Petrotech a.s
KNOWLEDGE

Well: 15/9-19SR

TRACE ELEMENT ANALYSES OF GAS, OIL AND WATER

CLIENT	: STATOIL
FORMATION	:
WELL	: 15/9-19SR
DATE	: 17.04.93 - 21.04.93
CLIENT REP.	: KJELL ARNE GRINI / LEIF ARNE DØSSELAND

Date of reporting	: 06.05.93
Project/report no.	: K-311/trace
Project responsible	: Roald Skjoldal
Participants	: Roald Skjoldal Rune Hamre

Report prepared by	: Roald Skjoldal
Report reviewed by	:

Number of issues	:
Distribution Petrotech	:
Distribution STATOIL:	

Petrotech a.s
P.O.Box 575
N-5501 HAUGESUND
Norway
Phone: + 47 4 73 71 00
Fax: + 47 4 73 71 10
Telex: 33207

SUMMARY

During the test of well 15/9-19SR , Petrotech a.s performed a sampling and analytical programme for trace components in gas, oil and water. The gas samples were taken from the test separator gas outlet line. Water samples from the flow orifice in gas outlet line. Oil samples were taken down stream of the choke manifold.

2 bottom hole samples were taken at the end of "Clean-up flow" build up.

Gas

The produced gas was analysed on-site for Hydrogen Sulphide (H_2S), Carbon dioxide (CO_2), Mercaptans (R-SH), and Radon (^{222}Ra)

Samples were brought to Petrotech's laboratory for determination of Hydrogen Sulphide (H_2S), Mercaptans (R-SH) and "other sulphur components" in the gas.

OIL

Water content in the oil was measured on-site.

Water

Condensed water was analysed on-site for chloride (Cl), alkalinity, carbonate, bicarbonate, pH, conductivity, density, sulphate and barium+strontium.

Flashed gas BHS

Flashed gas from SRS-021 was sampled in a 2000 cc teflon gas sampling bag, Hydrogen Sulphide and Carbon Dioxide was measured both with Dräger tubes and gas chromatography, all measurements were performed on site. Gas was flashed from a monophasic Bottom Hole Sample through a 1/8"O.D. stainless steel tubing and a 500 cc teflon coated high pressure vessel.

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I. INTRODUCTION

The production test from well 15/9-19SR was carried out during the period 17.04.93 - 21.04.93. One zone was tested with three different flow periods.

Flow period	
1	Clean-up flow
2	Sampling flow
3	Main flow

In this report Petrotech presents the oil , gas and water analysis from the various flow periods.

1.1.Sampling

Gas, oil and water were sampled and analysed on-site during each of the three flow periods. The samples were taken at the separator outlet lines. Samples for laboratory analyses were normally taken at the end of each flow period to obtain representative fluid from stable flowing conditions.

Bottom Hole Samples were taken after the build up of the "Clean-up flow". The well was opened at 07:00 hrs. April 19th. on a 12/64 "choke for sampling flow. The well was shut in at the choke manifold at 10:17 hrs prior to sampling at 10:30 hrs.

Gas samples for laboratory analysis were taken at a slightly higher than atmospheric pressure in 500 cc acid washed glass vessels.

Liquid samples were taken in 1 litre polyethylene bottles and 20 litre plastic cans.

1.2.Analyses

The following analyses were performed on-site with Petrotech mobile laboratory equipment.

Gas:	Oil:	Water:
hydrogen sulphide (H_2S),	density	chloride (Cl^-)
carbon dioxide (CO_2),	water	alkalinity,carbonate and bicarbonate
mercaptans (R-SH),		pH
radon (^{222}Ra)		conductivity
		sulphate (SO_4)
		barium+strontium (Ba+S

2. ANALYTICAL METHODS

2.1. Analytical methods in gas

2.1.1. Hydrogen sulphide

Dräger tube method: Concentration of H_2S was determined using Dräger tubes. Gas was vented through teflon coated lines to a small, open vessel where the gas was sampled with a hand pump.

The Dräger glass tubes are filled with a white metal salt (lead or copper) which form brownish metal-sulphide when hydrogen-sulphide is present. Concentration is read directly on the tube scale in ppm(vol).

The analyses were performed on-site.

