METHANE DETECTION AT THE SURFACE OF LANDFILL SITES AND BIOGAS PLANTS

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SUMMARY: Comparison of different methods, equipment of methane detection systems to detect emissions and to double-check gas emissions and leak tightness. Employment of FID systems, cameras, IR laser, and various devices from different companies.

Index (key) words: landfill gas, biogas, optimisation, gas collection system, FID, surface emission, extraction system, gas wells, manifold stations, IR camera, IR laser, RMLD technique, detection systems for methane, measurements on landfill sites, optimising LFG system, leckage of pipes, fermenter, Biogasplants, Remote Methane Leak Detector, Gas Surveying, Leak Detection, Landfill Cap Survey, Flame Ionization

1. INTRODUCTION

In addition to the monitoring of the collected amount of gas and its composition, regular efficiency monitoring of the landfill degasification at the landfill surfaces and at gas levels/gas wells in the vicinity of the landfill through measurements with a flame ionisation detector (FID), or through other equivalent methods, is of decisive importance in the measurement and monitoring programme, in order to implement optimum cost-effective landfill degasification and the reduction of the greenhouse effect (landfill gas emissions via the landfill surface) as is stipulated in the respective legal provisions.
These so-called "FID inspections" (double-check of surface emissions) may require several days,

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depending on the landfill cubature, vegetation, and floor area of a landfill, and on the screen definition, measuring-point density, measuring method, and employment of staff. The findings resulting from such efficiency monitoring range from theoretical emission forecasts in cubic metres of methane per hour, determined by means of empirical formulas, to practical advice, such as the adjustment of individual gas wells, or the replacement of the latter; meaning that this is the essential basic determination for the optimisation of the gas collection system.

Landfills usually have a horizontal or vertical gas collection system, with which the landfill or sectors are actively extracted (degasified) via individual gas wells. For this purpose, a vacuum (underpressure) is created using gas compressors, by means of which the landfill gas is finally supplied to the gas consumers via the gas wells, gas manifold stations, and the connecting pipes. As a result of later declining amounts of landfill gas and the real constructive design of the components of the gas collection system, the regular measurements are required for monitoring, in order to adapt these components at a later moment (number, dimensionings etc.). In order to upgrade these gas collection systems at a later date, the quantitative determination of the individual gas wells up to the gas collection stations is of utmost importance, in addition to the gas composition. Besides the functional check of the gas wells and gas well ducts (e.g. double checks for shearing, blockings, leachate build-up, and water pockets in the connecting pipes), the adjustment of the control paths / measuring sections in the gas manifold stations is required.

2. METHANE DETECTION ON LANDFILLS

In addition to the conventional efficiency monitoring via methane / emission measurements by means of FID, equivalent state-of-the-art methods can be used for the detection (BAT – best available technology). The check is implemented via so-called "surface inspections", where the released methane is collected and measured via a suction bell (cup) or an IR laser.
During the surface check, the suction bell (cup) of the FID is mainly carried at ground level in order to determine further emission sources between the individual measuring points. In addition to the optical criteria, for example changes that occur in the vegetation, the selection of the representative measuring points are also primarily conditional on the aforementioned boundary parameters (grid e.g. 25 m * 25 m and the number). The expressiveness of the entire efficiency monitoring, therefore, primarily depends on the measuring position. In this respect, a few cm on the surface can make a difference of 0 ppm or more than 1,000 ppm.
In order to minimise this systematic error, countless measuring points would be needed. However, this is not desirable for cost-benefit reasons.
Besides the aforementioned measuring methods (conventional FID and selective semiconductor), DAS - IB GmbH currently applies an optical method for the methane measurement which is called RMLD (Remote Methane Leak Detector). The instrumental structure of the RMLD is presented in the following illustration.

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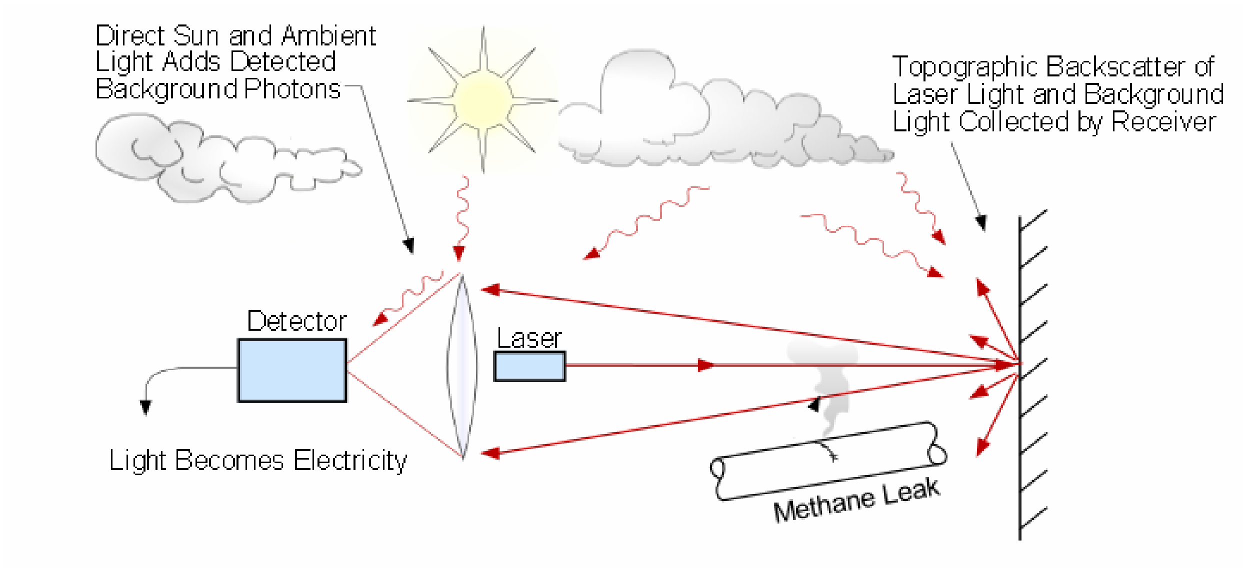

