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**TNO-report**

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**Comparison of OSPAR analytical methods for the  
determination of dispersed oil in produced water**

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## Summary

The aim of the study, of which the results are described in this report, was to compare dispersed oil concentrations as analysed with the GC-FID method (ISO 9377-2 mod) with the result of analyses carried out with the 'old' IR method. The ultimate aim of this comparison is to identify whether:

- these methods produce comparable results;
- GC-FID provides a correct indication of the dispersed oil concentration.

For this comparison, produced water samples were collected at 58 production platforms in the UK, Norway, Denmark, Germany and the Netherlands which were analysed at four different laboratories. A ring-test was carried out in order to determine the reproducibility of the reported concentrations and the accuracy of GC-FID for dispersed oil analysis.

From the results of the ring-test it can be concluded that there are significant differences between the concentrations reported by the four laboratories included in the study. As these differences are inconsistent between the laboratories, further standardisation of the analysis of oil in water using ISO 9377-2 (or modified) appears necessary (e.g., calibration routines). Furthermore, these differences may influence the outcome of the current study, as there was no correction for the differences in reported concentrations.

At 23 out of the 47 platforms in the analysis programme (where replicate samples were taken), significant differences were observed between the dispersed oil concentrations analysed using IR and using ISO 9377-2 (mod). Comparing IR with ISO 9377-2 in the overall dataset, the two methods produce again significant different results. In general, a difference of 50% between IR and GC-FID at a dispersed oil level of 5 mg/l and a difference of 20% at a level of 30 mg/l could be detected at a significant level. These results confirm the assumption that the two fundamentally different approaches also produce different results.

When quantifying the difference between IR and ISO 9377-2, a correction could be made for the absolute value of the measured concentrations. Therefore, the difference is quantified as the IR/GC ratio. Using the analysis results of the standard GC-FID method (ISO 9377-2) the IR/GC ratio is 1.64 and 1.78 for respectively oil and gas platforms. Using the results of the modified GC-FID method (ISO 9377-2 mod) the IR/GC ratio for oil and gas platforms is respectively 1.45 and 1.17. This ratio is independent of factors such as the absolute produced water volumes and the dispersed oil concentration. The differences between labs as found in the ring-test was also visible from the comparison study as the IR/GC ratio was significantly higher for the results produced by the laboratory from the UK compared to the Dutch laboratory.

The final conclusion of this study is that there is a significant difference between dispersed oil concentrations measured with IR or with ISO 9377-2 mod, where the concentrations reported after analysis with IR are in general approximately 1.3 times higher (1.7 when compared with the standard ISO 9377-2). Furthermore, knowing from the ring-test that ISO 9377-2 produced dispersed oil concentrations close to the known sample concentrations, it can be concluded that ISO 9377-2 provides a better estimate of the dispersed oil concentration than IR. This indicates the need for further standardisation of the procedures for carrying out the ISO 9377-2 (mod) method. Changing the reference method from IR to ISO 9377-2 might have implications for the reporting of loads and concentrations in order to relate them to performance standards.

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## 1. Introduction

### 1.1 Background

In OSPAR Recommendation 2001/1 the specified method for the analysis of oil in produced water, Infrared (IR) spectrophotometry, is described as reference method for the determination of dispersed oil in produced water. The IR analysis method uses Freon 113 or tetrachloroethene (TCE) as extraction liquid (ref. OSPAR Agreement 1997-16). However, the production and use of Freon 113 is being banned, because of its effects on climate change. The use of TCE is limited in some OSPAR countries, because of its potential carcinogenic properties. Therefore, OSPAR decided that a new reference method for the analysis of dispersed oil in produced water should be developed.

During a workshop (Voorburg, The Netherlands, October 2001) gas chromatography with flame ionization detection (GC-FID; ISO 9377-2) was proposed as new reference method. However, this method does not determine hydrocarbons with boiling points lower than 125°C (=C<sub>10</sub>H<sub>22</sub>, n-decane), which can lead to an underestimation of the dispersed oil content in produced water from gas, condensate and light oil producing platforms of which a major part of the hydrocarbons in produced water consists of volatile hydrocarbons. Therefore, a modification on the ISO 9377-2 was proposed, integrating the gas chromatogram from the peak of n-heptane (=C<sub>7</sub>H<sub>16</sub>) instead of from the peak of n-decane and subtracting the volatile aromatics TEX (toluene, ethylbenzene and xylenes) which are assumed not to form part of the dispersed oil content.

The development of the suggested method of analysis was triggered by a comparison program that was run in Norway (OLF). In this program, the GC-FID (ISO 9377-2) method of analysis was compared to the IR-Freon 113 method, by using data on analysis of 34 Norwegian offshore platform samples (OLF, 2001). From this comparison study, based on relatively few samples, it appeared that the GC-FID method provided promising results.

In 2001-2002 a programme for the comparison of the current reference method with the modified ISO 9377-2 method (integrating the gas chromatogram from the peak of n-heptane and subtracting TEX) was conducted in the Netherlands. The results of that program indicated that especially for gas platforms, integrating from C7 excluding TEX would lead to more comparable results.

During the OSPAR Offshore Industry Committee (OIC) meeting in 2002 (Cadiz, Spain), the Contracting Parties agreed to carry out a program for the comparison of a new analytical method (GC-FID) with the current reference method (IR). Contracting Parties agreed to carry out this program based on results from the preliminary comparison program that was run in the Netherlands.

A new comparison study was proposed based on a statistical analysis (Karman & Smit, 2002) leading to samples with higher replication from more offshore installations that operate under the jurisdiction of various Contracting Parties (The Netherlands, Germany, Denmark, Norway and the UK).

## 1.2 Description of the analytical methods

The current OSPAR reference method for the determination of the content of dispersed oil in produced water is based on infrared spectrophotometry. The method uses the absorption of radiation at specific frequencies of about 2960 and 2930  $\text{cm}^{-1}$  as a measure of the hydrocarbons present in the extract of a water sample. The preceding extraction and clean-up procedure should guarantee that only pure hydrocarbons – i.e. compounds containing only carbon and hydrogen atoms without any other elements such as oxygen, nitrogen, sulphur etc. – are present in the purified extract. This means that all hydrocarbons present in the extract are measured as far as they contain methyl- ( $\text{CH}_3$ -) or methylene- ( $-\text{CH}_2-$ ) groups.

The specific frequency of the aromatic CH- group - about 3030  $\text{cm}^{-1}$  - is not measured. A compound like benzene is therefore not contributing to the content of dispersed oil. This is completely in accordance with the decision of OSPAR to exclude aromatic compounds from the definition of dispersed oil. Other monocyclic aromatic hydrocarbons, such as toluene, ethylbenzene, xylene etc., contain one or more aliphatic side chain(s). These compounds should also be excluded from the measurement because they are excluded from the definition of dispersed oil. However the aliphatic side chains of the molecules do absorb radiation of about 2960 and 2930  $\text{cm}^{-1}$  and are therefore (partly) measured.

This means that the current OSPAR reference method may overestimate the content of dispersed oil if relatively large amounts of monocyclic aromatic hydrocarbons are present in produced water, as is often the case with gas- and condensate producing platforms.

On the other hand the current OSPAR reference method has no restrictions in measuring small (= volatile) and very large hydrocarbons as far as they are present in the purified extract.

The proposed new reference method under investigation in this study is based on gas chromatography with flame ionization detection. This method uses the electrical current that is generated in an electrical field when carbon containing compounds are combusted in a hydrogen-rich atmosphere. Also in this method the preceding extraction and clean-up procedure should guarantee that only pure hydrocarbons are present in the purified extract. The detection principle cannot

discern between aromatic and aliphatic hydrocarbons. This means that the distinction between total and dispersed oil should be made otherwise.

The proposed new method is based on ISO 9377-2. This method describes the gas chromatographic separation of hydrocarbons according to their boiling points and the quantification of the amount of hydrocarbons with boiling points between 175 and 525 deg. C. This boiling range corresponds with the boiling points of n-C<sub>10</sub>H<sub>22</sub> (n-decane) and n-C<sub>40</sub>H<sub>82</sub> (n-tetracontane) and is commonly abbreviated as C10-C40.

Because the monocyclic aromatic hydrocarbons have boiling points lower than 175 deg. C., ISO 9377-2 seems to be suited for measuring dispersed oil. The restricted boiling range however excludes hydrocarbons above C40 and below C10 which should be regarded as part of dispersed oil. This means that ISO 9377-2 as such may underestimate the content of dispersed oil in a purified extract of produced water.

Regarding the volatile hydrocarbons boiling below C10, which may be quite important in produced water from gas- and condensate platforms, ISO 9377-2 has been modified by starting the quantification of hydrocarbons with n-heptane (C<sub>7</sub>H<sub>16</sub>) and thus quantifying the range C7 – C40. Doing so, the aromatic hydrocarbons toluene, ethylbenzene and the isomers of xylene are incorporated in the total content. Their contributions have to be subtracted from the total to obtain the content of dispersed oil. The incorporation of the aliphatic hydrocarbons between heptane and decane in the amount of hydrocarbons measured, improves the capability of measuring the amount of dispersed oil.

The modification doesn't affect the higher boiling hydrocarbons above C40. Both methods, ISO 9377-2 and ISO 9377-2 mod., exclude these hydrocarbons from the measurement. In the case of produced water from oil platforms this may lead to an underestimation of the amount of dispersed oil.

The aforementioned aspects should be taken into account evaluating the results of the current OIC-study. The scope of the modified ISO 9377-2 still differs from the scope of the current OSPAR reference method based on infrared spectrophotometry. This may affect the comparability of the results obtained by both methods on the same samples. Differences observed between the results of both methods may depend on the type of platform, i.e. gas- condensate- or oil producing platforms.

For oil producing platforms, ISO 9377-2 and ISO 9377-2 mod, may show results that are lower than the IR-results, due to the presence of hydrocarbons above C40. Only in the case of relatively light oil ISO 9377-2 mod may show results that are higher than the results of ISO 9377-2.

For condensate platforms the results of ISO 9377-2 mod will be higher than those of ISO 9377-2 but still lower than the IR-results. This difference will be mainly caused by the overestimation of the content of dispersed oil by IR, due to the incomplete correction for the presence of monocyclic aromatic hydrocarbons caused by the aliphatic side chains which are still measured by IR.

For gas platforms the difference between ISO 9377-2 mod and ISO 9377-2 may become quite large due to the relatively high amounts of hydrocarbons in the range C7 – C10. The results may still be lower than the IR-results for the same reason as given by the condensate platforms. Produced water from gas platforms may also contain hydrocarbons below C7. These very volatile hydrocarbons will quickly evaporate from the water phase and are therefore very difficult to sample. Their contribution to the oil content measured by infrared spectrophotometry is therefore assumed to be low.

The tendencies described above indicate that in general there is no equivalency between the results of the current OSPAR reference method for dispersed oil in produced water and the results of the ISO 9377-2 mod. The current comparison study however can provide a good insight in the magnitude of the differences for the different types of platforms.

### **1.3 Programme**

The aim of the current study is to compare data of dispersed oil concentrations analysed with the GC-FID method (ISO 9377-2 mod) to data analysed with the 'old' IR method in order to determine a) how these methods compare and b) whether the GC-FID method provides a correct indication of the dispersed oil content. The OIC decided that the minimum detectable difference at a dispersed oil content of approximately 30 mg/l should be 20%, whereas the minimum detectable difference around 5 mg/l should be 50%. It is clear that the total number of laboratories participating in the comparison program will have influence on the reproducibility (error between results of participating laboratories). In order to reduce the variation in analysis results, it was decided that the total number of laboratories participating in the comparison program for each Contracting Party was to be kept to a minimum and the samples from one offshore installation should be analyzed by one and the same laboratory whenever possible.