Jerome Analyzers: Portable instruments for determination of mercury or hydrogen sulphide. A known amount of gas/air is drawn into the detector, and the concentration of hydrogen sulphide or mercury is automatically calculated. On site determination.

GC method: A carrier gas brings the injected sample through coloumns where the components are separated. The hydrogen sulphide are detected by a specified detector and the amount is calculated by a calibrated integrator. On site determination.

Potentiometric titration: The gas (1 - 50 L) is washed through an absorption liquid. This liquid is then titrated potentiometrically with silver nitrate, whose concentration depends on the amount of hydrogen sulphide in the gas. This method could also be used to determine H_2S in condensate and water by direct titration. This method is most suitable for larger concentrations of hydrogen sulphide. On site determination.

Microcoulometric detection: A GC method coupled with a microcoulometric detector enable detection of hydrogen sulphide, mercaptans, carbonyl sulphides, alkyl sulphides, thiophenes and total sulphur in one operation. The procedure used is a modified version of SMS (Shell Method Series) 2336 using a capillary column instead of a packed column to give improved separation of compounds. The gas sample is collected in a glass vessel, which are cleaned and prepared with acid.
Onshore laboratory determination.

2.1.2. Mercaptans

The concentration of mercaptans were determined using Dräger tubes. Sampling was performed as for hydrogen sulphide.

The Dräger glass tubes have a filter which removes hydrogen sulphide, followed by palladium salt which form yellowish mercaptide salt when mercaptans are present. Concentration is read directly on the tube scale in ppm(vol).

The analyses were performed on-site.

2.1.3. Carbon dioxide

Concentration of carbon dioxide was determined using Dräger tubes. Sampling was performed as for hydrogen sulphide.

The Dräger glass tubes are filled with crystal violet and hydrazine. Carbon dioxide reacts with the hydrazine to form carbonic acid monohydrazine, and crystal violet acts as a redox indicator to colour the internal blue. Concentration is read directly on the tube scale in vol%.

The analyses were performed on-site.

2.1.4. Radon-222

The concentration of radon-222 was measured with a RDA 200 radon detector. Gas was vented through teflon coated lines and collected in a sampling cell.

A fixed volume of gas is collected in a scintillation absorbtion cell with silver-activated zinc-sulphide phosphor coated internal. The radium daughter radon-222 has a half life of 3.82 days, whereafter it is converted to polonium-218 and an alpha-particle. The alpha-radiation reacts with the coating on the cell-wall, which produces a photon. The number of photons is proportional to content of radon-222, and counted with the RDA 200 high-gain photomultiplier.

The analyses were performed on-site.

2.2 Analytical methods in oil

2.2.1. Density

Density was measured with DMA-35 densitometer.

A fixed volume, u-shaped glass tube in contact with an oscillator is filled with sample. The oscillation-frequency of the undamped glass-tube is mass-dependent, thus density of the sample can be determined from the oscillation frequency.

The analyses were performed both on-site and in laboratory.

2.2.1. Water in oil

Karl Fischer: Used for determination of water content in a sample. It is a voltametric titration method; "controlled current- potentiometry with two indicating electrodes" The sampling lines are dried with nitrogen before sampling, and the equipments are dried as well. The determination is usually carried out on site.

2.2 Analytical methods in water

2.3.1. Chloride

The chloride content was analysed by titration.

The method is based upon ASTM method D 4458-85, which is a Mohr titration with silver nitrate. Chloride reacts with silver to form silver chloride, and precipitates as a white solid. Endpoint of titration is detected when excess silver react with chromate indicator to form a reddish silver chromate.

2.3.2. pH

pH was determined electrochemically with a Beckman 45 pH-meter.

An electrode with hydrogen sensor is immersed in the sample, and generates a voltage output which is proportional to concentration of hydrogen ions. The instrument is calibrated prior to each measurement, using standard buffer solutions with known pH.

2.3.3. Alkalinity

The alkalinity was determined with a Hach titration kit.

A fixed volume of sample is titrated with 1.6 N sulphuric acid down to pH 4.5. Alkalinity is reported as mg/l $CaCO_3$ equivalents. The analyses were performed on-site.

2.3.4. Carbonate and bicarbonate

Carbonate and bicarbonate were determined as for alkalinity.

