Available online at www.sciencedirect.com
ScienceDirect
Bioresource Technology 99 (2008) 6409–6418
BIORESOURCE TECHNOLOGY

Long-term assessment of efficacy of permeable pond covers for odour reduction

N. Hudson [a,b,*], G.A. Ayoko [a], G. Collman [b], E. Gallagher [b], M. Dunlop [b], D. Duperouzel [b]

[a] International Laboratory for Air Quality and Health, School of Physical and Chemical Sciences, Queensland University of Technology, GPO 2434, Brisbane, Queensland 4001, Australia
[b] Department of Primary Industries & Fisheries Queensland, P.O. Box 102, Toowoomba, Queensland 4350, Australia

Received 25 October 2006; received in revised form 21 November 2007; accepted 21 November 2007
Available online 8 January 2008

Abstract

Three anaerobic ponds used to store and treat piggery wastes were fully covered with permeable materials manufactured from polypropylene geofabric, polyethylene shade cloth and supported straw. The covers were assessed in terms of efficacy in reducing odour emission rates over a 40-month period. Odour samples were collected from the surface of the covers, the surface of the exposed liquor and from the surface of an uncovered (control) pond at one of the piggeries.

Relative to the emission rate of the exposed liquor at each pond, the polypropylene, shade cloth and straw covers reduced average emission rates by 76%, 69% and 66%, respectively. At the piggery with an uncovered control pond, the polypropylene covers reduced average odour emission rates by 50% and 41%, respectively. A plausible hypothesis, consistent with likely mechanisms for the odour reduction and the olfactometric method used to quantifying the efficacy of the covers, is offered.
© 2007 Elsevier Ltd. All rights reserved.

Keywords: Odour; Permeable; Pond; Cover; Anaerobic

1. Introduction

Our previous publication identified a number of criteria that could be used when evaluating potential solutions to odour problems. These included requirements for: low capital cost, easy installation, minimal management, limited maintenance, and efficient and consistent odour control over the life of the equipment. In addition, the control equipment would be compatible with existing waste management practices and equipment, minimising redundancy of existing infrastructure (Hudson et al., 2006a).

In Australia, most piggeries comprise naturally ventilated, slatted floor housing. Piggery waste is treated in one or more open storage or stabilisation ponds. Typically, supernatant liquor is recovered from one of the ponds and used to periodically flush the housing system, conveying urine, faecal matter and spilt feed and water to an anaerobic pond. Australian research demonstrated that up to 80% of odour emissions arose from the treatment ponds (Schulz and Lim, 1993; Dalton et al., 1997; Smith et al., 1999). It is therefore essential to minimise odour emissions from waste treatment ponds specifically if odour impacts are to be reduced.

We previously demonstrated that under laboratory conditions, supported biological covers reduced odour emissions from anaerobic liquor by an average of 84% relative to uncovered liquor surfaces (Hudson et al., 2006a). Subsequent field investigations demonstrated that supported biological covers reduced emissions from anaerobic liquor five to eight times relative to the uncovered pond surface (Hudson et al., 2006b). Similar reduction in odour emission was demonstrated for a spun-fibre polypropylene fabric cover. The efficacy of reduction in odour emission was unchanged over a 10-month period. Although these results

* Corresponding author. Present address: The National Institute of Water & Atmospheric Research Limited (NIWA). Tel.: +64 7 856 1746.
E-mail address: n.hudson@niwa.co.nz (N. Hudson).

0960-8524/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biortech.2007.11.058

were promising, it was anticipated that adoption of this technology would be limited by a number of issues revealed during the trial:

1. The long-term efficacy of odour reduction under full scale field conditions remained unknown.
2. The covers did not totally enclose the surface of the waste treatment pond. The potential existed that the cover was not subject to the total potential "odour load" – odorants could be accumulating in the liquor under the covers, to be emitted from the uncovered surface adjacent to the covers.
3. The likely life expectancy of the various covers trialled could not be predicted from a study that lasted only a few months.
4. Rapid accumulation of ammonia-N and reduced sulphur compounds (as sulphide) in the liquor was observed during the laboratory-scale trials. Accumulation of these substances may have indicated impairment of anaerobic waste treatment processes.
5. Increases in the concentration of these substances indicated that odorants were probably accumulating in the liquor. The potential existed for subsequent release, such as during shed flushing or application of the liquor to land.

