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Reinelt, T.; Clauss, T.; Hrad, M.; Scheutz, Charlotte

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“METHARMO” IS SETTING THE STANDARDS – JOINT EUROPEAN RESEARCH PROJECT DEVELOPS STANDARDS FOR DETERMINING METHANE EMISSIONS FROM ANAEROBIC DIGESTION PLANTS

T. REINELT*, T. CLAUSS*, M. HRAD° AND C. SCHEUTZ°°

** Biochemical Conversion Department, DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH, Torgauer Straße 116, 04347 Leipzig, Germany*
° Institute of Waste Management, University of Natural Resources and Life Sciences, Muthgasse 107/III, 1190 Vienna, Austria
°° Department of Environmental Engineering, Technical University of Denmark, Bygningstorvet, 2800 Kgs. Lyngby, Denmark

SUMMARY: The paper describes the current efforts to harmonize different approaches for the quantification of methane emissions from anaerobic digestion (AD) plants. There are different measurement methods based on on-site and remote sensing approaches established meanwhile in the scientific biogas community. However, these methods are not standardized to date. The transnational project “MetHarmo” was launched in early 2016 to close this gap. Within the project two comparative measurement campaigns with participation of different measurement teams and institutions were performed in 2016 and 2017 on German AD plants. These joint measurements are the base for the development of specifications for a standardized measurement procedure, which shall guarantee comparable measurement results from different institutions in the future.

1. INTRODUCTION

Within the biogas sector, the abatement of methane emissions from anaerobic digestion plants has become a very important issue for several years, because unwanted methane losses influence the environment and cause economic losses for the biogas plant operators. Suitable abatement measures as well as environmental and economic evaluation of the biogas technology require a precise and reliable determination of unintended methane emissions during plant operation. However, the quantification of the emission rates remains a challenge, since AD plants have different, heterogeneous and time variant emission sources (e.g. substrate storage, feeding system, digestate storage tanks, digester cover, gas utilization facilities, dewatering equipment etc.)

In the last years, several scientific studies applied different methods (on-site and remote sensing approaches) in order to quantify methane emissions from full-scale biogas plants or landfills (Daniel-Gromke et al., 2015; Flesch et al., 2011; Groth et al., 2015; Hrad et al., 2015; Liebetrau et al., 2013; Mønster et al., 2014; Reinelt et al., 2016, Reinelt et al., 2017,

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Westerkamp et al. 2014). While measurements performed on-site often focus on individual methane leakages and sources, remote sensing methods target the overall methane emission from the plant.

So far, the used methods are not standardized and harmonized, so that the results among the current available emission measurement techniques cannot be directly compared. Consequently, a harmonization of these methods to a common European standard would be highly appreciated by public authorities. Specifications for the determination of methane emission rates and the comparison of different measurement results as well as the representation of advantages and shortcomings from the measurement approaches and methods will form main parts of a harmonized standard. With start of the transnational project "MetHarmo - European harmonization of methods to quantify methane emissions from biogas plants" in March 2016, the necessary harmonization process was initiated. ERA-NET Bioenergy represented by the German, Austrian and Swedish project executing organizations (FNR, FFG and Swedish Energy Agency) funds the research project. The DBFZ coordinates and carries out the project in close collaboration with a group of transnational researchers from Germany, Austria, Sweden, Denmark, United Kingdom and Canada (ERA-NET Bioenergy, 2017).

2. METHODS FOR THE HARMONIZATION PROCESS

2.1 On-site approach

The on-site approach directly identifies and quantifies single methane emission leakages/sources, and determines their contribution to the overall emission rate from the AD plant (Daniel-Gromke et al., 2015; Liebetrau et al., 2013; Reinelt et al., 2016, Reinelt et al., 2017). Firstly, a survey of the plant is carried out with an infrared camera and/or a portable methane detector to identify all existing emission sources, both the unknown and known sources. The quantification of the different single emission sources needs each own suitable measurement methods, for example:

- "Quantification of methane emission rates from stationary sources with a conducted off-gas flow by standardized concentration and volume flow measurements.
- Quantification of methane emission rates by means of concentration and flow measurements in touch with dynamic chambers (ventilated wind tunnels) or High Volume Sampling.
- Quantification of methane diffusion rates from air-inflated double membrane layer roofs by means of concentration and flow measurements in the outlet of the inflation air.
- Quantification of methane emission rates from open digestate storages by means of dynamic or static chambers. The chamber measures a surface specific emission rate, which is extrapolated to the whole digestate surface area to calculate the emission rate from the whole storage tank.
- Quantification of methane emission rates from PRVs of biogas storages by means of permanent monitoring with explosion-proof measurement instrumentation." (Reinelt and Liebetrau, 2017)

Figure 1 shows the corresponding quantification methods in field operation. Eventually the on-site approach sums up the methane emission rates from all single sources to the overall emission rate from the investigated AD plant (Liebetrau et al., 2013). Since the on-site approach directly identifies emission weak points, it is a very important part for the implementation of abatement measures at an AD plant.