Carbonate is determined by titration down to pH 8.3, and bicarbonate down to pH 4.5. The analyses were performed on site.

2.3.5. Conductivity

Conductivity was determined with CDM 80/83 conductivity meter.

A potential is applied between two electrodes with defined areas. The electrodes are immersed in the water sample, and conductivity is read directly from the instrument. The analyses were performed on-site.

2.3.6. Density

Density was measured with DMA-35 densitometer.

A fixed volume, u-shaped glass tube in contact with an oscillator is filled with sample. The oscillation-frequency of the undamped glass-tube is mass-dependent, thus density of the sample can be determined from the oscillation frequency. The analyses were performed on-site.

2.3.7. Barium/strontium

Concentration of barium + strontium was determinated with Hach spectrophotometer.

A sulphate reagent is added to filtered samples to form a white Ba/Sr-sulphate precipitate, and absorbency is measured at 450 nm (UV). The fraction of absorbed or reflected light is proportional to the sum of Barium and Strontium in the sample, and is correlated to water standards. The analyses were performed on-site.

2.3.8.Sulphate

Concentration of sulphate was determined with Hach spectrophotometer.

A barium reagent is added to filtered samples to form a white Ba/Sr-sulphate precipitate, and absorbency is measured at 450 nm (UV). The fraction of absorbed or reflected light is proportional to the sulphate in the sample, and is correlated to water standards. The analyses were performed on-site.

3. RESULTS

3.1. Gas analyses

The gas analyses performed on-site are shown in table 1 and 2. Laboratory analyses are shown in table 3.

General results:

The level of carbon dioxide increased for the first 4 hours and eventually stabilised at 7.0 vol % during "Clean-up flow" period.

During "Main flow" the carbon dioxide level increased for the first 6 hours and eventually stabilised at 9.0-9.5 vol %.

The mercaptans concentration was below the detection limit throughout the whole test (<0.1 ppmv).

The Hydrogen Sulphide level increased for the first 5 hours, and eventually stabilised at an average of 2.4 ppmv using Dräger tubes, and 2.2 ppmv on GC-measurements performed on site during "Clean-up flow".

During the "Main flow" the H_2S level was higher, an average value of 4.9 ppmv using Dräger tubes, and an average value of 2.8 ppmv on GC-measurement performed on site.

Radon content was 15-24 Bq/m^3 during "Clean-up flow" except for one outlier at 6 Bq/m^3.

Radon content was 23-38 Bq/m^3 during "Main flow"which is a significantly higher count, this could be as a result of both the higher flow rate and the long duration of the main flow period.

3.2. Oil

The oil analyses performed on-site are shown in table 4.

General results:
The water content in oil sampled from down stream of the choke manifold during the last 9.5 hrs of main flow varied from 0.19 to 0.38 wt %

3.3. Water analyses

The water analyses performed on-site are shown in table 5.

TRACE ELEMENTS IN GAS	
Client	Statoil
Rig	Treasure Prospect
Field	
Well	15/9-19SR
Test No.	1
Flow period	Clean-up

Sample point	Date Time	H2S Draeger (ppm)	H2S GC (ppm)	CO2 Draeger (vol %)	R-SH Draeger (ppm)	^{222}Rn RDA-200 (Bq/m^3)
	17.04.93					
Choke manifold	6:30	0.20				
	7:00	0.50				
	7:20	2.00		3.00		
	7:35	2.00		3.00		
Seperator	8:00	2.00		4.50		
gas outlet line	8:30	1.00		4.50		
	9:00	1.60 *		6.00		
	9:45				< 0.1 *	
	10:00	1.70	1.00	6.00		
	10:30	2.00 *				
	11:00	2.00	1.30	7.00		
	11:30	2.70 *				
	11:45				< 0.1 *	
	12:15			7.00		24
	12:45	2.90		7.00		
	13:15	2.60	1.90	7.00		
	14:00	2.50		7.00	< 0.1 *	
	14:30	3.00 *				
	15:00	2.30	2.50			
	15:15	2.30		7.00		
	16:50	2.30 ¤				6
	17:00				< 0.1 *	
	18:00	2.20		7.00		
	18:15		2.30			
	18:45	2.20		7.00		
	19:15	2.00	2.30			
2 x Separators	19:41					
in parallel	20:00					
Samples from	21:00					
Separator A	21:30					
	22:00					
	23:30					
	23:57					15
Shut in	24:00					

¤ = On line HPA, 10 l @ separator press.
* = On line HPA,20 l @ separator press.