These requirements implied (based on a statistical analysis) that a minimum of 56 offshore installations should be sampled, with a minimum of four replicates per platform. Therefore, in the final programme analysis data were obtained from four laboratories (SGS, DTI, ITS and WLS) for 58 oil, gas or condensate platforms of The Netherlands, Germany, Denmark, Norway and the UK, of which the produced water has been analysed on dispersed oil content in two replicates for both methods (two samples analysed by IR and two samples analysed with ISO 9377-2 standard



and mod.). Samples from a second and third day were analysed using the two methods without replication. Two samples from the first day were kept in stock.

#### **1.4 Analysis of data, reading guide**

Data on dispersed oil content of produced water from 58 Dutch, German, Danish, Norwegian and UK oil, gas or condensate platforms analysed with IR and ISO 9377-2 standard and mod. by four laboratories were collected in an EXCEL database.

The four laboratories have performed a ring-test in which two samples with known dispersed oil content of 50 mg/l were analysed on aromatic hydrocarbons (one sample with a low and one sample with a high content on aromatic hydrocarbons) without TEX with the modified GC-FID method on two days. These data were used to determine within and between laboratory variation in analysis results and the influence of time, which is described in chapter 2.

In chapter 3, a quantitative analysis and qualitative analysis of the data is presented in order to review the submitted data without going into the details of the comparison.

Chapter 4 focuses on the presence of differences between the oil concentrations measured using the two different methods by using descriptive and statistical analysis. This only indicates whether there is a difference, without providing information about the actual difference between oil concentrations measured with IR and ISO 9377-2 mod.

The identification of the actual differences is presented in chapter 5, using the relative difference of the concentrations measured by both methods (expressed as the IR/GC ratio) as the basis for comparison. It is studied whether the actual difference depends on factors like produced water rate, platform type and laboratory.

## 2. Ring-test

A ring-test was carried out as part of the comparison programme in order to identify to what extent the analysis procedures within the laboratories introduce variation to the results that are not related to the difference in methods (within lab variation as measure of the repeatability). Furthermore the variation between laboratories was analysed in order to see how this may influence the comparison programme (between lab variation as measure of reproducibility).

### 2.1 Analysis of reported data

Dispersed oil was analysed in a ring-test in triplicate in two samples with known dispersed oil content of 50 mg/l (sample 0270 with a low and sample 0271 with a high concentration on aromatic hydrocarbons, see Table 1) by the four participating laboratories (SGS, ITS, DTI and WLS). A number of components groups (C7-C40, C7-C40-TEX, C7-C10, C7-C10-TEX and C10-C40) were analysed on day 1 and on day 2. It was tested whether the variability of the means and the variances of the concentrations of groups of components are significantly different between replicates or laboratories, related to day of analysis, by performing a 1-way and a 2-way ANOVA (significance level  $\alpha$  0.05). It was not possible to include results from WLS in the ANOVA as this laboratory has only measured duplicate (instead of triplicate) concentrations of each sample in most cases.

A 1-way ANOVA was carried out on concentrations of two samples (0270 and 0271) analysed on day 1 or day 2 in order to test whether the observed differences can be related to the analysing laboratory. A 2-way ANOVA was performed to determine whether observed differences are dependent on the laboratory and the day on which the sample is analysed.

The comparability of variances (is there a difference in repeatability between the various labs) was tested with the Bartlett's test (part of ANOVA). The comparison of means of the three laboratories (is there a difference in the actual reported concentrations by the different labs; i.e., are the results reproducible) was performed with the Bonferroni's multiple comparison test. The statistical analyses have been performed using the statistical software package Graphpad Prism for Windows version 2 (1995).

Table 1 Chemical composition of dispersed oil samples 0270 and 0271

	oil	toluene	ethyl benzene	xylene	benzene	TEX	BTEX	C7-C10
Sample 0270	50.0	3.5	3.5	3.5	-	10.4	10.4	14.0
Sample 0271	50.0	34.8	34.8	34.8	34.8	104.4	139.2	7.0

## 2.2 Results

It was tested whether differences between both methods of analysis can be related to differences within replicates of a single sample measured on day 1 or day 2 by the three laboratories and whether the observed differences can be related to the analysing laboratory. The results of the 1 and 2-way ANOVA are given in Table 2.

*Table 2 Results of 1 and 2-way ANOVA to indicate the significance of differences in the concentrations of (replicates) of samples measured on day 1 and 2 by four participating laboratories. The results are categorised to group of compounds analysed with ISO 9377-2 mod.*

	C7-C40	C7-C40- TEX	C7-C10	C7-C10- TEX	C10-C40
1-way ANOVA, ( $p < 0.05$ )					
<i>Day 1</i>					
Means significantly different	no	yes	no	no	yes
Variances significantly different	no	yes	no	no	yes
<i>Day 2</i>					
Means significantly different	no	yes	no	no	yes
Variances significantly different	no	yes	no	no	yes
2-way ANOVA ( $F > F_{crit}$ )					
Sample 0270					
Lab-effect	no	yes	no	no	yes
Day of analysis-effect	yes	yes	yes	yes	yes
Interaction effect	yes	yes	no	no	yes
Sample 0271					
Lab-effect	no	yes	no	no	yes
Day of analysis-effect	yes	yes	yes	yes	yes
Interaction effect	yes	yes	yes	no	yes

### *1-way ANOVA: Differences between laboratories and days of analysis*

Significant differences between means and variances ( $P < 0.05$ ) were observed for the group of compounds C7-C40-TEX and C10-C40 independent on the day on which the samples were analysed. The results of the Bonferroni multiple comparison test indicate that laboratory ITS measures significantly different concentrations for C7-C40-TEX and C10-C40 from the laboratories SGS and DTI.

### *2-way ANOVA: Differences between replicates and days of analysis*

The results of the 2-way ANOVA showed that the means and variances of the replicate concentrations for the samples 0271 or 0272 were not significantly different for each group of compounds, except for the groups C7-C40-TEX and C10-C40. For all groups of compounds, the mean and variance of the concentrations measured for each sample significantly differs between laboratories and in most cases, these differences are also dependent on the day of analysis.

**Observations and implications from this analysis:**

- Three instead of four laboratories were included in the statistical analysis of the ring test results, because WLS reported duplicate instead of triplicate results.
- Of a known oil in water dispersion, using either ISO 9377-2 standard or ISO 9377-2 mod significant differences in the analysed concentrations are observed between labs;
- These differences are inconsistent between labs;
- The day of analysis has influence on the result and this influence differs between labs;
- These observations indicate the importance of the further standardisation of the analysis of oil in water using ISO 9377-2 standard and ISO 9377-2 mod.
- These results will have an influence on the results of this comparison study, because different laboratories are involved. Therefore the results of this comparison study will be analysed as a whole and as four subsets from the four laboratories.

### **3. Analysis of data reports**

Results of the individual laboratories were submitted to the participating authorities and compiled in the forms that were provided with the sampling protocols. These (hardcopy) forms were subsequently submitted to TNO for the data analysis. In this chapter an overview will be given of the submitted data and its quality.

#### **3.1 Reported data**

The dispersed oil content in produced water from 2 Norwegian and 11 Danish platforms from the database were analysed by IR with Freon 113 detection. The produced water of the 18 Dutch platforms and the 1 German and 26 UK platforms was analysed by IR with TCE detection. For samples of 6 of the 18 Dutch platforms both Freon and TCE were used. For all platforms time series (day 1, day 2 and day 6) of analysed samples were available, replicate concentrations were only reported completely by The Netherlands, Norway and Germany. Data on produced water rates and monthly concentrations were provided for (almost) all platforms.

From produced water samples from the Danish and UK platforms no figures of total oil and aromatics measured with infrared were provided.

The submitted data reports were transferred to a database in MS Excel for further analysis. In several cases it appeared that the data was not consistently provided as indicated by the form. On the basis of discussions with the responsible authorities and laboratories these inconsistencies are removed.

#### **3.2 Quantitative description**

Four different laboratories (DTI, ITS, SGS and WLS) have analysed the concentration of dispersed oil in produced water for 58 Dutch, German, English, Danish and Norwegian oil, gas or condensate platforms with GC-FID and the C7-C40-TEX concentration by Infra-Red (IR) spectrometry (according to ISO 9377-2) in sets consisting of four produced water samples 1a, 1b, 2 and 3. For some platforms additional samples from previous studies were included (Figure 1).

Legend		All data				
n=	number of data	n=	243			
p=	number of platforms	p=	58 <sup>(1)</sup>			
c=	number of countries	c=	5			
l=	number of labs	l=	4			
oil=	number of oil platforms	oil=	28			
con=	number of condensate platforms	con=	11			
gas=	number of gas platforms	gas=	19			

NL	GE	UK	DK	NO
n= 95 <sup>(2)</sup>	n= 4	n= 101	n= 35	n= 8
p= 18	p= 1	p= 26 <sup>(3)</sup>	p= 11 <sup>(4)</sup>	p= 2
oil= 4	oil= -	oil= 13	oil= 9	oil= 2
con= -	con= -	con= 11	con= -	con= -
gas= 14	gas= 1	gas= 2	gas= 2	gas= -

<sup>(1)</sup> on 48 platforms replicate measurements

<sup>(2)</sup> Incl. 23 extra data points from the Dutch quick scan study

<sup>(3)</sup> for 3 platforms no replicate measurements

<sup>(4)</sup> for 9 platforms no replicate measurements

*Figure 1 Schematic overview of type and number of data available for Dutch, German, English, Danish and Norwegian oil, gas or condensate platforms.*

The database is dominated by measurements from UK platforms (mainly oil and/or condensate), followed by Dutch (mainly gas) and Danish platforms (mainly oil). The overall database consists for approximately 30% of gas production platforms, 20% condensate production platforms and 50% oil production platforms. Platforms with a combined production of oil, gas or condensate, are categorised to their main stream of produced hydrocarbons.

## 4. Significance of differences

As infrared spectrometry (IR) and gas chromatography (ISO 9377-2 mod) are fundamentally different methods, it is obvious that the final results produced will also be different. However, as there are many factors that introduce variation to the final results, this chapter aims at identifying whether the expected difference between both methods can actually be (significantly) identified. In the statistical analysis, it is assumed that the different samples taken for analysis with IR or GC are identical samples and therefore that variation in the results of the IR or GC analysis are not caused by variances in the samples. It is, however, recognized that inconsistencies due to sampling may have grave implications.

### 4.1 Method of analysis

#### *Students' t-test*

In order to identify whether the oil concentrations measured on individual platforms with GC and IR are significantly different, a Students' t-test was performed. Identical samples 1a and 1b from each platform were measured both with IR and GC. From the analysis of these samples the average concentration for both the IR and the GC analysis were calculated. These average values are subtracted and compared using a two sample t-test. It was intended to take the variance of four analyses of one sample as the variance around the averages. But as the averages are based on only two replicates in stead of the four (as was indicated in the setup), the variances posed on these averages (see equation below) is the within lab variation taken from the ISO protocols. These values are 8.0 % and 4.9 % respectively for the IR and GC method.

Knowing the variation in the results of the method (within lab variation) and the detected difference between the averages of the concentrations of each method, a Students' t-test was performed in order to determine whether the difference is statistically significant. The following equation (Sokal and Rohlf, 1995) describes a t-test of the hypothesis that the two methods produce comparable results:

$$t_s = \frac{D}{\sqrt{\frac{1}{n}(s_1^2 + s_2^2)}}$$

in which:

$t_s$	<i>t-value</i>
$D$	<i>Detected difference</i>
$n$	<i>number of samples analysed with each method</i>
$s_1^2$	<i>variance in results of method 1</i>
$s_2^2$	<i>variance in results of method 2</i>

The calculated t-value is compared with the critical t-value from the Students' t-distribution for a significance level ( $\alpha$ ) of 0.05 and  $2*(n-1)$  degrees of freedom. A difference is statistically significant if the calculated t-value is higher than the critical t-value.

