Ammonia Emissions from Dairy Cow Buildings

cafre
College of Agriculture, Food & Rural Enterprise

The Cafre dairy unit has been designed to best meet the education and training needs of agriculture students and the dairy industry, to enable the delivery of knowledge and technology transfer and to comply with all relevant legislation and animal welfare recommendations.

This is one of a series of technical notes aimed at farmers and students designed to provide the level of technical detail required to assist farmers in adopting technologies and practices demonstrated in the Greenmount Campus dairy unit on their farm business.

Emissions of ammonia contribute to environmental acidification and increase the nitrogen content of surface and soil water. Emissions of ammonia (NH_4) can be environmentally harmful because of their damaging effect on sensitive plants and soil ecosystems, and may be increasingly recognised as having implications for human health through the formation of fine atmospheric particles.

In animal houses, ammonia in the liquid phase is produced by the enzymatic breakdown of urea present in urine excreted by the animals. This reaction is catalysed by the enzyme urease. Volatilization of the liquid ammonia then takes place, where ammonia transfers across the liquid-air boundary. Ammonia emission occurs when ammonia, volatilized from the liquid to gas phase, in the animal house is emitted to the outside air through the ventilation process.

Adopting ammonia reduction methods represents an opportunity not just to contribute to protecting the environment but improve nitrogen utilisation and potentially reduce production costs.

European regulations on ammonia emissions

The 1999 Gothenburg Protocol set emission ceilings for 2010 for air pollutants including ammonia. The emission ceilings were negotiated on the basis of scientific assessments of pollution effects and abatement options. The Protocol targets were to reduce European ammonia emissions by 17% compared to 1990. The UK target was to reduce ammonia emissions to less than 297 thousand tonnes by 2010. This target was exceeded by 4%. New international protocols to reduce ammonia emissions are currently being negotiated.

Ammonia emission research

About 60% of the total ammonia emission from a dairy cow building originate from floors within the building, (including the slatted floor surface), with the remaining 40% emitted from the slurry tank. Work carried out in The Netherlands estimated that 28% of ammonia emissions from Dutch agriculture were attributable to dairy cow buildings.

Research also carried out in The Netherlands in the mid 1990's showed that ammonia emissions could be reduced by up to 50% from cubicle houses with slatted floors through a variety of measures. These include

replacing the slatted floor with a double-sloped solid floor (e.g. sloped from each cubicle heelstone to the centre of the passage) fitted with a central urine drainage gutter; flushing floors with water or dilute formaldehyde; slurry acidification; and optimised feeding strategies to minimise surplus protein in the diet.

Most of the recent innovations in ammonia emission reduction from dairy cow housing systems in Europe are related to floors. The principle features of innovative floors are fast drainage of urine to the slurry pit or to outside storage. In some innovations, slurry tank ammonia emission is reduced through the application of flaps or valves that ensure transport of urine and faeces to the tank, but prevent air flow from the tank to the air inside the house.

Commercially available flooring systems to reduce NH3 emissions

Farmers in countries such as The Netherlands and Denmark, where animal stocking densities are relatively high, have been required to take specific measures to control ammonia emissions. These include slurry spreading technologies and building flooring technologies.

The commercially available ammonia reduction technologies to reduce ammonia emissions from floors can be grouped into 3 main categories:

- traditional concrete slatted floor systems with slurry tanks (7 technologies)
- profiled floor elements with slurry tanks (5 technologies)
- solid floors with external slurry storage (5 technologies)

Some Dutch technologies include roof insulation to lower the indoor air temperature in warm weather and/or automatically controlled natural ventilation (ACNV) to reduce the air speed in the house when the external wind speed is high. These features improve the ammonia emission reduction of the systems.

Specification of the CAFRE dairy unit slurry handling system

Prior to construction of the new Cafre dairy unit 3,500 m^3 of storage capacity was provided through three above ground slurry stores. A large capacity of slurry storage within the new dairy unit was not required. Slurry handling facilities within the new dairy unit were designed to:

1. Optimise cleanliness of floor surfaces to reduce lameness and mastitis incidence.
2. Minimise ammonia volatilisation from floor surfaces.
3. Remove fresh slurry from the building quickly to optimise biogas production from an anaerobic digestion project under consideration.
4. Provide adequate internal slurry storage to allow for extended equipment breakdowns over winter holiday periods.

FLOORING TECHNOLOGIES INSTALLED IN THE CAFRE DAIRY UNIT

The flooring technologies installed in the CAFRE dairy unit were selected to provide both high hoof grip surfaces to improve cow welfare through reducing the incidence of slip injuries and reduce ammonia emissions from floor surfaces and slurry storage. The technologies installed include:

1. Tank and slurry channel covers with factory moulded urine drainage grooves and rubber flaps to reduce ammonia emission from the stored slurry

2. Concrete grooved flooring units with factory moulded high grip surfaces

3. Rubber grooved floors manufactured with high grip surface

Research studies have shown that these flooring technologies reduce ammonia emissions from the dairy cow accommodation by approximately 20%.

Rubber grooved floor installed either side of the feed passage in the Cafre dairy unit