

Quantification of methane emissions in the exploration and production of natural gas and petroleum in The Netherlands

Hans Oonk¹ and Mariëlle Vosbeek²

¹ TNO-ME, P.O. Box 342, 7300 AH Apeldoorn, The Netherlands

² KEMA Nederland B.V., P.O. Box 9035, 6800 ET Arnhem, The Netherlands

Abstract

Methane emissions from the oil and gas industry contribute significantly to the total methane emissions. For this reason, methane emissions from this sector are further quantified for The Netherlands. This quantification, based on both a detailed engineering study and on measurements, indicates Dutch methane emissions to be about 30 to 50 ktonne higher than previously expected. The main reason for this difference is, that in this quantification emissions during exploitation and fugitive and incidental emissions are incorporated, whereas they have been neglected earlier.

1. INTRODUCTION

The exploration and production of natural gas and oil belong to the major sources of methane emissions. The magnitude of these emissions is still considerably uncertain, both world wide and in The Netherlands. Various estimates of methane emissions have been made by both government (Nielen, 1991; Elzenga en Smit, 1993) and the producing industry (in Elzenga and Smit, 1993; NAM, 1993). As indicated in table 1 results differ significantly. In these studies however several sources were not included such as possible emissions in the exploration phase, during drilling and well tests. Neither have fugitive and incidental emissions during exploitation been considered, such as those incurred during maintenance or as a consequence of accidents.

The interest of formulating a climate change policy requires more and better information on methane emissions due to oil and gas production because it may affect future use. This information includes a better quantification as well as an identification of opportunities for emission reductions. A joint project of TNO-ME and KEMA has the objective to provide this information.

Table 1 Quantification of methane emissions in the oil and natural gas production (in ktonne/y)

Year	Government	Industry	Industry
	1989	1990	1992
Total onshore		14	15
Total offshore		69	99
Total gas prodn.	40 - 70		
Total oil prodn.	1 - 35		
Total sector	41 -105	83	114

2. METHODOLOGY

The methodology used in this study is designed to meet the nature of methane emissions of oil and gas productions. These methane emissions can be divided into three types:

1. continuous emissions due to leakages of systems used and from off-gases of various gas treatment installations
2. operational emissions due to periodic tests and maintenance of installations
3. incidental emissions due to failures of devices.

The continuous emissions are best quantified in an engineering study; information on periodic emissions can be given as well, although less accurate. The quantification of operational and incidental emissions will mainly come from a combination of measurements and dispersion modelling. This method is less suited for estimating continuous emissions.

3. ENGINEERING STUDY

In an engineering study all possible sources in the production process are identified and for every single source emissions are quantified. Due to the heterogeneity of emission sources a variety of methods is used, for example:

- emission factors along with material and energy balances are used for estimating fugitive emissions during exploration
- maintenance and test procedures are used to assess operational emissions
- process simulations are used to calculate emissions from specific process-equipment, e.g. from glycol dehydrators.

Table 2 shows the sources and relative source strengths of methane emissions in the oil and natural gas exploration and production. Because this estimate is not completed yet, the individual source strengths are only given indicatively.

Table 2 Sources of methane emissions in the oil and natural gas exploration and production

Sources	Strength ¹⁾
<i>during exploration</i>	minor
- drilling	moderate/major
- well-tests	
<i>emissions during exploitation of natural gas</i>	
<i>* continuous</i>	
- vents	major
- flares	moderate
- exhaust gases of turbines	minor
- exhaust gases of reciprocating engines	moderate
- exhaust gases of furnaces	minor
- chronic leaks in production	major
- chronic leaks in gathering and transport	minor
- glycol dehydration	major
- treatment of formation water	moderate
- use of pneumatic devices	minor/moderate
- condensate treatment	moderate
- condensate storage	minor
- purge gas from venting systems	moderate
<i>* non-continuous</i>	
- maintenance in production	minor
- maintenance of gathering and transport pipelines	minor
- non-exhaust engine emissions	moderate
- incidents and accidents in production	moderate
- incidents and accidents pipelines	minor
<i>emissions due to exploration of oil</i>	
<i>* continuous</i>	
- flaring of associated gas	minor
- exhaust gases of reciprocating engines	minor
- treatment of production water	minor
<i>* non-continuous</i>	
- non-exhaust engine emissions	minor
<i>abandoned phase</i>	
- chronic leaks from abandoned wells	none