#### Box-Whisker plots

When comparing the results of both methods in the overall dataset it is helpful to look at descriptive summary statistics. Box-Whisker plots provide such statistics as they graphically show the median concentration and the variation (at different levels) of the observed concentrations (Figure 2). Vertical box-plots will be presented in this report for each sample, side-by-side for comparison.

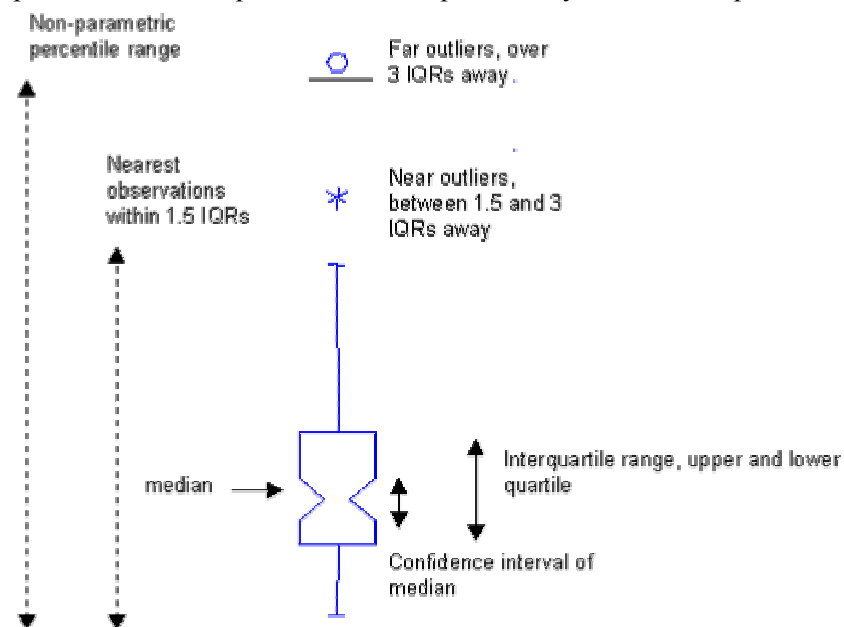


Figure 2 Explanatory scheme of Box-Whisker plot. The notched box shows the median, lower and upper quartiles, and confidence interval around the median. The line connects the nearest observations within 1.5 IQRs (inter-quartile ranges) of the lower and upper quartiles. Crosses (+) and circles (o) indicate possible outliers - observations more than 1.5 IQRs (near outliers) and 3.0 IQRs (far outliers) from the quartiles. The vertical lines show the requested non-parametric percentile range.



*Paired t-test*

Following the comparison on the basis of the descriptive statistics using Box-Whisker plots, a Paired t-test was carried out in order to identify whether in general (the overall dataset, not individual platforms) the difference between both methods is significant. It is assumed that the measured concentrations are log-normally distributed.

The following equation was used for the Paired t-test (Sokal and Rohlf, 1995):

$$t_s = \frac{D}{s_D / \sqrt{n}}$$

*in which:*

$t_s$	<i>t-value</i>
$D$	<i>average detected difference</i>
$n$	<i>number of platforms to include</i>
$s_D$	<i>variance in differences for all samples</i>

The calculated t-value is compared with the critical t-value from the Students' t-distribution for a significance level ( $\alpha$ ) of 0.05 and (n-1) degrees of freedom. A difference is statistically significant if the calculated t-value is higher than the critical t-value.

Taking into account a minimal detectable difference of 20% at a concentration of 30 mg/l and 50% at 5 mg/l, it has been indicated that 56 platforms should be included in the comparison program. In the database results of 58 platforms are available. This together with the fact that on all platforms at different times samples (containing different amounts of oil in water) have been taken, results in a large amount of data (240 measurements with both IR and GC) which can be used as an input for a paired t-test.

Although a difference between methods of analysis might be tested statistically significant, there is still a probability that in reality it is not. This is referred to as the Type II error and used to express the power of a statistical test. For this study, the power is calculated using the ratio between the minimal detectable difference and the variation in the results (standard deviation). Using this ratio, the probability P for a Type II error is derived from the t-distribution. The power is expressed as (1-P), thus the higher the power, the smaller the probability that a significant difference is found in the test that appears to be invalid in practice.

Table 3 Overview of statistical methods and objectives

Method	Objective
Students t-test	Indicates differences in the average detected concentrations with IR and GC of one replicated sample on one platform, taking into account the variances of the analysis around the averages. This test is performed in order to indicate on how many platforms significant differences between the results of the two methods can be indicated
Box whisker plots	Descriptive summary statistics to present distributions of concentrations measured with different methods
Paired t-test	Indicates differences between distributions of paired values (analysis with IR and GC of one sample). This test is performed in order to indicate whether, in general and when divided in subsets, both methods lead to significant different results.

## 4.2 Results

### *Differences between IR and GC on individual platforms*

Using the Students' t-test for comparison as described in the previous paragraph, the results of IR (2 replicates) and GC (2 replicates) analyses were compared on each platform. For 23 out of the 47 platforms (which reported replicate samples and had dispersed oil concentrations above the detection limit) the two methods lead to significantly different results.

### *Differences between IR and GC in the overall dataset*

Using a box whisker plot, an overview of the distributions of the measured values using IR, ISO 9377-2 mod and ISO 9377-2 standard is presented in Figure 3. These distributions are compared using a paired t-test. Table 4 shows the results of this comparison. It appears that in the overall dataset there is a significant difference between IR and GC (for both the standard and modified protocol). The power (indication for the probability that the conclusion is indeed correct) shows that, although the difference is significant for both protocols, the standard protocol is more likely to be different from IR than the modified protocol.

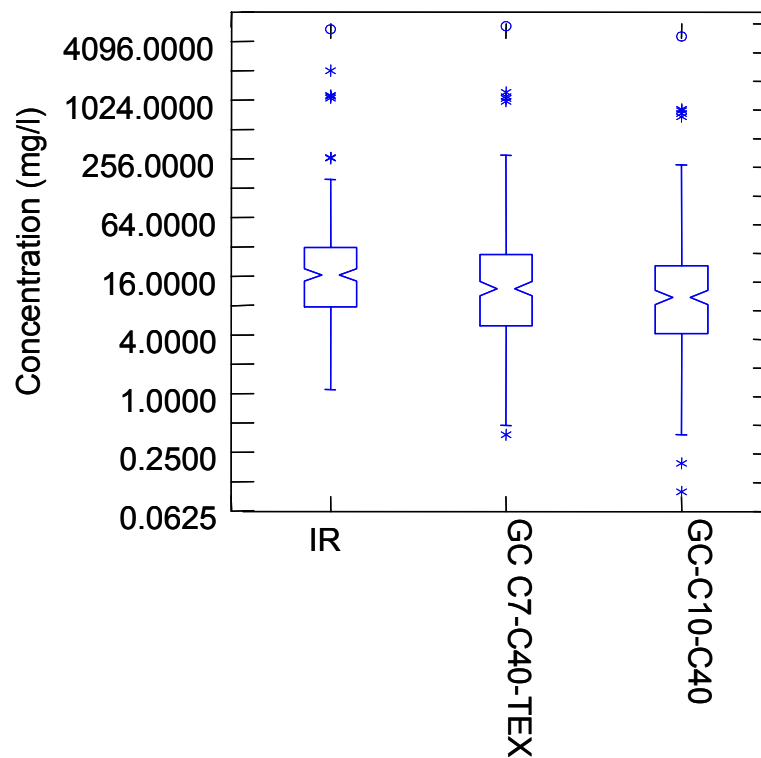


Figure 3 Overview of the distributions of the concentrations obtained using IR, ISO 9377-2 mod and ISO 9377-2 standard.

Table 4 Paired *t*-test results of the comparison of the distributions describing the IR and GC results

Comparison	IR and GC differ significantly	Number of data	Power
IR and GC (C10-C40)	Yes	240	0.56
IR and GC (C7-C40 –TEX)	Yes	240	0.39

We can use the variances in the differences of the whole dataset in order to see whether a detected difference of 20 % between the results of both methods around 30 mg/l and a difference between the results of 50 % around 5 mg/l, would imply that the analysed concentrations are indeed different results and not within the variance of both methods.

Table 5 Significant detectable differences

Method	50% around 5 mg/l	Power	20% around 30 mg/l	Power
IR and GC (C10-C40)	Yes	0.42	Yes	0.17
IR and GC (C7-C40 –TEX)	Yes	0.48	yes	0.20

Following the first generic analysis, the dataset is categorized to the factors that might influence the difference between the results of the two methods. These factors are produced water volume (as this might influence the accuracy of sampling), platform type (as this influences the ‘type’ of hydrocarbons in the produced water) and laboratory (as the ring-test showed that there are significant differences between the various labs). For these analyses, only the results from the ISO 9377-2 mod analysis are used.

Table 6 shows the results of the Paired t-test for five produced water volume categories. For most of the produced water rates the generic results are confirmed (there is a significant difference), apart from platforms with a produced water discharge rate of 100-1000 m<sup>3</sup> per day. However, although the difference appeared not to be significant, the extremely low power indicates that there is a high probability that this conclusion is incorrect. Table 7 shows the results of the Paired t-test categorized to the three types of platforms. For each of these categories the difference appeared significant.

Finally, Table 8 shows the results of the Paired t-test categorized to the four laboratories that participated in this programme. It appeared that the difference between the two methods is only significant for samples analysed by SGS and ITS, while for DTI and WLS the difference was not found significant. The number of samples included in the analysis per laboratory (which is much lower for DTI and WLS) might explain these results.

*Table 6 Paired t-test results of the comparison of the distributions describing the IR and GC results categorised to produced water rate (m<sup>3</sup>/day)*

<b>Produced water rate</b>	<b>IR and GC differ significantly</b>	<b>Number of data</b>	<b>Power</b>
< 100	Yes	40	0.42
100 – 1000	No	46	0.01
1000-10000	Yes	76	0.49
10000-100000	Yes	51	0.43
> 100000	Yes	18	0.64

*Table 7 Paired t-test results of the comparison of the distributions describing the IR and GC results categorised to platform type*

<b>Platform type</b>	<b>IR and GC differ significantly</b>	<b>Number of data</b>	<b>Power</b>
Gas	Yes	85	0.34
Condensate	Yes	42	0.31
Oil	Yes	112	0.47

*Table 8 Paired t-test results of the comparison of the distributions describing the IR and GC results categorised to laboratory*

Laboratory	IR and GC differ significantly	Number of data	Power
SGS	Yes	96	0.34
ITS	Yes	100	0.52
DTI	No	35	0.20
WLS	No	8	0.28

We can use the variances in the differences of the separate datasets in order to see whether a detected difference of 20 % between the results of both methods around 30 mg/l and a difference between the results of 50 % around 5 mg/l, would imply that the analysed concentrations are indeed different results and not within the variance of both methods.

