Performance of a membrane filter system with untreated vs digested liquid manure

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Introduction

This was a preliminary study carried out during the fall and winter 2005/06. The goal was to assess the difference in performance of a membrane filtration system in recovering water from two manures. One was un-processed liquid swine manure. The other was the same manure after anaerobic digestion. Recovery of water from liquid manure would have two benefits for livestock producers: a) reduce storage and spreading costs, and b) reduce fresh water costs. Future tests will include cattle manure (digested and non-digested).

Sample Preparation

There were 3 forms of manure in the study:

a) Untreated manure – liquid manure from a local swine farm – removed from the long-term storage

b) Untreated manure to VSEP – The RO unit could not handle the solids in the untreated manure without pre-filtering – i) passed through a 100 mesh screen, ii) allowed to settle overnight, iii) the decanted liquid from top of storage was used in the VSEP

c) Digestate – Removed from anaerobic digester - same screening – allowed to settle overnight and liquids for testing decanted from top of storage

Membrane Filtration System

Manure was separated using a VSEP - Series LP (New Logic, Emeryville, California). The unit is a laboratory scale model. This system was set up with a vibrating stack of 18 reverse osmosis membranes. It uses high pressure and a timed (open and closed) outlet valve to remove water from liquid manure. Adjustments can be made to change the filtrate recovery rate.

Fig.1 – VSEP test unit equipped with reverse osmosis filter pack.

Fig. 2 – Recovery of water from VSEP unit (liquid manure input)

Anaerobic Digestion System

This is a pilot scale unit. It is a “complete-mixed” system, operating in the mesophilic temperature range (around 37°C). It consists of a mixing/preheat tank (3200 L), the main digestion tank (7900 L, stainless steel), and all related piping, pumps, heating system and controls. The “design” hydraulic retention time is 21 days.

Fig. 3 – Anaerobic digester – main digestion tank is at right end

Observations

The membrane filter system was set for 2 water recovery rates: 50% and 65% (i.e. 100 L of manure in and 50 or 65 L of water out – the remaining volume was concentrated manure). In general, the performance of the VSEP unit was better for the digested manure – see Table 1.

Table 1 – Flow rates through VSEP unit

	Clean Water Recovery (%)	Clean Water Flow Rate (mL/min)
Untreated manure to VSEP	50	550
Untreated manure to VSEP	62	450
Digestate	51	775
Digestate	63	545

Fig. 4 – Soil screens used to find particle size distribution – mesh sizes were: 18, 60, 100 and 350 (i.e. openings per 25.4 mm)

Table 2 – Nutrient content of inputs and outputs

Parameter	Manure	Digested Manure	Recovered Water
NH_4-N (mg/kg)	2200	2000	130
TKN (%, “as is”)	0.36	0.27	0.011
P (%, “as is”)	0.085	0.027	0.0
K (%, “as is”)	0.26	0.21	0.0
Dry Matter (%, “as is”)	3.0	1.3	0.02
E.C. (mS/cm)	16	14	1.1
pH	7.9	8.3	8.5

Surprisingly, the particle size distribution was not significantly different between untreated manure and digestate. However, the number of samples was fairly small, the sample volume was small (1 L) and variability was high.

Summary

- It was easier to run digested manure through the VSEP membrane filtration system than untreated manure – flow rates were higher for similar water recovery percentages.
- The digested manure was pre-filtered – even though there was a breakdown of solids in the digester, some large coarse solids (including hair) remained.
- Larger samples and more samples are needed to more accurately show differences in particle size distribution.

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