Figure 1: Schematic structure of the RMLD Measurement [operating instructions, Hermann Sewerin GmbH] translation into English by DAS – IB GmbH

Here, the surface is "scanned" via the infrared ray. When the IR ray of the RMLD penetrates a methane cloud, an acoustic signal is released. The concentration can be concluded from the indicated numerical value in ppm-m.
The advantages of the RMLD measuring method are, in addition to the fast sample recovery from large areas and the connected target-oriented determination of methane emissions, also the uninfluenced sampling (e.g. by means of measuring gas pumps).
Besides the comparatively high investment costs, the disadvantage here is that, subsequent to the fast and flat methane determination, a conventional concentration determination needs to be implemented using one of the aforementioned measuring methods. This, however, will be carried out in a targeted manner directly at the emission source.
The manipulation through existing vegetation is currently being tested at different landfill sites, and the results will be presented in Sardinia.

The first practical experience was gained in May 2012; amongst others in Vilnius (Lithuania) and Germany. As is shown in the following pictures, detections regarding methane emissions took place despite the waist-high vegetal cover within a radius of up to 25 m on the slope and in the plain of the surface.

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Figure 1: Measurable surface emissions with changes in the vegetation

Figure 2: Fast methane detection, also on the roadways

In addition to this "new" measuring method, DAS-IB GmbH already implemented a comparison between the conventional FID measurement and a selective semiconductor in 2009. Ever since, it was shown in numerous practical measurements that a selective semiconductor – due to its measurement free from fuel gas and the lower purchase, operating and maintenance costs – represents an equivalent measuring method to the conventional FID measurement. The disadvantages of selective semiconductors are the cross sensitivities, e.g. to hydrogen and humidity (avoidance through the corresponding measurement set-up / sets).

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Figures 4 and 5: Surface emissions and double-check at the manifold station, Kazokrakes landfill site (Lithuania, Vilnius)

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Figure 6: Surface emissions Morocco – Tangier landfill site

3. BIOGAS APPLICATIONS AND IN GENERAL

What type of measuring device with which measuring principle do you use for the methane detection at your biogas plant?
What about cross sensitivities and sensor poison?
Is your measuring device cross-sensitive to H2S or air humidity or even sensitive to pressure fluctuations?
From our own experience and from the findings of our safety-related checks, we can state that partially absolutely unsuitable measuring devices are sold and used for the methane detection at biogas plants.

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Figure 7: Not in this way! Operator protection / personal security measuring device for the leak test – but the plant is leaky!

What do you, as the user (operator), need to observe?
First, you need to ask yourself in which milieu you want to detect any possible methane emissions. Which accompanying gases do I have to reckon with – and how humid is the gas? Do I have to anticipate air pressure variations or pressure impulses?

What do you need to know as the operator?
Every measuring principle has its advantages and disadvantages. With the decided knowledge regarding the employment conditions and the advantages and disadvantages, the optimum measuring principle and device for your application can be determined.
The heat of reaction measuring principle (heat tone / heat of reaction) is particularly suitable for the detection of inflammable vapours and gases. Here, two ceramic pearls are exposed to the gas into which platinum coils that are heated to approximately 450°C are embedded. One of the two pearls, the so-called pellistor, is manufactured out of a catalytically acting material, that oxidises (burns) at a temperature that is defined by the operating current, thereby causing an increase in the temperature. The latter can be measured through the resistance change of the embedded platinum coils in comparison to the non-active pellistor. It is proportional to the gas concentration in the range between 0 and 100 vol.-%.
The heat conduction principle (conduction of heat / thermal conduction) is based on the different heat conductivity of gases and vapours. Two sensors are in a WL transmitter and they are both catalytically inactive. The sensor elements are interconnected in a Wheatstone bridge. Gas is admitted to the detector-sensor, the compensation sensor is in a closed room that is filled with air, into which no measuring gas can enter. If, from the signal sensor, heat is abducted through a

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measuring gas as a consequence of its higher or lower heat conductivity compared to air, the temperature will change and with it the resistance of the platinum filament. Tension will then become measurable at the Wheatstone bridge. The reference sensor ensures that the change in the temperature of the signal sensor was caused by the measuring gas, and not by other influences, such as a change in the ambient temperature.

The laser absorption spectroscopy (Ill. 1,4, 8 - 12) is a method for the detection of methane, where an invisible laser is used which, when passing a methane gas cloud, is partially absorbed by the methane so that the concentration can be measured.

From practice:

Figure 8: Leak measurement using the semi-conductor technology (not FID) at the one-foil roof of a biogas plant fermenter (gasholder)

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Figure 9: Leak check at the roof of the inflatable structure of a biogas plant

Figure 10: Leak test at random in a biogas plant

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Figure 11: Methane detection at an MBT

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Figure 12: Leak detection at a gas tank

Figure 13: Methane detection at the technical plants and gas pipes of an MBT

Figure 14: Methane emissions in a valve unit of a raw / crude gas analysis device of a biogas

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plant

Figure 15: "Bottle test" at leak measuring devices for the determination of pressure and cross sensitivities

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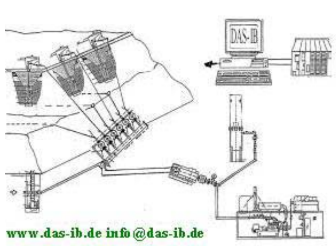

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