D. Reduced emission manure storage techniques

Introduction

29. Ammonia losses from buildings and after spreading livestock manures are usually the most important emission sources, however losses from stored slurries and solid manures can also make a significant contribution to the total emission of ammonia. Storage enables manures to be spread on to land at times of the year when there is a crop nutrient requirement and the risk of water pollution (e.g. through nitrate leaching) is low.

Storage of slurry and other liquid manures

30. After removal from livestock buildings, slurry is stored either in concrete, steel or wooden tanks (or silos) or in lagoons. The latter usually have a relatively larger area per unit volume than the former and thus a greater potential for ammonia emissions. There may be national or regional regulations controlling the design, construction and management of manure stores.

31. Techniques for reducing ammonia emissions from manure stores include:

(a) Design of the store:

(i) Size. The store should be of sufficient size to avoid spreading on land at times of the year when there is a risk of water pollution (e.g. through nitrate leaching) and to allow application at the best time with regard to crop nitrogen demand.

(ii) Surface area. Reduce the surface area (or emitting surface) of the store. For example, the surface area of a 1000 m^3 slurry store can be reduced by more than one third, if the height of the sides is increased by 2 m from 3 to 5 m. Generally, for practical (mixing, reducing required volume for precipitation) and abatement reasons, the height of the store should be at least 3 m where feasible.

(b) Management and surroundings of slurry tanks

(i) Frequent mixing and emptying should be avoided wherever possible because these operations increase ammonia emissions. However, mixing and removal of slurry for spreading is likely to be more frequent on grass than on arable farms to ensure effective utilization of the slurry.

(ii) Reduction in the air velocity on the slurry surface can be achieved by a sufficiently high freeboard and by planting a tree shelterbelt.

(iii) Both below ground tanks outdoors and shadowing of stores may reduce the temperature of the slurry in the storage tank and thus result in a significant reduction of ammonia (and methane) emissions.

(c) Covers for slurry tanks or silos: Covers on slurry stores are an effective means of reducing ammonia emissions. The options for covering tanks or silos are summarized in Table 5.1. They include:

(i) Solid covers. These are the most effective techniques for reducing ammonia emissions but also the most expensive. Whilst it is important to guarantee that covers are well sealed to minimize air exchange, there must be small openings or a facility for venting to prevent the accumulation of inflammable methane gas, especially with tent structures;

(ii) Floating covers. These are usually made from plastic sheets and are less effective than roofs, although they are usually less expensive. Double sheets with shrink-wrapped polystyrene are often used to avoid gas bubbles and sinking of parts of the sheet. The floating cover should be fixed to vertical ropes that are fastened to the store wall. This prevents the cover from turning during manure mixing and being lifted off by wind. Properly constructed roofs and some floating covers also exclude rainfall from the store and so increase the volume of slurry that can be stored;

(iii) Floating plastic bodies (hexacovers). Floating hexagonal plastic bodies form a closed floating cover on the slurry surface. The vertical ribs in the bodies prevent the elements from being pushed one on top of the other. They may be used only in pig slurry or other liquid manures without natural crust. They are not suitable for slurries rich in organic matter.

(iv) Natural crusts. Cattle slurries normally build up a natural crust of floating organic materials. The crust will only form if the dry matter is high enough (>7%) and stirring can be minimized. The crust should cover the whole of the surface area of the manure. The store must be filled from below the crust to avoid breaking it up;

(v) Floating crusts. The introduction of straw, granulates (light expanded clay aggregates or perlite) or other floating material on the slurry surface in tanks or lagoons can reduce emissions by creating an artificial crust.

- Straw. The most effective way is to introduce chopped straw with a self-propelled field chopper (forage harvester) at a length of about 4 cm. About 4 kg straw/m2 should be blown into either the emptied or the filled tank by a well-instructed and experienced driver; Straw covers may likely lead to an increase in CH4 and N2O emissions. The slurry dry matter is also increased which as a consequence raises NH3 emissions after slurry application.
- Granulates (LECA balls / Perlite). The introduction of granulates can be done very easily. It is more expensive than straw but only about one third as costly as a compared to a tent structure. About 10% of the material is usually lost yearly from emptying the store. Agitating one day before spreading and briefly just beforehand can help to reduce losses.
- The use of oil and peat is not recommended because of practical difficulties of its use and lacking experience under farm conditions and because it is likely to lead to a strong increase in CH_4 emissions.