*Table 9 Significant detectable differences*

Subset	50% around 5 mg/l	Power	20% around 30 mg/l	Power
<i>Produced water rate</i>				
< 100	Yes	0.45	No	0.24
100 – 1000	Yes	0.56	Yes	0.20
1000-10000	Yes	0.48	Yes	0.17
10000-100000	Yes	0.41	No	0.44
> 100000	Yes	0.85	Yes	0.19
<i>Platform type</i>				
Gas	Yes	0.50	Yes	0.21
Condensate	Yes	0.39	No	0.16
Oil	Yes	0.51	Yes	0.21
<i>Laboratory</i>				
SGS	Yes	0.67	Yes	0.30
ITS	Yes	0.39	Yes	0.16
DTI	Yes	0.60	No	0.26
WLS	Yes	0.97	Yes	0.67

**Observations and implications from this analysis:**

- On 23 of the 47 platforms where replicate samples were taken, significant differences between the results of the IR and the GC method were detected, in spite of the fact that only 2 instead of 4 replicates per platform were analysed.
- The distributions of the results of the two methods are (in general) significantly different. This applies to the overall data set as well as the different subsets (classified to produced water rate, platform type and laboratory)
- The observed variances in the differences of both methods are, in general, small enough to state that a difference in the results of both methods of 50 % around 5 mg/l and 20 % around 30 mg/l means that the measured concentrations are indeed different results and not within the variance of both methods.
- The implication of these observations is that the results of both methods are different. This applies both for the ISO 9377-2 mod and ISO 9377-2 standard compared to IR.

## 5. Quantification of differences

Having identified, in the previous chapter, that there is considerably consistent difference between the results of GC and FID, the next question is to quantify this difference. For each sample this difference is quantified by calculating the IR/GC ratio. Furthermore, the influence of relevant factors like produced water rate, type of platform and laboratory (as explained in the previous paragraph) is evaluated.

### 5.1 Method of analysis

#### *Graphical presentation*

The correlation between the IR/GC ratios and the amount of produced water discharged, and with the concentration of dispersed oil is visualized in scatter plots. Furthermore, box-whisker plots are presented in order to provide the descriptive statistics (see paragraph 4.1 for an explanation).

#### *Statistical analysis*

The IR/GC ratios were statically analysed by performing a 1-way and 2-way ANOVA (significance level  $\alpha$  0.05) to determine whether the average ratios are different and whether the variation of the ratios are significantly different between, respectively, the amount of produced water, the type platform and the four laboratories.

The statistical analysis was performed with the statistical software package Graphpad Prism for Windows version 2 (1995). The comparability of variances was tested with the Bartlett's test (part of ANOVA). Bonferroni's multiple comparison test was performed to compare differences between means of ratios for different laboratories.

### 5.2 Results

#### 5.2.1 Overall dataset

In Table 4 it was indicated that based on all the results of the IR and GC method, significant different results can be indicated. How much this difference is can be displayed by the IR/GC ratio. The descriptive statistics for the IR/GC ratio is presented in Figure 4, showing the data for both the standard and modified GC-FID protocols. In total 240 IR/GC ratios could be calculated. Table 10 shows the (geometric) mean, minimum and maximum IR/GC ratio that corresponds with the data in the figure. From both the table and the figure it can be concluded that the modified GC-FID (ISO 9377-2 mod) protocol corresponds more to the IR method than the standard GC-FID (ISO 9377-2) (IR/GC ratio of 1.3 vs. 1.7).

Figure 5 demonstrates that there is no correlation between the dispersed oil concentration (as measured using the IR method) and the ratio between IR and GC (regression coefficient  $R^2=0.0004$ ).

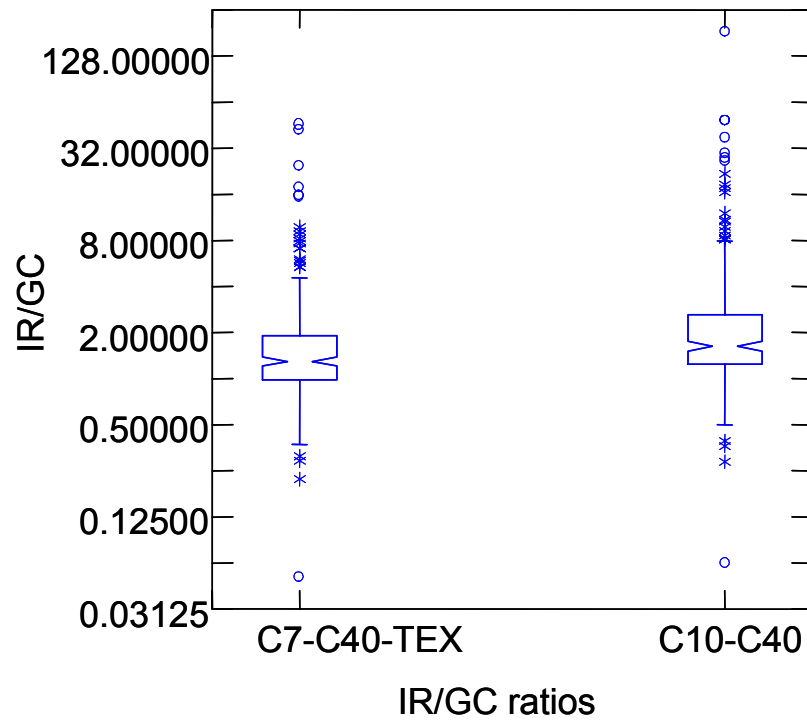


Figure 4 Box-Whisker plots of all IR/GC ratios for, respectively, the modified and standard protocol for GC-FID.

Table 10 Minimum, maximum and average values of the IR/GC ratio of corresponding samples

	IR / GC ratio C7 – C40 - TEX	IR / GC ratio C10 – C40
Min	0.05	0.06
Max	45.5	182
Mean	1.33	1.72



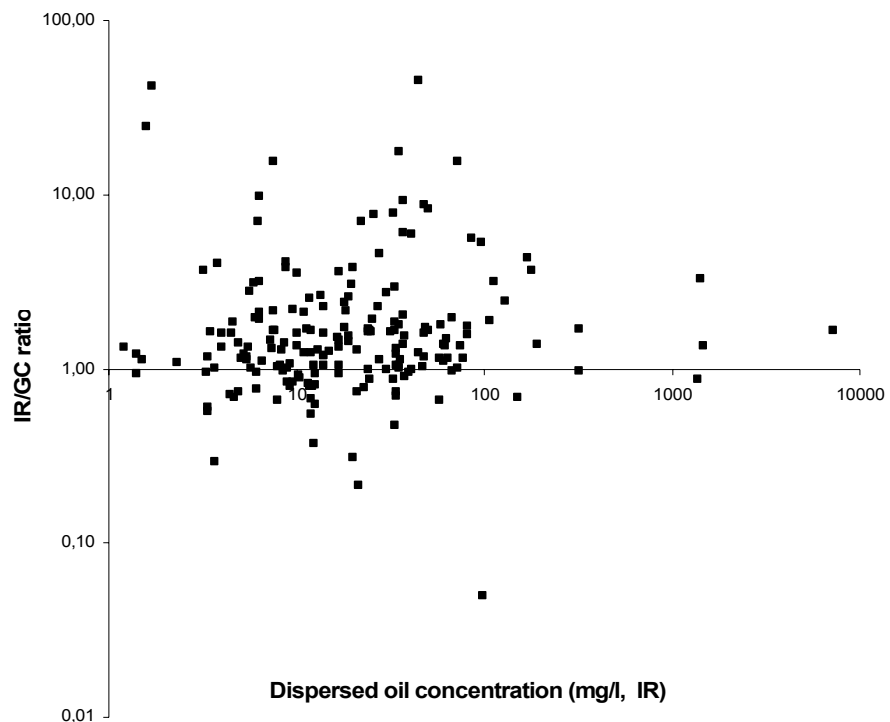


Figure 5 Scatter plot of the IR/GC ratio versus the concentration of dispersed oil in water measured using IR

### 5.2.2 Influence of produced water discharge rate

In Table 6 it was indicated that for all subsets classified to produced water rate except one the results of the IR and GC method differ significantly. Figure 6 it is demonstrated that this difference (expressed as the IR/GC ratio) is not dependent of the produced water discharge rate (expressed as  $\text{m}^3/\text{day}$ , regression coefficient  $R^2$  is 0.0002). Box-whisker plots for five categories of produced water discharge rates (Figure 7, geometric means in Table 11) show that, on average, the ratio is the lowest for samples taken on platforms with a produced water discharge rate of 100-1000  $\text{m}^3$  per day. Although the differences between the geometric mean IR/GC ratios are not significant, the variation in the ratio is significantly different among the five categories (see Table 12). This might confirm the conclusion drawn in the previous chapter that the discharge rate of produced water influences the accuracy of taking samples, but also the amount of data point per subset plays a role in this.

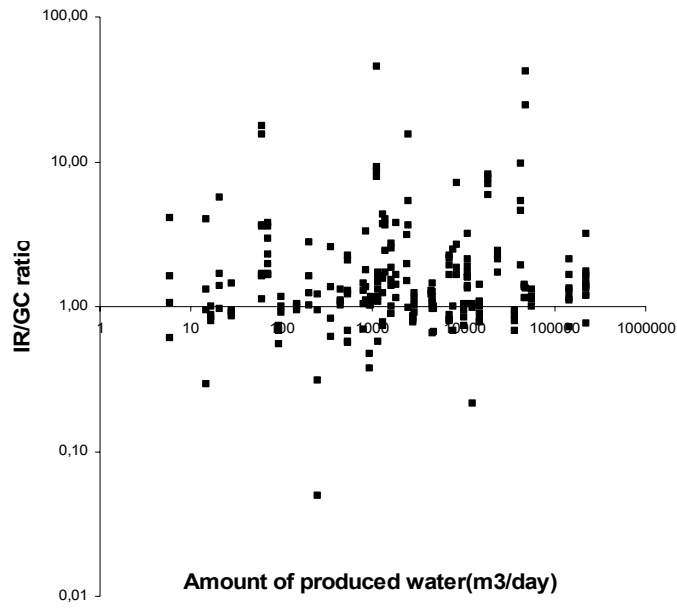


Figure 6 Scatterplot of the relation between IR/GC ratio and the amount of produced water

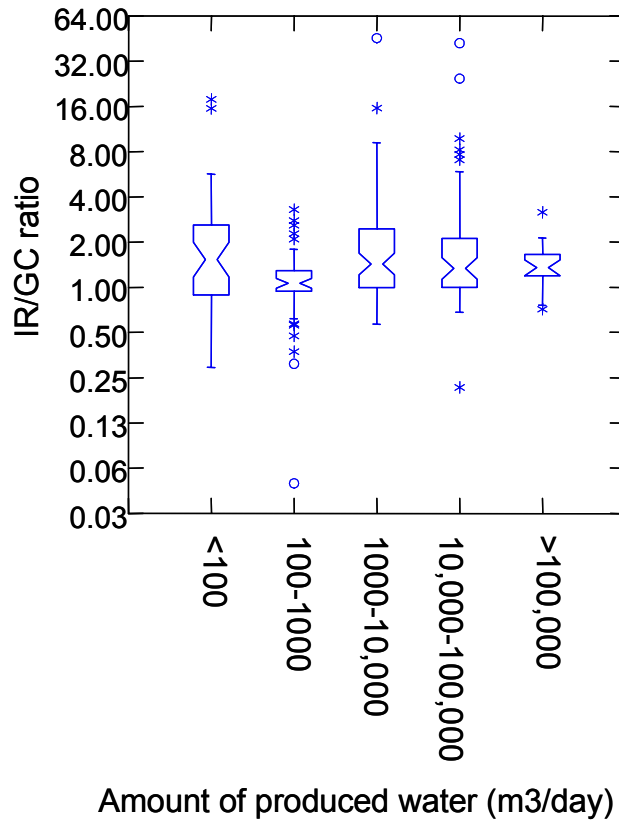


Figure 7 Box-Whisker plots of all IR/GC ratios categorised to produced water rate

*Table 11 Geometric mean values of the IR/GC ratio of corresponding samples categorised to produced water rate (m<sup>3</sup>/day)*

<b>Produced water rate</b>	<b>Geomean</b>
< 100	1.45
100-1000	1.08
1000-10000	1.47
10000-100000	1.38
> 100000	1.38

*Table 12 Results of an ANOVA to indicate the significance of differences in the IR/GC ratio of corresponding samples categorised to produced water rate (m<sup>3</sup>/day)*

<b>Type of statistical analysis</b>	<b>1-way ANOVA</b>
P value for means	0.1797
Are means significantly different (P < 0.05)?	no
P value for variances	< 0.0001
Are variances significantly different (P < 0.05)?	yes

### **5.2.3 Influence of the type of platform**

In this study the objective was to compare the results of the dispersed oil measurements using IR and the modified GC-FID method (C7-C40 – TEX). However, for part of the platforms in the database the results of the standard GC-FID (C10-C40) analyses are also included. It is assumed that for gas production platforms the C7-C40 - TEX measurement is a better indication for the dispersed oil concentration than the C10-C40 measurement, while for oil production platforms no substantial difference is expected.

