LANDFILL GAS (LFG) FUGITIVE EMISSIONS ON LANDFILL SURFACE - COMPARATIVE TEST OF ON SITE ANALYSIS DEVICES

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Background

Fugitive emissions through landfill top liners consist mainly of methane and carbon dioxide. These gases entail direct and indirect greenhouse effect and contribute to contamination of the atmosphere. Methane emissions are energy and heat reducers as it escapes to the atmosphere prior to valorisation and then cause a cut in exploitation efficiency. This is why it is necessary to survey periodically methane emissions at landfill surfaces.

As regards on site measurements of biogases concentration in such emissions, it's a challenge for devices manufacturers to provide a good compromise between output linearity, detection limit, reliability, exactness and flexibility in use.

For 10 years, ISSeP is controlling the gaseous and liquid emissions of several landfills in Wallonia. Within this framework, flame ionisation detector (FID) is used for methane emission detection and localisation in landfill capping system. Used portable devices (PORTAFID M2 and M3K) give semi-quantitative measurements of methane concentration within the range of 0-10 000 ppm. Such technical performances only allow distinguishing zones with significant degasification from those producing negligible emissions. Within the zones with strong release (> 10 000 ppm), the intensity of emission remains unknown. In addition, portable FID works on CH_4 exclusively, without providing any information on the other components of biogas (CO_2, Hydrocarbons and O_2).

The objective of the present research is to test another type of portable gas analyser, based on PID and IR technologies and to compare its performances with FID devices for analysing landfill biogas emission.

Materials and methodology

The main component embedded in the new device tested, is a multi-channel IR-probe. It has been developed with the main vocation of detecting and characterizing soils contaminated with any hydrocarbons. Its theoretical performances in CH_4 detection should be better than FID by giving a response in a 50-500.000 ppm range (according to manufacturer's technical chart). Furthermore, it offers simultaneous measurement of temperature, CO_2 (IR probe) and O_2 (paramagnetic probe) and should be able to detect ionisable hydrocarbons (PID probe). In other words, announced performances of tested device should let it able to supplant definitively FID detectors.

The tests aims at validating CH_4 concentrations measured with IR-detector by comparing them with measurement achieved with other devices:

- Range 0-1 000 ppm: PORTAFID M2/M3K, Static FID HC51M (Environnement S.A.);
- Range 1 000 ppm-1 %: PORTAFID M2/M3K;
- Range 1-50 %: CH_4 IR field-analyser GA2000 (Geotechnical Instruments Ltd).

The comparative study has been carried out with three series of gas samples:

- The first batch is obtained by diluting a 50 % methane/air etalon gas at various ratios.
- The second series results of a similar dilution protocol using a landfill biogas.
- The samples of the third series have been taken directly on the surface of a capped landfill cell by volumetric pump connected with the sampling cane of FID apparatus.

Objectives of the two first batches is to compare the exactness and signal linearity of each device, first on "methane alone" samples, then with the interaction of others landfill-gas components. The third batch aim at comparing devices in "real using conditions" of landfill surface emissions.

Results and discussions

Results show that tested portable methane analysers are better than binary detectors: they provide output values proportional to real CH_4 concentrations in the air. However, the measuring precision depends on many parameters, varying from one to another device and-or sampling methods. External factors as weather conditions or spatial uncertainty of landfill surface emission areas can be significant. Comparing performances between several detectors is really not easy, especially when the working range is wide.

The IR-PID probe comprises many advantages compared with FID devices:

- Wider working range for CH_4 measurements (upper limit up to 50 time higher than FID);
- Very good linearity and measuring precision in this range;

- Wider spectrum of gas components (CH_4, CO_2, O_2, T°).

Moreover, the IR-probe is easy to use on field; it can be scheduled for automatic monitoring during long time period; their output data are stored on a dischargeable electronic memory; and, according to the manufacturer, it is insensible to humidity and flow variations.

Nevertheless, the measured detection limit reached 200 and 300 ppm for methane concentration, which is far from the announced 50 ppm value. It could be due to the calibration system. Standard version of the IR-probe is optimised for analysing a wide range of gas components met in soil contamination problems. This optimisation deteriorates the detection limit when measuring CH_4 in landfill biogases; CH_4 which is the prevailing component.

PID detector seems to be useless in the particular case of volatiles organic compounds (VOCs) measurement in landfill biogas. It is probably due to "quenching effect" (masking of VOCs caused by the high concentrations of methane in gas).

Conclusion and further investigations

Three tests sequences have been performed on gas samples to compare the performances of portable CH4 analysers. The results show that classical devices (FID and mono channel IR-probe (GA2000)) are totally unable to cover the full useful range of CH_4 concentrations encountered in biogaz surface emissions (from 50 to 30 000 ppm).

The new IR-MP technology tested, which combine multiple detectors with multichannel IR-analyser has been developed for many years with the objective of becoming able to detect a very large spectrum of hydrocarbon contaminants. This development has been achieved to the detriment of its initial CH4 sensitivity. Its apparent CH_4 detection limit varies from 4 to 10 times the announced 50 ppm value. It implies that IR-MP can not replace FID device.

Anyway, IR-MP device presents a lot of advantage that are explained above giving to this device a real added value for research teams, landfill owners and authorities implied in the characterisation and semi-quantification of landfill surface fugitive emissions. Further investigations and test are already in hand including:

- testing IR-MP on its announced insensitiveness to gas moisture;
- development of on-field gas dilution coupled to FID device;
- modifying the signal treatment software of the IR-MP technology and going back to a less multi-component but more CH_4-sensible version;
- in collaboration with INERIS research team, the test of these devices coupled with flux chambers on various landfills of the wallonian control network.