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METHODS FOR DETECTION OF GAS LEAKAGES DURING EXTRACTION, TRANSMISSION AND STORAGE OF NATURAL GAS

(Draft consolidated report prepared by the Government of the Netherlands)

INTRODUCTION

1. This study was conducted in the framework of the interrelationship between gas and climate change. The combustion of natural gas generates less carbon dioxide (CO_2) per unit of energy produced than coal or heating oil. However, as natural gas is constituted primarily of methane, which is a potential greenhouse gas, a reduction of emissions from natural gas operations will contribute to the reduction of global warming. The growing consumption of natural gas on a worldwide scale will make this effort even more worthwhile. Next to this a reduction of methane losses will reduce the operating costs for the gas operating companies.

2. To find out what kind of methods are used by the different sections of gas industry for the detection and quantification of methane leakages, a questionnaire was prepared and approved by the Meetings of Experts on the Use and Distribution and on the Transport and Storage of Gas and was later circulated to member States (ENERGY/WP.3/GE.3/R.16/Add.1).

METHODS

3. The methods mentioned in the questionnaire are derived from technical literature and the experience of the Dutch gas transmission company Gasunie and GASTEC, the Dutch gas centre for distribution technology. In particular the questionnaire asked for any other methods applied.

4. The following methods for detection of methane leakages or emissions are included:

- Visual inspection: a regular inspection of the pipeline system for leakages, on foot, by vehicle or by helicopter or aeroplane.
- F.I.D.: detection of small concentrations of methane (0-10,000 PPM) in a sampled gas/air mixture by flame ionisation. Instruments based on this method are suitable for portable use.
- S.C.D.: a gas leakage detection method with a high sensitivity for very small concentrations of methane (and other combustible gases) 0-1000 PPM, based on measuring the change in electrical resistance in a semi-conductor sensor. No absolute concentrations can be measured by this method.
- T.C.D.: a detection method based on thermal conductivity for measuring higher concentrations of methane (0-100 Vol.%). This method is sensitive to interference by carbon dioxide.
- I.R.D.: a method based on measuring the change in Infrared adsorption of gases with an optical gas sensor.
- T.D.L. spectrometer: a simulation method as above but a tunable diode laser is used as a light source. Both methods measure traces of gas and instruments are normally of the stationary type, however based on I.R detection techniques vehicle leak survey systems are developed.
- P.A. detection: a photo acoustic method combined with laser radiation for analysing the composition of gases, but also for measuring low concentrations of gases.
- Catalytic detectors: a method based on catalytic sensors, particularly suitable for measuring in the lower volume ranges of 0-5 vol.% methane.
- E.C.D.: a simulation method, based on electrochemical sensors, often used for toxic gases (carbon monoxide), not so much for methane.
- Tracer gas: an easily detected tracer gas (could be an odorant) is injected into the system. This method is also frequently used to estimate the emission rate of equipment leaks.

5. For the quantification of methane leakages or emissions the following methods were included in the questionnaire.

- Calculation of the actual process flow balance: performance of a detailed mass balance on a system or part of a system by examining the differences in upstream and downstream meter readings.
- computer process simulation: by applying typical emission factors for types of equipment and components in a computer simulation of a process, an estimation of methane emissions can be calculated.
- emission factors for standard equipment: for a large number of components, such as compressors, control valves, meters and pieces of equipment, for example M&R stations, glycol dehydrators and heaters, average methane leaking rates have been calculated or measured.
- methane dispersion models: for large emissions detected by air with infrared photography or by a high stack sampler, comparison with methane dispersion models can give an indication of the leakage rate.
- pressure decay test in isolated part of the pipeline system: part of the system is isolated and repressurized. The volumetric flow needed to maintain the normal operating pressure is equal to the leak rate.

RESULTS

6. Replies to the questionnaire were received from eleven countries: Algeria, Austria, Croatia, Denmark, France, Netherlands, Russian Federation, Slovenia, Slovakia, Spain and Turkey. In the tables, which summarize the results, the following abbreviations are used:

Algeria: ALG
Austria: A
Croatia: HG
Denmark: DK
France: F
Netherlands: NL
Russian Federation: RUS
Slovenia: SLO
Slovakia: SK
Spain: E
Turkey: TR

Table 1: Methods for methane detection

Type of method	Sections of Gas Industry			
	extraction	transmission	storage	distribution
Visual inspection: - foot	SK, HR, TR, RUS, A	SLO, NL, ALG, E, HR, A, SK, DK, F, RUS	E, A, SLO, F, RUS	HR, NL, E, A, SLO, DK, RUS
- vehicle	HR, TR, A, RUS	HR, NL, ALG, E, A, SLO, F, RUS	A, RUS	E, A, SK, DK, RUS
- by air		NL, ALG (inc.), E, F, A, SK (inc.), DK		
F.I.D. (Flame Ionisation Detection)	A, NL	SLO, E, A, SK, DK, RUS (inc.)	A	HR, NL, E, A, SLO, DK, F
Semi Conductor detection		RUS (inc.)		NL
T.C.D. (Thermal Conductivity Detection)	A, Nl	HR, TR (inc.), A, DK, F	E, A	HR, NL, TR (inc.), A, DK, F
I.R. detection				
Tunable Diode Laser Spectrometer	NL	RUS (inc.)		
Photo acoustic detection		DK		DK
Catalytic detectors	SK.	SLO, ALG, F, TR (inc.), SK, DK	E, SK	NL, F, TR (inc.), SK, DK
Electro Chemical detectors	HR, RUS (inc.)	HR, SK, RUS (inc.)	RUS (inc.)	HR, NL, SK, RUS (inc.)
Tracer gas method	A (inc.)	SLO (inc.), F (inc.)		NL (inc.)

Table 2: Methods of quantification of methane leakage

Methods	Sections of Gas Industry			
	extraction	transmission	storage	distribution
Calculation of actual process flow balance	HR, TR, A, RUS, NL	SK, HR, NL, ALG, E, A, SLO, DK, RUS	HR, E, A, RUS	HR, E, SLO, A, SK, DK, F (inc.), RUS
Computer process simulation	NL.	SLO, NL, E, TR, A, SK, DK, F	A	TR, DK.
Emission factors for standard equipment	HR, A, RUS, NL	SLO, A, SK, F, RUS	HR, A, RUS	NL, RUS
By appliance of methane dispersion models	A, RUS	A, RUS	E, A, RUS	RUS
Via pressure decay tests in isolated part of distribution system (British Gas method)	RUS, NL (inc.)	SLO, RUS	RUS	NL, SLO, RUS

CONCLUSIONS

Detection

- for detection of methane leakages visual inspection, in particular in the transmission sector, is most widely used in all sectors of the gas industry
- next to visual inspection the F.I.D. method which will detect traces of gas (10-20 PPM) is widely applied
- remarkably the Semi-Conductor method, which is cheaper and also suitable for the range of 10-20 PPM, is rarely used
- catalytic detectors for detection of all combustible gases at higher concentrations (percentages) are used only by some countries
- more expensive methods, such as I.R. detection and tunable diode laser spectrography, which will be used for stationary purposes, are not yet or rarely applied
- in the extraction section of the gas industry in the Netherlands a methane sniffing dog is successfully used.

Quantification

- for quantification the calculation of the actual process flow and the appliance of emission factors for standard equipment parts is applied in all sectors
- the use of computer process simulation is almost restricted to the transmission sector.