In Table 7 it was indicated that for all subsets classified to platform type the results of the IR and GC method differ significantly. The IR/GC ratio's for gas, oil and condensate producing platforms are summarised in Figure 8 (ISO 9377-2 mod, C7-C40-TEX), Figure 9 (ISO 9377-2 standard, C10-C40) and Table 13.. These results are consistent with those presented earlier, showing lower IR/GC ratios when based on ISO 9377-2 mod. The difference in ratio is the highest for gas production platforms, followed by condensate and oil production platforms respectively. Although the ratio is lower for gas production platforms, this appears not significant. The difference in variation among the different types of platform is significant (see Table 14, applied to ratios calculated for the modified GC-FID only). The results of the ISO 9377-2 mod and the results of ISO 9377-2 standard are more similar for oil and condensate platforms than for gas platforms.

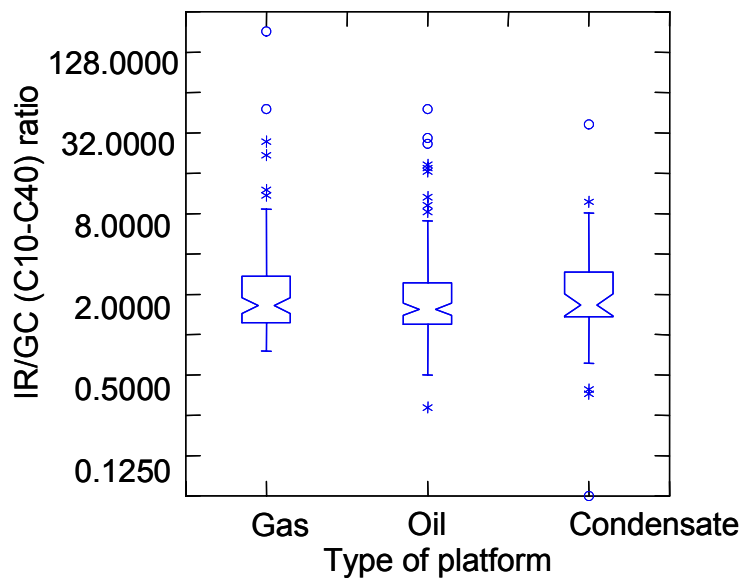


Figure 8 Box-Whisker plots of all IR/GC ratios (based on the standard GC-FID protocol, C10-C40) categorised to platform type

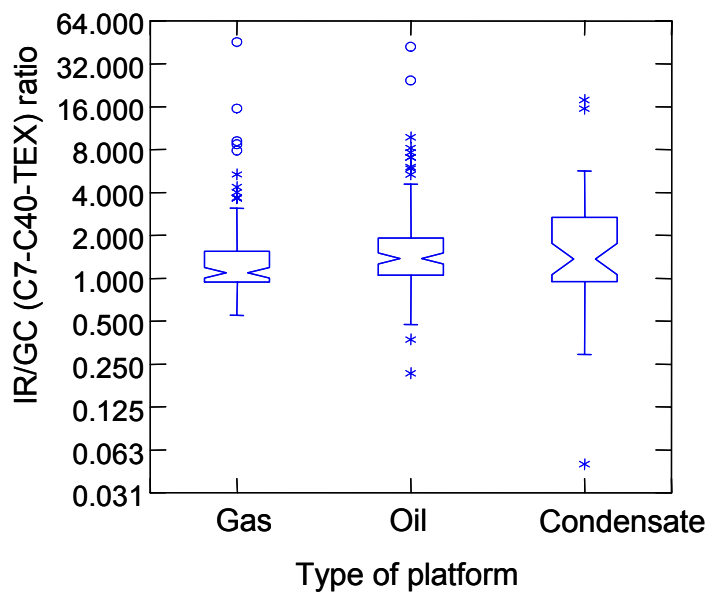


Figure 9 Box-Whisker plots of all IR/GC ratios (based on the modified GC-FID protocol, C7-C40-TEX) categorised to platform type

Table 13 Average values of the IR/GC ratio and the GC standard / GC mod ratio of corresponding samples categorised to platform type

Platform type	Geomean C7-C40 - TEX	Geomean C10-C40	Geomean GC C10-C40 /GC C7-C40 - TEX
Gas	1.17	1.78	1.52
Condensate	1.45	1.85	1.28
Oil	1.43	1.64	1.15

Table 14 Results of an ANOVA to indicate the significance of differences in the IR/GC ratio of corresponding samples categorised to platform type

Type of statistical analysis	1-way ANOVA
P value for means	0.9841
Are means significantly different ( $P < 0.05$ )?	no
P value for variances	0.0111
Are variances significantly different ( $P < 0.05$ )?	yes

#### 5.2.4 Influence of the analysing laboratory

In the previous chapter it was identified that the difference between IR and GC-FID analysed concentrations was significant for (at least) two of the four participating laboratories. Figure 10 and Table 15 provide an overview of the IR/GC ratios for these laboratories, where the ratio from samples analysed by ITS is considerably higher than from samples analysed by the other labs. This difference appears significant (Table 16) from, at least, the samples from SGS. There is no significant difference from the other labs probably due to, as explained before, the limited number of samples included in the analysis from DTI and WLS.

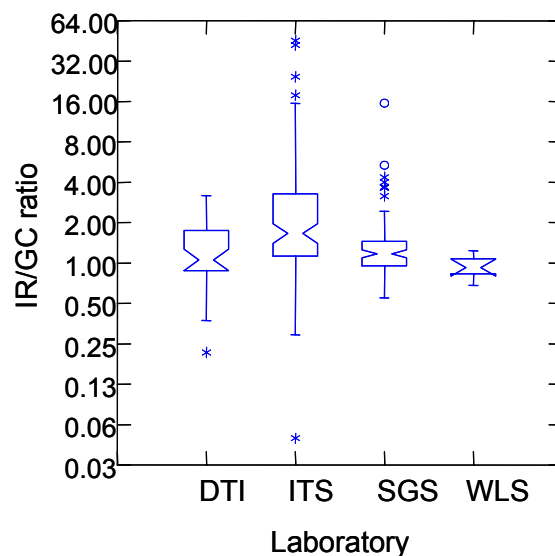


Figure 10 Overview of the cumulative log-normal distributions of IR/GC ratios of corresponding samples categorised to laboratory

*Table 15 Average values of the IR/GC ratio of corresponding samples categorised to laboratory*

<b>Laboratory</b>	<b>Geomean</b>
DTI	1.18
ITS	1.79
SGS	1.17
WLS	0.93

*Table 16 Results of an ANOVA to indicate the significance of differences in the IR/GC ratio of corresponding samples categorised to laboratory*

<b>Type of statistical analysis</b>	<b>1-way ANOVA</b>
P value for means	0.0024
Are means significantly different (P < 0.05)?	yes (between labs ITS and SGS)
P value for variances	<0.0001
Are variances significantly different (P < 0.05)?	yes

**Observations and implications from this analysis:**

- In general the results of the ISO 9377-2 mod resemble the results of the IR method better than the results of the ISO 9377-2 standard do;
- On average, the actual significant difference between the results of the IR and ISO 9377-2 mod (expressed as the ratio of the results) is 1.33 (for standard ISO 9377-2 this value is 1.72 );
- The value of the significant difference between the results of the IR and ISO 9377-2 mod (expressed as the ratio of the results) does not depend on the dispersed oil concentration;
- For different produced water rates the significant difference between the results of the IR and ISO 9377-2 mod (expressed as the ratio of the results) has different values between 1.08 and 1.47. However these different values are not significantly different.
- For gas platforms the significant difference between the results of the IR and ISO 9377-2 mod (expressed as the ratio of the results) has a value of 1.17, for oil platforms this value is 1.45. The significant difference between the results of the IR and ISO 9377-2 standard (expressed as the ratio of the results) has a value of 1.78 for gas platforms. For oil platforms this value is 1.64.
- For different laboratories the significant difference between the results of the IR and ISO 9377-2 mod (expressed as the ratio between the results) has different values (between 1.17 and 1.79). These values are respectively for ITS and SGS and significantly different.
- These observations imply that, in general for gas platforms, a factor of 1.17 is the best factor to calculate results of ISO 9377-2 mod into results of IR (1.45 for oil platforms). But, based on this study, for different laboratories different factors might be used. This again indicates the need for further standardisation of the GC method.

## 6. Conclusions

### 6.1 Ring-test

- The four participating laboratories SGS, WLS, DTI and ITS have analysed dispersed oil concentrations in the two samples consistently deviating (more or less) from the known content on dispersed oil (50 mg/l). This is possibly due to differences in the calibration of the modified GC analysis method.
- The calibration of the IR and GC methods of analysis will be responsible for differences between laboratories that have analysed concentrations of dispersed oil in produced water. This variation between laboratories is not further taken into account in the comparison program for the analysis results obtained with the IR and GC analysis methods.
- Generally, it can be concluded that analysis of dispersed oil in produced water by GC gives a better indication of the realistic dispersed oil concentration for a produced water sample than IR (considering the ringtest results and an IR/GC ratio  $>1$ ).

### 6.2 Comparison program

- For 23 of the 47 oil, gas or condensate platforms for which a comparison of the methods of analysis for the determination of the dispersed oil content of produced water could be performed, a significant difference between both methods of analysis was observed.
- Overall, the analysed concentrations of dispersed oil in produced water with GC or IR do differ significantly.
- The presence of this significant difference does not depend on the amount of produced water discharged (excl. 1 of the 5 classes), the type of platform or laboratory (excl. 2 of 4 labs, which is probably due to the small number of samples with large standard deviations in concentrations of dispersed oil in produced water analysed by these 2 laboratories.).
- The IR/GC ratio is 1.7 when samples of dispersed oil in produced water are analysed with the standard GC-FID method (ISO 9377-2), the ratio is 1.3 when the samples are analysed with the modified GC-FID method (ISO 9377-2 mod).



- The IR/GC ratio does not correlate to the dispersed oil concentration or with the produced water rate.
- The IR/GC ratio was not significantly different per amount of produced water discharged daily
- For gas platforms the significant difference between the results of the IR and ISO 9377-2 mod (expressed as the ratio of the results) has a value of 1.1. For oil platforms this value is 1.45. The significant difference between the results of the IR and ISO 9377-2 standard (expressed as the ratio of the results) has a value of 1.78 for gas platforms. For oil platforms this value is 1.64.
- The IR/GC ratio was significantly higher for the laboratory ITS.

Taken into account:

- The fact that GC-FID provides a better estimation of the dispersed oil concentration than IR;
- The significant difference in the results of the IR and GC-FID analyzing method, and;
- The fact that the different laboratories have the highest influence on the value of the actual difference between the results of analysis with IR and GC-FID:

Further standardization of the GC-FID method seems necessary when this method is proposed to be the reference method.

