Pilot testing three methane oxidation techniques on practical farm sites: flare, biofilter and soil filter.

Rik Maasdam[1], Karin Groenestein[1], Co Daatselaar[2], Nico Bondt[2], Léon Jansen[3], Kees Kroes[4], Hans Oonk[5].

[1] Wageningen Livestock Research, [2] Wageningen Economic Research, [3] Schuttelaar & Partners, [4] LTO Noord, [5] Oonkay

Background

From the total methane emission in the dairy sector roughly 20% originates from the manure. Manure storages are therefore a good point source to capture methane emission. In this study methane from the manure storage was captured passively, without active ventilation using the overpressure in the manure storage, and subsequently converted to CO_2 (figure 1). Manure storages with active ventilation were not tested in this study. In total three pilot methane oxidation techniques were tested on practical farms

Objective

The aim of this study is to demonstrate the pratical application of methane oxidation techniques to convert CH_4 generated by manure into CO_2.

The biofilter was continuously ventilated with an airstream of ambient air to supply oxygen for the methanotrophic bacteria in the biofilter. Due to variations in the biogas release while keeping a constant ambient air-flow, sometimes concentrations of methane in excess of the LEL were measured.

The soil filter has to consist of a specific soiltype to guarantee enough permeability for the biogas and ambient air to create conditions for methanotrophic bacteria to oxidise methane. During the pilot it proved difficult to measure the biogas flow going into the soil filter due to high fluctuations.

For all the pilots H_2S in the biogas was a bottleneck. In the flare this causes an odour during combustion, in the biofilter it is corrosive for the system and in the soil filter an increased concentration of sulphate was measured in the groundwater. The addition of a sulphur filter solved these problems.

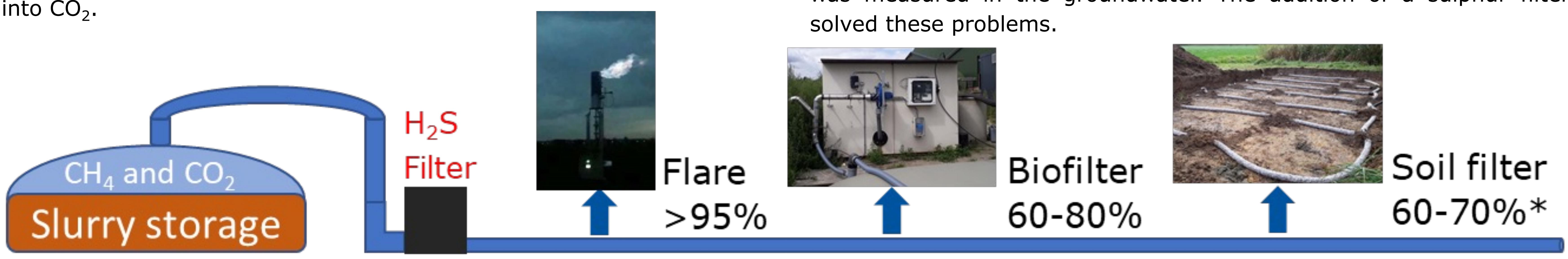

Figure 1. Schematic overview of the three oxidation techniques used in this research to convert methane, originating from a manure storage bag, into CO_2. The three techniques used are: a flare, biofilter and soil filter. The methane flow is passively captured, without the need for ventilation, using the overpressure in the manure storage. The flare has an assumed efficiency of >95%, while for the biofilter and soil filter efficiencies ranging between 60-80% and 60-70% were measured. *The pilot was under dimensioned, in the costs analysis a higher efficiency is assumed based on experiences withe methane oxidation at landfills (Scheutz et al., 2009).

Results

Pilot testing three methane oxidation techniques

Due to methanogenesis a gas mixture similar to biogas is formed in the headspace of manure storages. In the pilot-flare this biogas mixture is directly burned with a assumed efficiency of over 95%, due to methane slip (Flesch et al., 2011).

For the biofilter and soil filter the efficiency measurements of converting methane to CO_2 are shown in figure 2.