33. It is more difficult to reduce ammonia emissions from lagoons than from tanks. The construction of new lagoons should be discouraged in favour of tanks. The replacement of existing lagoons with tanks can be considered to be an abatement technique. Covers for lagoons, however, are available and artificial

crusts of straw, LECA balls, plastic bodies and foils have been successfully used. About 7-12 kg/m^2 straw is needed in this case. It may be difficult to retain these materials on large lagoons under windy conditions.

34. Storage bags are suitable for reducing emissions from slurry on small farms (e.g. < 150 fattening pigs). They may not be permitted in all countries due to a risk of water pollution.

Table 5.1. Effectiveness and applicability of ammonia abatement techniques for slurry stores

Abatement Measure	Livestock Class	Emission reduction (%)	Applicability	Remarks
rigid lid or roof	all	80	tanks and silos only	no additional capacity for rain water needed, limitation through static requirements
flexible cover (e.g. tent structure)	all	80	tanks and silos only	limitation through static requirements
floating foil	all	60		
Floating plastic bodies	all		Not on crusting manures	
Natural crust	cattle, pig slurries with more than 5-7 % DM	40	not on farms with frequent spreading	[Comment - is 40% what is in the Guidance document? (I'm not up-to-date with this). In the UK we use 50% based on
artificial crusts: straw	pig and cattle slurry	60	not practicable on thin liquid manures, not on farms with frequent spreading	increased N_2O and CH_4 emissions
artificial crusts: leca balls etc.	pig slurry, liquid manures	60	also on thin liquid manures, not on farms with frequent spreading	loss of some LECA through pumping

Replacement of lagoons with covered/open tanks	all	30-60		[Comparing losses from lagoons and tanks in NARSES losses from lagoons are *5 those from tanks for cattle slurry and * 4 for pig slurry. Hence the abatment would be 75-80%]
Storage bag	all	100	Only for small farms	

Storage of solid manure

34. At present there are no proven techniques for reducing ammonia emissions from stored solid manures. After removal from animal houses, solid manure may be stacked on a concrete area, sometimes with walls, usually with drainage and a pit for collecting leachate. In some countries, it is permitted to store manure in stacks on the soil in fields –at least over a limited period. Litter and manure from poultry, especially air-dried dung from laying-hens, is increasingly stored in bunkers. Management guidelines for limiting ammonia emissions are as follows:

(a) Cover solid manure stores. This will reduce ammonia emissions but is impractical when manure has to be loaded frequently. Furthermore, the emission reduction is often neutralised by higher emissions at later stages of manure handling;

(b) Make the surface area of the stack as small as possible (e.g. by constructing walls to increase the height);

(c) Keep the manure as dry as possible. This is particularly important for litter from broilers and laying-hens and air dried laying hen excreta collected on belts.

Measures are for example:

(i) Storing under a roof, preferably on a concrete base;

(ii) Covering with a sheet;

(iii) Storing in narrow A-shaped heaps that shed water more readily, when no cover is used.

(iv) Add straw to the manure

35. Air-dried laying-hen excreta collected on manure belts that have a dry matter content of at least 60 to 70%, emit very little ammonia. These manures must be kept dry and prevented from remoistening. Therefore storing under a roof (see 34.(c)) is the most appropriate option.

3 6 . Excreta from deep pit battery-laying hen houses, which are often stored for a year beneath the surface of the house, emit high rates of ammonia due to their low dry matter content. To prevent ammonia emission, the dry matter content may be increased by passing exhaust air from the building over the manure heap.

37. Other techniques include maintaining the temperature of the heap below 50° C or increasing the C:N ratio to >25, e.g. by increasing the amount of straw or other bedding material used.

38. It is essential to take national or regional regulations concerning the avoidance of water pollution into account when locating manure stacks directly on the soil in fields.