## 7. References

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OLF (2001): Comparative study of Freon-IR (NS 9803) and GC-FID (ISO 9377-2) for analysis of oil in produced water on 33 platforms in the Norwegian sector. OLF Working Group on Oil in Water.

Sokal R.R. & F.J. Rohlf (1969): Biometry: the principles and practice of statistics in biological research. W.H. Freeman and Company, San Francisco.

## 8. Authentication

Name and address of the principal:

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North Sea Directorate  
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2280 HV Rijswijk  
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Names and functions of the cooperators:

M.G.D. Smit	Project leader
K.I.E. Holthaus	Research scientist
C.C. Karman	Research scientist
P. Frintrop (RIZA)	Scientific Advisor

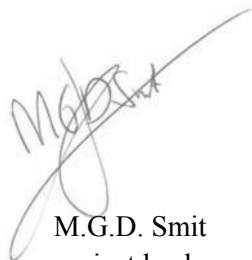
Names and establishments to which part of the research was put out to contract:

-

Date upon which, or period in which, the research took place:

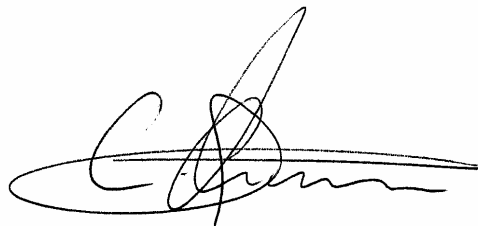
November 2002 - February 2003

Signature:



M.G.D. Smit  
project leader  
February 24, 2003

Approved by:



C.C. Karman  
head of department  
February 24, 2003

## Appendix 1: Results of the ring-test

	oil	toluene	ethyl benzene	xylene	benzene	TEX	BTEX	C7-C10
Sample 0270	50.0	3.5	3.5	3.5	-	10.4	10.4	14.0
Sample 0271	50.0	34.8	34.8	34.8	34.8	104.4	139.2	7.0
Sample 0272	-	-	-	-	-	-	-	-

Day	sample	lab	C7-C40	C7-C40 - TEX	C7-C10	C7-C10 - TEX	C10-C40
Day 1	sample 0270, 1	SGS	83.1	65.1	30.8	12.7	52.3
	sample 0270, 2	SGS	83.4	65.2	30.7	12.5	52.7
	sample 0270, 3	SGS	81.8	63.7	30.6	12.5	51.2
	sample 0271, 1	SGS	207.9	60.4	154.0	6.5	53.9
	sample 0271, 2	SGS	209.7	61.0	155.2	6.5	54.5
	sample 0271, 3	SGS	205.7	59.3	152.9	6.4	52.9
	sample 0272, 1	SGS	2.9	2.9	1.2	1.1	1.8
	sample 0272, 2	SGS	2.8	2.7	1.1	1.1	1.7
	sample 0272, 3	SGS	2.7	2.6	1.1	1.1	1.6
Day 2	sample 0270, 1	SGS	83.1	65.2	30.4	12.5	52.7
	sample 0270, 2	SGS	79.8	65.5	29.4	12.2	50.3
	sample 0270, 3	SGS	81.4	63.8	29.9	12.4	51.4
	sample 0271, 1	SGS	201.4	59.6	148.1	6.3	53.3
	sample 0271, 2	SGS	199.5	58.5	147.3	6.3	52.3
	sample 0271, 3	SGS	196.4	56.6	145.9	6.1	50.4
	sample 0272, 1	SGS	4.0	3.9	1.0	0.9	3.0
	sample 0272, 2	SGS	3.9	3.8	1.0	0.9	2.9
	sample 0272, 3	SGS	3.9	3.8	1.0	0.9	2.9
Day 1	sample 0270, 1	ITS	98.9	74.6	35.8	11.6	63.1
	sample 0270, 2	ITS	100.5	76.6	35.3	11.5	65.2
	sample 0270, 3	ITS	105.3	80.6	36.6	11.8	68.8
	sample 0271, 1	ITS	305.5	75.0	235.9	5.4	69.6
	sample 0271, 2	ITS	316.0	77.3	244.4	5.7	71.6
	sample 0271, 3	ITS	313.6	78.8	240.3	5.5	73.4
	sample 0272, 1	ITS	-	-	-	-	-
	sample 0272, 2	ITS	-	-	-	-	-
	sample 0272, 3	ITS	-	-	-	-	-
Day 2	sample 0270, 1	ITS	93.6	69.7	34.8	10.9	58.8
	sample 0270, 2	ITS	93.1	70.2	33.9	10.9	59.2
	sample 0270, 3	ITS	93.4	69.7	34.6	11.0	58.8
	sample 0271, 1	ITS	291.9	63.1	233.9	5.2	57.9
	sample 0271, 2	ITS	289.0	64.4	229.9	5.2	59.2
	sample 0271, 3	ITS	282.4	66.3	231.3	5.2	61.2
	sample 0272, 1	ITS	-	-	-	-	-
	sample 0272, 2	ITS	-	-	-	-	-
	sample 0272, 3	ITS	-	-	-	-	-

Day	sample	lab	C7-C40	C7-C40 - TEX	C7-C10	C7-C10 - TEX	C10-C40
Day 1	sample 0270, 1	WLS	78.6	63.3	25.3	10.0	53.3
	sample 0270, 2	WLS	77.7	62.5	25.3	10.1	52.4
	sample 0270, 3	WLS	-	-	-	-	-
	sample 0271, 1	WLS	263.3	56.9	210.0	3.6	53.3
	sample 0271, 2	WLS	260.5	58.0	206.0	3.5	54.5
	sample 0271, 3	WLS	-	-	-	-	-
	sample 0272, 1	WLS	<2	<2	<0.2	<0.1	<2
	sample 0272, 2	WLS	<2	<2	<0.2	<0.1	<2
	sample 0272, 3	WLS	-	-	-	-	-
Day 2	sample 0270, 1	WLS	-	-	-	-	46.6
	sample 0270, 2	WLS	68.3	55.7	20.9	8.3	47.4
	sample 0270, 3	WLS	-	-	-	-	46.2
	sample 0271, 1	WLS	251.3	51.8	203.0	3.5	48.3
	sample 0271, 2	WLS	250.6	51.0	203.0	3.5	47.6
	sample 0271, 3	WLS	-	-	-	-	47.6
	sample 0272, 1	WLS	<2	<2	<0.2	<0.1	<2
	sample 0272, 2	WLS	<2	<2	<0.2	<0.1	<2
	sample 0272, 3	WLS	-	-	-	-	<2
Day 1	sample 0270, 1	DTI	55.243	41.503	25.306	11.566	29.937
	sample 0270, 2	DTI	53.948	40.238	26.034	12.324	27.914
	sample 0270, 3	DTI	57.813	44.013	27.214	13.414	30.599
	sample 0271, 1	DTI	199.323	41.349	164.290	5.980	35.370
	sample 0271, 2	DTI	174.460	31.160	149.483	6.183	24.978
	sample 0271, 3	DTI	209.150	43.350	173.316	7.516	35.834
	sample 0272, 1	DTI	-	-	-	-	-
	sample 0272, 2	DTI	-	-	-	-	-
	sample 0272, 3	DTI	-	-	-	-	-
Day 2	sample 0270, 1	DTI	63.251	45.291	32.657	14.697	30.593
	sample 0270, 2	DTI	60.940	43.010	29.958	12.028	30.981
	sample 0270, 3	DTI	56.447	41.057	27.626	12.236	28.822
	sample 0271, 1	DTI	207.760	34.160	180.242	6.642	27.518
	sample 0271, 2	DTI	203.507	31.607	178.528	6.628	24.978
	sample 0271, 3	DTI	215.429	36.029	186.959	7.559	28.470
	sample 0272, 1	DTI	-	-	-	-	-
	sample 0272, 2	DTI	-	-	-	-	-
	sample 0272, 3	DTI	-	-	-	-	-

## Appendix 2: Data reports (anonimised)

Platform-code	Oil (O), condensate (C) or Gas (G)	PW rate (m3/d)	AV oil content (mg/l)	Results IR TCE method [mg/l]			Results IR freon method [mg/l]			ISO 9377-2 [mg/l]				
				Dispersed [mg/l]	Oil	Aromatics	Dispersed [mg/l]	Oil	Aromatics	C <sub>10</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>40</sub> minus TEX	C <sub>7</sub> - C <sub>10</sub>	C <sub>7</sub> - C <sub>10</sub> minus TEX	
24	O	0	0	-	319	-	-	-	-	134.3	155.9	165.8	31.6	21.6
24	O	0	0	-	323	-	-	-	-	216.6	250.5	258.9	42.3	33.9
24	O	0	0	-	7220	-	-	-	-	6048	7770	8162	2114	1721
24	O	0	0	-	24.7	-	-	-	-	1.5	4.1	16.6	15.1	2.6
20	C	250	5.8	-	67.2	-	-	-	-	185.8	217.4	260.6	74.8	31.6
20	C	250	5.8	-	17	-	-	-	-	271.7	344	384.3	112.6	72.3
20	C	250	5.8	-	3.4	-	-	-	-	2.7	3.6	16.5	13.8	0.9
20	C	250	5.8	-	3.5	-	-	-	-	2	2.9	18.6	16.6	0.9
37	C	70	7.8	-	12.7	-	-	-	-	7.7	7.7	24.6	17	0
37	C	70	7.8	-	11.8	-	-	-	-	7.1	7.1	23.4	16.3	0
37	C	70	7.8	-	5.9	-	-	-	-	2	2	11.5	9.4	0
37	C	70	7.8	-	6	-	-	-	-	3.6	3.6	12	8.3	0
38	O	42490	8.58	-	16.6	-	-	-	-	0.9	3.1	11.3	10.4	2.2
38	O	42490	8.58	-	10.5	-	-	-	-	0.6	2.3	11	10.5	1.7
38	O	42490	8.58	-	11.7	-	-	-	-	0.4	1.2	4.6	4.2	0.8
38	O	42490	8.58	-	4.6	-	-	-	-	0.5	2.4	9	8.5	2
44	C	350	11.17	-	10.3	-	-	-	-	11.6	12.6	53	41.4	1
44	C	350	11.17	-	8.3	-	-	-	-	12.7	13.4	50.4	37.7	0.7
44	C	350	11.17	-	8.6	-	-	-	-	5.2	6.3	49.7	44.5	1.1
44	C	350	11.17	-	8	-	-	-	-	3.1	3.1	4.6	1.5	0
33	C	6	13	-	35.3	-	-	-	-	32.7	33.5	36.5	3.8	0.8
33	C	6	13	-	33.2	-	-	-	-	54.1	54.7	61.2	7.1	0.7
33	C	6	13	-	12.3	-	-	-	-	7	7.6	14.2	7.2	0.6
33	C	6	13	-	3.7	-	-	-	-	0.1	0.9	7.1	7	0.8
29	G	1590	14.1	-	11.4	-	-	-	-	4.2	4.2	6	1.8	0
29	G	1590	14.1	-	6.3	-	-	-	-	4.1	4.1	6.5	2.3	0
29	G	1590	14.1	-	4	-	-	-	-	2.9	2.9	4.7	1.8	0
29	G	1590	14.1	-	4	-	-	-	-	4	4	5.9	1.9	0
17	O	46834	15	1.7	1.7	0	-	-	-	1.1	1.2	1.6	<0,5	<0,5
17	O	46834	15	1.7	1.6	0.1	-	-	-	1.4	1.4	1.9	<0,5	<0,5
17	O	46834	15	1.2	1.2	0	-	-	-	0.91	<1	1.41	<0,5	<0,5
17	O	46834	15	1.5	1.5	0	-	-	-	1.1	1.1	1.6	<0,5	<0,5
30	G	1100	16.8	-	18.1	-	-	-	-	2.1	2.3	14.1	12	0.2
30	G	1100	16.8	-	18.2	-	-	-	-	0.1	0.4	13.6	13.5	0.3
30	G	1100	16.8	-	11	-	-	-	-	0.4	1.2	9.1	8.6	0.7
30	G	1100	16.8	-	9.6	-	-	-	-	0.2	1.1	9.8	9.6	0.9
19	O	56408	17	29	26	3	-	-	-	21	23	24	2.9	1.7
19	O	56408	17	30	27	3	-	-	-	21	23	24	3	1.7
19	O	56408	17	22	20	2	-	-	-	19	20	22	2.7	1.4
19	O	56408	17	20	17	3	-	-	-	12	13	14	3.1	1.3