Figure 1. Single quantification methods of the on-site approach in field operation; from left to right: encapsulation and quantification of a leakage by means of an aerated windtunnel; permanent monitoring of pressure relief valves; right top: heated sampling at a conducted emission source (CHP off-gas); Chamber measurements at an open digestate storage tank with static and dynamic chambers (modified from Reinelt 2017).

2.2 Remote sensing approach

Remote sensing approaches include a number of different methods all aiming for quantification of the whole site emissions by sampling atmospheric methane concentrations at points upwind and downwind of the emission source (Flesch et al., 2011; Groth et al., 2015; Holmgren et al., 2015; Hrad et al., 2015; Mønster et al., 2014). The determination of whole site emissions enables the opportunity to include sources that might be missed by other methods (e.g. chamber methods) without affecting plant operation. This approach is very suitable for continuous measurements and monitoring of time-independent and/or operational emissions. However, remote sensing methods depend on transport processes in the atmosphere and are affected by conditions of atmospheric stability.

To date, there are three remote sensing methods applied in the biogas sector. The first and mostly used one is the Inverse Dispersion Modeling Method, which uses the measurement of atmospheric methane concentration with open path laser spectrometers as well as the measurement of the atmospheric conditions downwind of the AD plant. A mathematical model processes the data and calculates the emission rate from the investigated site. (Reinelt and Liebetrau 2017) Frequently, the freeware "Windtrax" is used (Flesch et al., 2011; Groth et al., 2015; Hrad et al., 2015; Westerkamp et al., 2015).

The Tracer Dispersion Method uses a controlled release of a specific tracer gas from the source area and concentration measurements of the tracer and the target gas (methane) downwind of the AD plant as well. Since the distance from the source area to the downwind measurement points can be very long, the very sensitive Cavity Ring Down Spectroscopy is applied for the concentration measurements. The method assumes that the released tracer gas disperses into the atmosphere likewise the emitted methane (Mønster et al., 2014).

A third remote sensing method is the so-called Differential Absorption Lidar (DIAL; Lidar…Light detection and Ranging), which was seldom used for the investigation of AD plants so far. In Wolf and Scherello (2013), a helicopter-based version had been already used on a German AD plant. In 2016, a ground-based version was used in the MetHarmo project (cf. section 3).

3. COMPARATIVE EMISSION MEASUREMENTS

An essential part of the project are two joint comparative measurement campaigns at two different German AD plants with participation of two (2nd campaign: three) on-site and five (2nd campaign: four) remote sensing teams. The on-site teams used infrared cameras and hand-held methane detectors for leakage detection while different methods were applied for the quantification of the single leakages (e.g. dynamic chamber method) (Liebetrau et al., 2013). Three remote sensing teams used the Inverse Dispersion Modeling Method (Flesch et al., 2011; Groth et al., 2015; Hrad et al., 2015) with open path laser spectrometers and a backward Lagrangian stochastic model. Another team applied the Tracer Gas Dispersion Method (Mønster et al., 2014), which combines controlled tracer gas release (acetylene) from the source area with time-resolved measurements of downwind concentrations of both tracer and the gas of interest (methane) at the same location. The last remote sensing team used a DIAL method (Robinson et al., 2011), which was used as a reference method, which is usually not applied for the measurement of methane emission from AD plants. The measurement campaigns are the base for the development of specifications for a standardized measurement procedure, which shall guarantee comparable measurement results from different institutions in the future.

During the first measurement campaign performed in October 2016, the different methods were applied side by side to simultaneously identify the emissions from a German AD plant. Although the different measurement approaches resulted in determined emission factors of the same order of magnitude (between 0.2 % - 1.2 % CH_4-loss), the reasons for the deviations still have to be clarified. In the second measurement campaign performed in May 2017, the first harmonized proceedings were applied and the differences between the different methods should be quantified more accurately, so that recommendations for a preferably accurate and harmonized determination of emission factors can be declared.

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