¹⁾ minor: < 2 ktonne/y; moderate: 2 - 10 ktonne/y; major: 10 - 100 ktonne/y

Vents are the largest source of methane from the oil and gas industry in The Netherlands. Off-shore venting is common practice, while onshore most of the methane containing streams are flared. For this reason, most of the Dutch emissions from the industry occur off-shore. Other major sources of methane are glycol dehydrators, chronic leakages and maybe the testing of wells. The latter two sources are not incorporated in the emission inventories, as given in table 1. As a result of this, the result of this new emission estimate will be about 30 to 50 ktonne higher than the estimates in table 1.

It is not a simple matter to compare emissions in The Netherlands with those reported abroad. Partly because the quantifications are not equally detailed and partly because regional circumstances make any comparison difficult. With this proviso, one can conclude from Table 3 that the relative methane emissions from oil and gas production in The Netherlands are comparable with emissions in other countries of Northwestern Europe. The emissions per cubic meter of gas produced are somewhat higher in the United States, while the emission situation in the former Soviet Union is far worse.

Table 3 Emission factors (in percentage of production)

Netherlands onshore	0.03 - 0.05
Netherlands offshore	0.6 - 1.0
Netherlands total	0.15 - 0.25
Western Europe	0.15 - 0.3
United States	0.2 - 0.3
Former USSR	approx. 2

4. MEASUREMENTS

Since July 1991 methane is measured in Kollumerwaard, located to the north-west of the Groningen gas field. The background concentration is around 1.8 and 2.0 ppm methane, depending on season and wind direction (KEMA, 1993a, b; KEMA, 1994a). South-easterly winds bring on average the highest methane concentrations to the measuring site due to sources in a large part of the European continent. Once or twice a month elevated methane concentrations are measured at Kollumerwaard, most likely due to anthropogenic emissions of methane probably from onshore natural gas production activities.

Mobile measurements were carried out to support the continuous measurements in Kollumerwaard. Three campaigns were carried out, each covering one day. The campaigns were performed around the Groningen gas field and consisted of several natural gas production locations and several exploration locations. During all three campaigns no elevated methane concentrations were measured. Under normal circumstances it is not possible to measure elevated methane concentrations near production or exploration locations.

Estimates of methane emissions, using the continuous measurements in Kollumerwaard from July 1991 until December 1993, were made in the following way:

- screening methane concentrations for events with elevated concentrations
- rejection of extreme events due to meteorological conditions
- identification of production locations possibly causing the events
- identification of exploration locations possibly causing the events
- estimation of amounts of methane emitted with dispersion calculations.

The applied method resulted in an average estimate of incidental methane emission for an exploration location (127 tonne methane per year) and for a production site (225 tonnen of methane per year) for the year 1991. Taking into account the total of exploration and production locations active in 1991 in The Netherlands, this results in an estimate of the total incidental CH₄-emissions during onshore exploration and production activities in 1991 of 7.8 ktonne CH₄. This estimate still has to be considered with great care.

A comparison is needed with previous published emission data from the industry (see table 1). For this purpose it was assumed that the elevated methane concentrations, measured in Kollumerwaard, are caused by onshore natural gas production activities. This assumption seems to be valid, since the off-shore facilities are located far away on the continental shelf. The calculated emission of 7.8 ktonne methane is 55% of the published on-shore emission. A comparison between the calculated emission and the emission, as obtained in the engineering study (table 2) was also made. The order of magnitude of both estimates is about the same.

5. CONCLUSIONS

Methane emissions from the Dutch oil and gas industry are quantified both in an engineering study and by interpreting methane concentration measurements, using dispersion models. The engineering-study proves to be the most convenient way to quantify the continuous emissions, where a good indication of incidental emissions may be obtained from monitoring measurements.

National emissions are probably about 30 to 50 ktonne higher than estimated before. The main reason for this is, that several significant sources, e.g. emissions in the exploration phase, fugitive emissions, were neglected in previous inventarisations.

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