Our previous work summarised most of the earlier assessments of permeable pond covers for odour control (Hudson et al., 2006a,b). The review that follows focuses on more recent assessments where odour emissions were quantified during evaluation of either straw or geotextile covers for odour control.

1.1. Straw based covers

Relatively few field trials have been conducted to assess the efficacy of permeable pond covers in reducing odour emission rate. Clanton et al. (1999) performed large scale laboratory trials of unsupported straw covers over a 60-day period. The straw cover reduced the odour emission immediately by 60% and by up to 78% three weeks later. The trial could not be continued because the unsupported cover sank.

In a subsequent trial, Clanton et al. (2001) used straw as a surface layer on a geotextile fabric base. Over a 10-week study period, odour emissions were reduced by 47% and 79% for 100 and 300 mm thick layers of straw, respectively. The small "anaerobic waste volume" to "cover thickness" ratio caused by the experimental facilities selected for the trial may have caused under-loading of the cover with regard to odour.

Cicek et al. (2004) undertook a short-duration assessment of the efficacy of an unsupported straw cover. An entire pond was covered with a straw layer (thickness unspecified). Odour samples were collected from the surface of this pond and a similar uncovered pond on a neighbouring farm. Three sets of samples were collected over a 10-day period using a wind tunnel of the type developed at the University of New South Wales (Jiang et al., 1995). These were analysed using dynamic olfactometry. Although emission rates were not calculated, it was possible to compare the odour concentration of the samples because the wind tunnel was operated under standardised conditions. The straw cover reduced the odour concentration by an average 31% over the three sample days.

Hudson et al. (2006a,b) assessed supported straw covers under laboratory and field conditions. Under laboratory conditions supported straw covers reduced odour emissions by 84%. Under field conditions, very consistent performance was observed, with odour emission rates reduced by 87–90% over a 10-month period. These supported straw covers did not, however enclose the entire surface of the treatment pond.

1.2. Geofabric based covers

Little information has been published regarding the performance of geofabric-based covers either. Clanton et al. (1999) evaluated a 0.3 mm geotextile cover on a series of 7500 L tanks containing pig manure. Following an assessment period of approximately three weeks, it was concluded that a geotextile cover reduced odour by about 59%.

In a subsequent investigation Clanton et al. (2001) investigated the efficacy of three thicknesses of geofabric in reducing odour emissions. Over a ten-week assessment period, 0.3, 1.1 and 2.4 mm thick geofabrics provided −22%, −4% and 39% odour reduction, respectively.

Dobson and Townsend (2002) assessed the efficacy of a composite permeable cover based on geofabric. The cover was a commercial product called Biocap™. Odour reduction was assessed using field odour assessment techniques, so actual odour emission rates were not reported. The number of field observations reported as "below the detection threshold" was 84% for the covered pond, while it was 30% for an uncovered control pond. The frequency of detection of objectionable odour near the covered pond was 16%, while it was 70% at the uncovered control.

Bicudo et al. (2004) conducted a two year evaluation of a commercial permeable cover (Biocap™). The trial took place at full scale at three pig farms. At each farm, one treatment pond was covered completely, while another pond was left uncovered as a control. About 200 odour samples were collected from either the pond or cover surfaces over the trial period using a UNSW-style wind tunnel. Olfactometry was performed according to the CEN standard (1999), upon which the Australian olfactometry standard is based (Standards Australia and Standards New Zealand, 2001). Odour emission rates from the covered ponds were reduced by between 15% and 76% over the trial period, with an overall average reduction of 51%. It was observed that the performance of the cover deteriorated in the second year of the trial relative to the first year. Deterioration in cover performance was specula-

Download English Version:

https://daneshyari.com/en/article/684892

Download Persian Version:

https://daneshyari.com/article/684892

Daneshyari.com