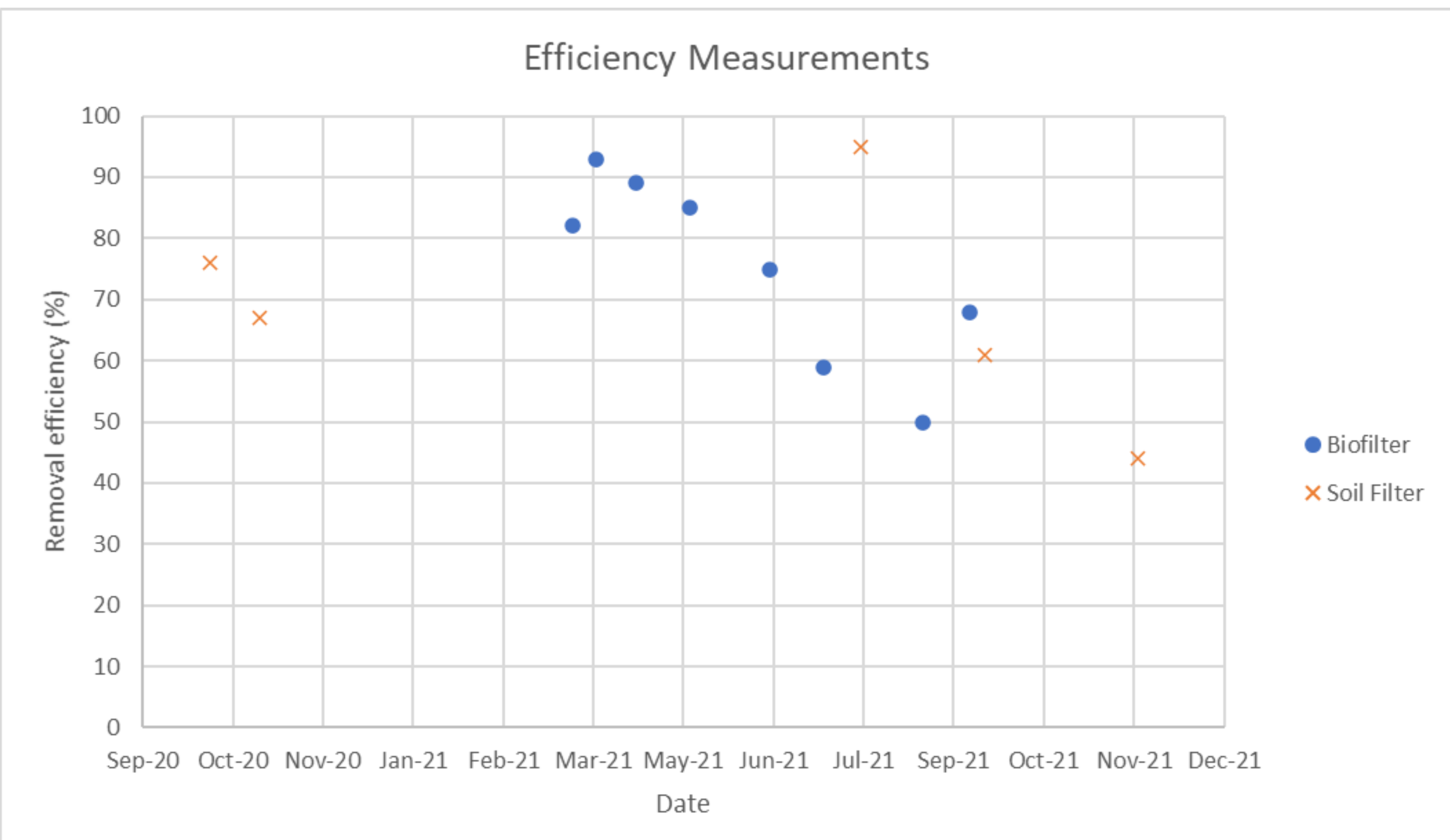

Figure 2. Removal efficiency measurements of CH_4 for the biofilter and soil filter.

Costs analysis

To compare the efficiency of the techniques a methane production model for manure based on Sommer (2004) was coupled with a costs analysis for each pilot for an average Dutch diary farm (table 1).

Table 1. Comparison of the total amount of methane converted into CO_2 and the costs per tonne of CO_2-eq prevented for an average dairy farm in the Netherlands: 100 dairy cows, 720 hours of grazing per year, a milk yield of 9000kg/animal and a GWP of 28 for methane. *The pilot was under dimensioned, in the costs analysis a higher efficiency is assumed based on experiences withe methane oxidation at landfills (Scheutz et al., 2009).

	Flare	Biofilter	Soil Filter*
Yearly converted methane (kg)	4200	3200	4000
Costs / Tonne CO2-eq	€ 14	€ 23	€ 8

Conclusions

- Flares, biofilters and soil filters are capable to convert methane from manure storages to CO_2 at practical farm locations.
- H_2S has to be removed from the methane flow for all three the methane oxidation techniques.
- A first costs analysis shows that the costs per avoided tonne of CO_2-equivalent range from € 8 - € 23 depending on the methane oxidation technique.

Literature

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Wageningen University & Research
Contact: Rik.Maasdam@wur.nl
T + 31 (0)317 489031
M +31 (0)6 34027440
https://www.wur.nl/en/Research-Results/Research-Institutes/livestock-research.htm

Schuttelaar & Partners
Contact:
Léon Jansen
leon.jansen@schuttelaar.nl
https://www.schuttelaar.nl/

LTO Noord
Contact:
Kees Kroes
kkroes@ltonoord.nl
https://www.ltonoord.nl/

OonKAY
Contact:
Hans Oonk
hans@oonkay.nl
http://www.oonkay.nl/