Hydrogen sulphide emissions during slurry agitation

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Introduction

Hydrogen sulphide (H_2S) gas is produced in animal slurry stored anaerobically in under floor slatted tanks. The gas is toxic and is released during agitation which homogenises the material prior to the removal from the slurry tank. The gas is a safety hazard for both humans and animals. At low concentrations (3-5 µl/l) H_2S has an offensive odour. A concentration of 150 µl/l leads to olfactory nerve paralysis. Concentrations of 500-600 µl/l for a duration of 30 minutes cause nausea, excitement, insomnia, unconsciousness and possible death. Concentrations above 700 µl/l are rapidly fatal for humans (Nordstrom and McQuitty, 1976). H_2S Occupational Exposure Limits (OEL) for humans are 10 µl/l and 15 µl/l for 8 hour and 15 minute exposure periods respectively (NSAI, 1994). The objectives of this study were to measure H_2S concentrations during slurry agitation on beef and dairy farms and to make recommendation regarding safe procedures for use on farms.

Materials and Methods

Eighteen farms were visited during the summer of 2003 to measure H_2S production from slurry tanks located beneath slatted floors. Farms were chosen at random from lists available to staff from the Agricultural Research Institute of Northern Ireland and Teagasc. The concentration of H_2S was measured using ImpulsePro portable gas monitors/loggers (Zellweger Analytics, Poole, UK) fitted with a H_2S smart sensor capable of recording concentrations up to 500 µl/l. Five monitors were used on each occasion and these were set to record H_2S concentrations every 10 seconds. The monitors were placed at five different locations (loc 1 – floor level at location of agitator; loc 2 – 1m above loc 1; loc 3 – floor level at point of maximum slurry movement; loc 4 – 1m above loc 3 and loc 5 – 1.5 m above slat level in the middle of the building). Because of health and safety implications arising from H_2S emission during slurry agitation, farmers were asked not to vary their agitation routine (duration of agitation, opening/closing doors etc.) during the on-farm measurements. When agitation stopped, monitors remained in place recording until their alarms (visual and audible) indicated that gas levels were low enough to allow safe entry into the building to recover the monitors. Details of building design and management practices were recorded. Ambient weather conditions were measured and slurry samples were taken for DM assessment.

Results and Discussion

As agitation proceeded according to the normal practice on the farm there was considerable variation between farms in the length of time slurry was agitated.

In order to compare values from all farms for the concentration and duration of H_2S emissions during agitation, it was necessary to express these in a comparable unit. A calculation was therefore carried out to give the proportion of total agitation time (%TAT) that concentrations were above threshold values. This calculation removed the variation between farms in the length of time spent agitating. Highest average emissions of H_2S were recorded at the location of maximum slurry movement. The data presented in Table 1 indicate that when averaged over all farms H_2S was produced for 66% of TAT at slat level at this location (loc 3). Of particular interest is that at this location, 36% of TAT had concentrations of H_2S above the 15 minute OEL of 15 µl/l.

Table 1. Average % of *Total Agitation Time* above given H_2S threshold concentrations across all farms for each monitoring locations

H_2S Threshold (µl/l*)	***Location***				
	Loc 1	***Loc 2***	***Loc 3***	***Loc 4***	***Loc 5***
499	0.0	0.0	2.3	0.1	0.1
250	0.7	0.1	6.1	0.2	0.1
200	0.8	0.3	7.6	0.4	0.1
150	1.4	1.2	8.6	0.8	0.2
100	2.7	3.6	11.8	2.7	0.5
50	7.4	9.6	18.7	8.2	2.8
20	18.9	19.5	31.8	17.8	6.6
15	23.1	23.2	35.5	22.8	9.1
10	28.5	27.0	40.1	27.8	12.4
0	58.5	53.1	66.4	57.7	43.3

* 1 µl/l = 1 ppm

A number of regressions were carried out to try and relate the concentration and duration of H_2S emissions from slurry tanks to: wind speed, wind direction relative to house, volume of slurry in the tank, slurry to slat head space, depth of slurry in the tank, surface area of slurry, slurry DM concentration, slurry surface to volume ratio and quality of ventilation. No relationships were established.

Conclusions

During agitation there was no safe position in the vicinity of the tank since H_2S was always produced at varying concentrations and durations. It is recommended that operators should not enter buildings and that livestock should be removed from buildings during agitation.

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References

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