Platform-code	Oil (O), condensate (C) or Gas (G)	PW rate (m3/d)	AV oil content (mg/l)	Results IR TCE method [mg/l]			Results IR freon method [mg/l]			ISO 9377-2 [mg/l]				
				Dispersed			Dispersed			C <sub>7</sub> - C <sub>40</sub> minus		C <sub>7</sub> - C <sub>10</sub> minus		
				[mg/l]	Oil	Aromatics	[mg/l]	Oil	Aromatics	C <sub>10</sub> - C <sub>40</sub>	TEX	C <sub>7</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>10</sub>	TEX
16	O	143378	18	11	10	1	30	29	1	13	14	13.9	0.9	0.67
16	O	143378	18	7.1	5.7	1.4	12	11	1	4.6	5	5.21	0.61	<0,5
16	O	143378	18	6.5	5.6	0.9	4.7	4.7	0	3.7	4.2	4.39	0.69	<0,5
16	O	143378	18	9.6	8.8	0.8	9.4	8.6	0.8	6.2	6.8	7.06	0.86	0.64
16	O	143378	18	9.7	8.6	1.1	8.7	7.8	0.9	4.9	5.2	5.4	<0,5	<0,5
16	O	143378	18	72	64	8	-	-	-	29	30	29.74	0.74	0.54
16	O	143378	18	55	50	5	-	-	-	44	45	44.99	0.99	0.77
21	C	60	18	-	8.8	-	-	-	-	0.9	2.4	26.4	25.5	1.5
21	C	60	18	-	8.9	-	-	-	-	1.1	2.5	28.1	27	1.4
21	C	60	18	-	8.9	-	-	-	-	0	0.5	22.1	22.1	0.5
21	C	60	18	-	9.3	-	-	-	-	0	0.6	25.4	25.4	0.6
45	O	10050	18.53	-	26.4	-	-	-	-	23.6	25.6	33.8	10.2	2
45	O	10050	18.53	-	22.7	-	-	-	-	25.7	27	36.5	10.8	1.3
45	O	10050	18.53	-	34.3	-	-	-	-	34.7	36.1	44.8	10.1	1.4
45	O	10050	18.53	-	33.3	-	-	-	-	21.4	44.9	58.3	36.9	23.5
47	O	7595	20	-	-	-	-	15	-	10	14.9	17.3	7.3	4.9
47	O	7595	20	-	-	-	-	19	-	4.1	7.7	9.2	5.1	3.6
47	O	7595	20	-	-	-	-	7	-	6.3	10.2	12	5.7	3.9
57	O/G	36851	22	-	-	-	42.76	31.3	11.46	32.8	33.46	48.5	15.7	0.66
57	O/G	36851	22	-	-	-	29.5	25.6	3.9	31.5	32.27	47.3	15.8	0.77
57	O/G	36851	22	-	-	-	15.45	10	5.45	13.7	14.7	28.75	15.05	0.7
57	O/G	36851	22	-	-	-	24.87	16.4	8.47	18.1	18.85	34.73	16.63	0.75
2	G	15227	23	41	34	7	40	33	7	24	34	39	15	10
2	G	15227	23	52	48	4	46	44	2	26	34	39	13	8.2
2	G	15227	23	15	9.2	5.8	90	16	74	5.8	8.6	10.4	4.6	2.8
2	G	15227	23	12	7.9	4.1	12	8.5	3.5	7.5	10	13.4	5.9	2.8
2	G	15227	23	12	7.3	4.7	11	7	4	6.4	9.4	13	6.6	3
2	G	15227	23	21	15	6	-	-	-	15	17	18.8	3.8	1.6
2	G	15227	23	18	14	4	-	-	-	12	13	15.1	3.1	1
10	G	2830	23	62	6.1	55.9	-	-	-	7.3	7.5	10	2.9	<0,50
10	G	2830	23	68	6.4	61.6	-	-	-	7.1	7.4	9.9	2.8	<0,50
10	G	2830	23	58	5.4	52.6	-	-	-	6.8	7	9.6	2.8	<0,50
10	G	2830	23	58	5.4	52.6	-	-	-	6.4	6.6	9.2	2.8	<0,50
52	G/C	2384	23	-	-	-	-	127	-	24	41	65.4	41.4	17
52	G/C	2384	23	-	-	-	-	32	-	9.7	16.3	24	14.3	6.6
52	G/C	2384	23	-	-	-	-	22	-	8.3	14.6	25.5	17.2	6.3
40	O	8480	23.94	-	19.8	-	-	-	-	2.8	2.8	2.8	0	0
40	O	8480	23.94	-	24.1	-	-	-	-	9.1	9.1	9.1	0.1	0.1
40	O	8480	23.94	-	34.9	-	-	-	-	18.6	18.8	18.8	0.2	0.2
40	O	8480	23.94	-	35.3	-	-	-	-	21.4	21.5	21.8	0.3	0
41	O	11130	24.75	-	12.4	-	-	-	-	8.8	8.9	11	2.2	0.2
41	O	11130	24.75	-	5.3	-	-	-	-	5.1	5.1	7.3	2.2	0
41	O	11130	24.75	-	3.4	-	-	-	-	2	2	4.4	2.3	0
42	O	11130	24.75	-	12.6	-	-	-	-	6	6	8.1	2.2	0
42	O	11130	24.75	-	12.1	-	-	-	-	7.6	7.6	10.5	2.9	0
42	O	11130	24.75	-	4.7	-	-	-	-	3.5	3.5	5.3	1.8	0

Platform-code	Oil (O), condensate (C) or Gas (G)	PW rate (m3/d)	AV oil content (mg/l)	Results IR TCE method [mg/l]			Results IR freon method [mg/l]			ISO 9377-2 [mg/l]				
				Dispersed [mg/l]	Oil	Aromatics	Dispersed [mg/l]	Oil	Aromatics	C <sub>10</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>40</sub> minus TEX	C <sub>7</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>10</sub>	C <sub>7</sub> - C <sub>10</sub> minus TEX
48	O	10935	25	-	-	-	-	25	-	8.8	13.3	15.2	6.4	4.5
48	O	10935	25	-	-	-	-	45	-	8.6	14.1	16.6	8	5.5
48	O	10935	25	-	-	-	-	21	-	8.5	13.1	15.1	6.6	4.6
54	G/C	4749	25	-	-	-	-	25	-	31	37.6	44.2	13.2	6.6
54	G/C	4749	25	-	-	-	-	31	-	24	32	40.2	16.2	8
54	G/C	4749	25	-	-	-	-	18	-	13	18.1	20.7	7.7	5.1
58	O/G	2857	26.7	-	-	-	18.89	15.4	3.49	12.9	13.78	20.07	4.17	0.89
58	O/G	2857	26.7	-	-	-	18.43	15.7	2.73	14.3	15.29	18.92	4.62	0.99
58	O/G	2857	26.7	-	-	-	58.08	50.5	7.58	37.7	40.88	44.83	7.13	3.18
58	O/G	2857	26.7	-	-	-	22.69	18.6	4.09	18.7	20.36	24.72	6.02	1.66
27	O	1830	26.94	-	14	-	-	-	-	3.3	3.7	11.1	7.8	0.3
27	O	1830	26.94	-	18.4	-	-	-	-	10.9	13.1	21.9	11	2.2
27	O	1830	26.94	-	6.2	-	-	-	-	4.6	5.4	13.8	9.2	0.8
27	O	1830	26.94	-	13.5	-	-	-	-	6.4	8.2	16.7	10.3	1.8
18	O	220434	27	32	30	2	31	29	2	19	22	22	3.4	2.5
18	O	220434	27	40	38	2	40	35	5	22	24	25	3.3	2.5
18	O	220434	27	41	37	4	45	41	4	19	21	22	2.5	2
18	O	220434	27	26	24	2	26	23	3	16	18	19	2.6	1.9
18	O	220434	27	36	33	3	37	32	5	18	20	21	2.6	2.1
18	O	220434	27	49	45	4	50	43	7	28	31	31	3.3	2.8
18	O	220434	27	42	37	5	42	37	5	24	26	27	3.4	2.5
18	O	220434	27	53	48	5	-	-	-	36	40	41	5.2	4
18	O	220434	27	55	50	5	-	-	-	38	42	43	5.3	4
18	O	220434	27	25	22	3	-	-	-	27	29	30	2.9	2
18	O	220434	27	44	41	3	-	-	-	12	13	14	1.6	0.86
25	C	15	27	-	33.2	-	-	-	-	17.2	25.5	36.9	19.6	8.3
25	C	15	27	-	33.3	-	-	-	-	24.8	35	47.7	22.9	10.2
25	C	15	27	-	96.7	-	-	-	-	18.1	24.1	30.6	12.5	6
25	C	15	27	-	27.9	-	-	-	-	71.5	95.5	103.7	32.1	24
53	O/G/C	1611	27	-	-	-	-	51	-	43	57	68.7	25.7	14
53	O/G/C	1611	27	-	-	-	-	61	-	15	24	37.9	22.9	9
53	O/G/C	1611	27	-	-	-	-	2652	-	870	1420	1560	690	550
35	O	850	27.9	-	4.5	-	-	-	-	3	3.3	5.8	2.8	0.3
35	O	850	27.9	-	2.3	-	-	-	-	0.4	0.7	2.7	2.3	0.3
35	O	850	27.9	-	63.1	-	-	-	-	33.6	35.3	39.1	5.4	1.7
35	O	850	27.9	-	3.4	-	-	-	-	2.7	3.1	5.7	3	0.4
43	O	24000	28.4	-	32.6	-	-	-	-	13.4	13.5	20.3	6.9	0.1
43	O	24000	28.4	-	27.9	-	-	-	-	15.9	16.3	23.2	7.4	0.4
43	O	24000	28.4	-	47.2	-	-	-	-	21.9	22.3	29.8	7.9	0.4
43	O	24000	28.4	-	44.4	-	-	-	-	19.5	20.3	28	8.4	0.7
26	C	200	30.49	-	6.3	-	-	-	-	4	5.1	43.4	39.4	1
26	C	200	30.49	-	6.3	-	-	-	-	2.8	3.9	42.2	39.4	1.1
26	C	200	30.49	-	7.7	-	-	-	-	5.4	7.6	50.3	45	2.2
26	C	200	30.49	-	25.5	-	-	-	-	6.8	9.2	52.9	46.1	2.4
12	G	4405	32	2.6	1.4	1.2	-	-	-	0.56	<1	1.2	0.66	<0,50
12	G	4405	32	2.7	1.4	1.3	-	-	-	0.67	<1	1.3	0.59	<0,50
12	G	4405	32	6.4	3.2	3.2	-	-	-	1.9	2.5	6	4.1	0.58
12	G	4405	32	16	10	6	-	-	-	7.8	8.3	11	2.9	0.51



