. Gaseous emissions (ammonia, odor, and greenhouse gases (methane, nitrous oxide)) from six different systems for pig slurry treatment were measured. Emissions appeared to be are mainly determined by treatment technique and not by treatment capacity of the system. Biological N-removal systems are responsible for a large increase of greenhouse gas emissions. In comparison with a regular farm without manure treatment greenhouse gas emissions are three- to ninefold. Only after process optimization use of such systems can be justified.

1 INTRODUCTION

In the Netherlands, locally high pig and poultry concentrations resulted in strict regulations on ammonia emission to prevent acidification of soils and forests. The limited availability of nearby land created a local manure surplus (MANF 1997) resulting in very high off-farm disposal costs (12 to 17 US$/ton). Development and application of manure treatment technologies can be very advantageous in these cases. Besides improving market prospects for minerals from manure, manure treatment systems should be ecologically sound (sustainable) by not only increasing reuse of minerals and/or energy, but also by preventing unwanted emissions. At the moment odor emission from pig facilities is becoming a major topic (nuisance) and the same is expected for greenhouse gases. Therefore, insight in and prevention of gaseous emissions (greenhouse gases, ammonia, odor) from manure treatment systems is of increasing importance.

2 MATERIAL AND METHODS

Six running systems for treatment of liquid pig manure were selected (Table 1). All were operated on farm scale. Flow and composition of manure (input) and manure products (output) was measured during four weeks. Use of chemicals, energy, and labor was measured. Exploratory measurements of emission of ammonia (NH_3), odor and greenhouse gases (CH_4, N_2O) were carried out. Emission of a component (kg/h) is calculated as the product of exhaust airflow (m^3/h) and concentration (g/m^3 or OU_E/m^3).

3 RESULTS AND DISCUSSION

The gaseous emissions are presented in Table 1. Emissions of ammonia, odor, and greenhouse gases significantly vary from system to system. Ammonia emission varies from 0.03% to 0.7 % of the total amount of nitrogen that enters the system (data not shown). Odor emission varies from 0.005% to 8% of the odor emission of the pig facility (data not shown). As expected (e.g. Burton 1993) the emission of greenhouse gases (mainly N_2O) from the biological N-removal systems is very high. Compared with an average emission of 8.8 g CO_2-eq./h per animal at a regular farm without manure treatment (Hilhorst 2001), the measured emission is three- to ninefold. This means that application of biological manure treatment techniques has a large negative effect on greenhouse gas emissions. Process optimization and improvement of process control must take place to reduce these emissions. In municipal wastewater treatment, however, biological N-removal with its known inherent N_2O emission is widely accepted.

Table 1. Gaseous emissions from systems for pig slurry treatment on farm scale (exploratory measurements).

Description of techniques	Treatment capacity (ton slurry/year)	Ammonia (g/h)	Odor (OU_E/h)	Greenhouse gases (*) (kg CO2-eq./h)
Mechanical / Chemical:				
1 Straw filter in greenhouse, sun light evaporation, air washing (Melse & Gijsel 2001)	1800	11	5.8E+05	1.8
2 Screw press, centrifuge, UF, composting	3600	5.9	1.6E+07	5.0
3 Flotation, belt press, MF, RO	8000	4.0	9.4E+05	0.6
Biological (N-removal):				
4 (De-)nitrification, lime addition, sedimentation	3000	1.1	3.1E+05	46.2
5 Flotation, belt press, (de-)nitrification, sedimentation	5000	2.4	1.1E+06	44.7
Thermal:				
6 Centrifuge, heating, washing, condensing	16,000	3.2	6.7E+03	n.m.

(*) Sum of N_2O and CH_4 expressed as CO_2-equivalents (IPCC 1996).
MF = microfiltration; UF = ultrafiltration; RO = reversed osmosis; n.m. = not measured

4 CONCLUSIONS

Exploratory measurements of emissions (NH_3, odor, CH_4, N_2O) from pig slurry treatment indicate:

1. Emission is mainly determined by treatment technique.
2. No direct relation exists between treatment capacity and emissions.
3. Biological N-removal systems are responsible for a large increase of greenhouse gas emissions..

Only after process optimization the use of such treatment systems can be justified.

A detailed report on each system will be published later this year.

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