Platform-code	Oil (O), condensate (C) or Gas (G)	PW rate (m3/d)	AV oil content (mg/l)	Results IR TCE method [mg/l]			Results IR freon method [mg/l]			ISO 9377-2 [mg/l]				
				Dispersed [mg/l]	Oil	Aromatics	Dispersed [mg/l]	Oil	Aromatics	C <sub>10</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>40</sub> minus TEX	C <sub>7</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>10</sub>	C <sub>7</sub> - C <sub>10</sub> minus TEX
23	O/C	60	32.44	-	59.3	-	-	-	-	23	36.1	56	33	13.1
23	O/C	60	32.44	-	61	-	-	-	-	22.6	36.1	54.1	31.5	13.6
23	O/C	60	32.44	-	85.6	-	-	-	-	43.3	75.8	106.9	63.6	32.5
23	O/C	60	32.44	-	192	-	-	-	-	74.1	118.9	159.5	85.4	44.8
28	O	47460	34.36	-	33.7	-	-	-	-	0.7	0.8	15.7	15	0.1
28	O	47460	34.36	-	31.8	-	-	-	-	1.2	1.3	16.5	15.3	0.1
28	O	47460	34.36	-	60.5	-	-	-	-	43.2	45.6	59.6	16.4	2.4
28	O	47460	34.36	-	34.3	-	-	-	-	29.1	30.2	43.5	14.4	1.2
39	O	6970	35.85	-	57.6	-	-	-	-	29.9	34.6	38.2	8.3	4.7
39	O	6970	35.85	-	67.4	-	-	-	-	29.9	35.1	40.4	10.5	5.2
39	O	6970	35.85	-	40.9	-	-	-	-	14.8	18.1	22.3	7.6	3.3
39	O	6970	35.85	-	48.4	-	-	-	-	17.9	22.3	26.8	8.9	4.3
46	O	937	36	-	-	-	-	33	-	26	32.6	37.7	11.7	6.6
46	O	937	36	-	-	-	-	12	-	19	25.3	33.1	14.1	6.3
46	O	937	36	-	-	-	-	7	-	14	18.8	23	9	4.8
31	O	18750	36.87	-	11.5	-	-	-	-	1.4	1.4	14.4	13	0
31	O	18750	36.87	-	12.7	-	-	-	-	1.8	1.8	14.1	12.3	0
31	O	18750	36.87	-	10	-	-	-	-	1.7	1.7	16.8	15.1	0
31	O	18750	36.87	-	19.1	-	-	-	-	1.8	2.5	18.9	17	0.7
15	G	93	41	29	3.3	25.7	-	-	-	3.4	6	15	12	2.6
15	G	93	41	32	3.8	28.2	-	-	-	3.1	5.6	15	12	2.5
15	G	93	41	31	3.7	27.3	-	-	-	2.9	5.3	15	12	2.4
15	G	93	41	22	11	11	-	-	-	13	15	22	9.4	2.3
49	O	1141	41	-	-	-	-	86	-	66	79	83.3	17.3	13
49	O	1141	41	-	-	-	-	135	-	72	91	94.9	22.9	19
49	O	1141	41	-	-	-	-	25	-	34	44	48.2	14.2	10
34	C	17	43	-	130	-	-	-	-	81.5	154	165	83	72.2
34	C	17	43	-	150	-	-	-	-	79.1	149	160	80.7	70
34	C	17	43	-	108	-	-	-	-	72.4	136	146	73.9	63.4
34	C	17	43	-	113	-	-	-	-	65.9	130	140	74	63.8
5	G	797	51	37	4.4	32.6	-	-	-	3.8	4.2	8	4.2	<0,50
5	G	797	51	36	5.1	30.9	-	-	-	3.5	4	7.9	4.4	<0,50
5	G	797	51	40	5.5	34.5	-	-	-	3.3	3.8	7.6	4.3	0.55
5	G	797	51	48	8.3	39.7	-	-	-	11	12	18	7.5	1.2
50	O	12576	59	-	-	-	-	19	-	15	19.5	22.9	7.9	4.5
50	O	12576	59	-	-	-	-	33	-	23	31.5	40.4	17.4	8.5
50	O	12576	59	-	-	-	-	6	-	21	27.8	34.3	13.3	6.8
51	O	6925	61	-	-	-	-	34	-	33	39.2	42.5	9.5	6.2
51	O	6925	61	-	-	-	-	24	-	23	29.6	33.2	10.2	6.6
51	O	6925	61	-	-	-	-	25	-	26	31.6	34.9	8.9	5.6
6	G	149	62	54	7.5	46.5	-	-	-	6.1	7.2	13	7.3	1.1
6	G	149	62	54	7.6	46.4	-	-	-	6.9	8.1	14	7.4	1.2
6	G	149	62	51	6.6	44.4	-	-	-	5.6	6.6	12	6.7	1
6	G	149	62	36	4.9	31.1	-	-	-	3.7	4.7	9.8	6.1	0.98

Platform-code	Oil (O), condensate (C) or Gas (G)	PW rate (m3/d)	AV oil content (mg/l)	Results IR TCE method [mg/l]			Results IR freon method [mg/l]			ISO 9377-2 [mg/l]				
				Dispersed			Dispersed			C <sub>7</sub> - C <sub>40</sub> minus		C <sub>7</sub> - C <sub>10</sub> minus		
				[mg/l]	Oil	Aromatics	[mg/l]	Oil	Aromatics	C <sub>10</sub> - C <sub>40</sub>	TEX	C <sub>7</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>10</sub>	TEX
32	C	70	63	-	8	-	-	-	-	1.9	3.5	11.6	9.7	1.6
32	C	70	63	-	9.5	-	-	-	-	1.2	2.5	12.6	11.4	1.3
32	C	70	63	-	6.1	-	-	-	-	1.2	1.7	3.4	2.2	0.6
32	C	70	63	-	4.9	-	-	-	-	1.7	2.5	4.1	2.4	0.8
8	G	440	64	110	82	28	-	-	-	58	81	88	30	23
8	G	440	64	110	81	29	-	-	-	54	75	81	27	21
8	G	440	64	32	17	15	-	-	-	9.6	13	15	5.6	3.3
8	G	440	64	26	12	14	-	-	-	9	11	14	4.7	2.3
1	G	28	74	52	7.5	44.5	-	-	-	5.1	8.7	23	18	3.6
1	G	28	74	56	8.2	47.8	-	-	-	5	8.7	23	18	3.7
1	G	28	74	73	9.1	63.9	-	-	-	6.2	10	25	19	3.9
1	G	28	74	93	13	80	-	-	-	5.3	9	25	20	3.7
3	G	528	94	780	40	740	740	49	691	21	32	92	71	11
3	G	528	94	320	12	308	140	7.4	132.6	12	21	77	65	9.3
3	G	528	94	460	19	441	590	26	564	18	28	79	61	9.5
3	G	528	94	380	14	366	590	22	568	12	25	64	52	13
3	G	528	94	1200	23	1177	1200	28	1172	6.7	11	32.7	26	4.3
3	G	528	94	1200	34	1166	1200	26	1174	8.6	15	38.6	30	6.7
3	G	528	94	1700	170	1530	-	-	-	76	140	260	180	62
3	G	528	94	1800	180	1620	-	-	-	80	140	260	180	65
7	G	945	124	210	58	152	-	-	-	34	54	68	34	20
7	G	945	124	200	56	144	-	-	-	34	54	68	34	20
7	G	945	124	170	62	108	-	-	-	41	61	74	33	20
7	G	945	124	210	75	135	-	-	-	36	64	78	42	28
11	G	2493	127	200	30	170	-	-	-	3.7	5.6	25	21	1.9
11	G	2493	127	190	7.4	182.6	-	-	-	5.9	7.6	18	12	1.7
11	G	2493	127	200	20	180	-	-	-	4.1	5.5	16	12	1.4
11	G	2493	127	190	98	92	-	-	-	4.5	6.3	14	10	1.8
13	G	4509	137	120	35	85	100	28	72	22	30	44	22	7.8
13	G	4509	137	170	72	98	170	74	96	41	67	85	44	26
13	G	4509	137	120	72	48	100	66	34	73	110	119	46	33
13	G	4509	137	130	77	53	160	90	70	32	53	64	32	21
13	G	4509	137	90	38	52	94	40	54	17	30	37	20	13
13	G	4509	137	200	25	175	-	-	-	19	24	41	22	4.8
13	G	4509	137	190	24	166	-	-	-	20	25	42	22	5
4	G	1371	182	220	12	208	-	-	-	1.1	3.3	20	19	2.2
4	G	1371	182	220	12	208	-	-	-	1	3	18	17	2
4	G	1371	182	540	34	506	-	-	-	5.9	20	86	80	14
4	G	1371	182	330	21	309	-	-	-	3.3	8.6	36	33	5.3
14	G	1295	190	160	36	124	220	47	173	14	29	46	32	15
14	G	1295	190	170	48	122	160	45	115	15	31	44	29	16
14	G	1295	190	180	37	143	120	22	98	9	23	38	29	14
14	G	1295	190	80	21	59	100	23	77	11	27	47	36	16
14	G	1295	190	160	17	143	120	15	105	8.7	23	51.7	43	14
14	G	1295	190	500	37	463	-	-	-	5.5	8.5	36	31	14
14	G	1295	190	500	34	466	-	-	-	5.6	9.2	38	32	15

Platform-code	Oil (O), condensate (C) or Gas (G)	PW rate (m3/d)	AV oil content (mg/l)	Results IR TCE method [mg/l]			Results IR freon method [mg/l]			ISO 9377-2 [mg/l]				
				Dispersed			Dispersed			C <sub>7</sub> - C <sub>40</sub> minus		C <sub>7</sub> - C <sub>10</sub> minus		
				[mg/l]	Oil	Aromatics	[mg/l]	Oil	Aromatics	C <sub>10</sub> - C <sub>40</sub>	TEX	C <sub>7</sub> - C <sub>40</sub>	C <sub>7</sub> - C <sub>10</sub>	TEX
9	G	1157	330	420	17	403	-	-	-	6	13	64	58	7.1
9	G	1157	330	530	19	511	-	-	-	6.4	11	61	55	4.2
9	G	1157	330	450	14	436	-	-	-	5.1	8.8	59	54	3.7
9	G	1157	330	427	14	413	-	-	-	5.9	12	62	56	6
36	C	21	525	-	8.5	-	-	-	-	1.5	1.5	5.5	4	0
36	C	21	525	-	8.2	-	-	-	-		5.9	14.1		
36	C	21	525	-	21.4	-	-	-	-	8.3	12.7	25.7	17.4	4.4
36	C	21	525	-	24.5	-	-	-	-	17.5	25.4	35.4	17.9	7.9
22	C	100	1900	-	1370	-	-	-	-	1010	1358	1400	390	348
22	C	100	1900	-	1460	-	-	-	-	941	1263	1293	352	322
22	C	100	1900	-	1420	-	-	-	-	1041	1571	1631	590	530
55	O			-	-	-	-	50	-	24	29.1	34.3	15.3	5.1
55	O			-	-	-	-	46	-	13	15	18.6	9.6	2
55	O			-	-	-	-	50	-	27	30.4	34.2	7.2	3.4
55	O			-	-	-	-	58	-	29	32.5	36.2	7.2	3.5
56	O			-	-	-	-	13	-	11	12.3	17.8	6.8	1.3
56	O			-	-	-	-	13	-	11	12.4	18.6	7.6	1.4
56	O			-	-	-	-	12	-	8.8	9.9	15.1	6.3	1.1
56	O			-	-	-	-	14	-	11	12	17	6	1