TRACE ELEMENTS IN GAS	
Client	Statoil
Rig	Treasure Prospect
Field	
Well	15/9-19SR
Test No.	1
Flow period	Main Flow

Sample point	Date Time	H2S Draeger (ppm)	H2S GC (ppm)	H2S ASTM (ppm)	CO2 Draeger (vol %)	R-SH Draeger (ppm)
2 x Separators	19.04.93					
in parallel	21:30	1.10	1.40		5.80	
	22:00	0.80			6.00	
Samples from	22:30	2.50 *	1.80			< 0.1
Separator A	22:45	2.50 *				
gas outlet line	23:00	2.50			6.50	< 0.1 *
	23:30	2.50	2.40			
	20.04.93					
	0:00	2.50			6.00	
	0:30	8.00			6.00	
	0:45	6.00 *				
	1:00		2.60			< 0.1
	1:15	6.00				
	1:30	6.00			8.00	< 0.1 *
	2:00	4.00 *				
	2:30				9.00	
	3:00	4.00 *	2.50			< 0.1 *
	3:30				10.00	
	4:00	4.00 *				
	4:30	3.50	2.60		9.50	
	5:15	3.50 *				
	5:30				9.50	
	6:00					
	6:30		2.60			
	7:00	4.00			9.50	< 0.1
	7:30				9.50	
	8:00		2.20			
	8:30	3.50			9.50	
	9:00		2.60		9.50	< 0.1
	9:30					
	10:00	4.50	2.70		9.50	
	11:00	6.00	3.70	5.00	9.50	< 0.1
	12:00	6.00	3.50		9.50	
	13:00	5.00	3.50		9.50	< 0.1
¤ = On line HPA, 10 l @ separator press.						
* = On line HPA,20 l @ separator press.						

TRACE ELEMENTS IN GAS	
Client	Statoil
Rig	Treasure Prospect
Field	
Well	15/9-19SR
Test No.	1
Flow period	Main Flow

Sample point	Date Time	H2S Draeger (ppm)	H2S GC (ppm)	H2S ASTM (ppm)	CO2 Draeger (vol %)	R-SH Draeger (ppm)	^{222}Rn RDA-200 (Bq/m^3)
Separator A	20.04.93						
Choke manifold	13:20	5.00					
Separator A	14:00	6.00	3.60		9.00	< 0.1	
	15:00	6.50	3.50		9.50		
Choke manifold	15:00	5.00					
Separator A	16:00	6.00	2.80		9.00	< 0.1	
	17:00	5.50	2.90		9.00		
	18:00			4.50			
	19:00	4.50	2.60		8.00		
	20:00	7.00	2.90		9.00		
	21:00	7.00			9.00		38
	22:00	3.00	2.20		9.00		
	23:00	3.50	1.90		9.00		
	24:00	4.00	2.00		9.00		
	21.04.93						
	01:15	4.00	2.20	3.70	9.00		23
Shut in well:	01:40						

Table #3

TRACE ELEMENTS IN GAS	
Client	Statoil
Rig	Treasure Prospect
Field	
Well	15/9-19SR
Test No.	1
Flow period	Clean-up/Main flow

Sampl. point	Date	Time	H2S
			Micro coulomn ** (ppm)
Separator	17.04.93	18:30	1.58 +/- 0.2
	"	18:40	1.12 +/- 0.2
	20.04.93	14:50	.3.3 +/- 0.2
	"	15:05	3.4 +/- 0.2

** Samples were taken offshore and analysed onshore. (See method , cap 2.1.1.) Microcoulometric detection.

TRACE ELEMENTS IN OIL	
Client	Statoil
Rig	Treasure Prospect
Field	Sleipner
Well	15/9-19SR
Test No.	1
Flow period	Main flow

	Time	(wt %)
Down stream	20.04.93	
Choke manifold	16:00	0.32
	17:00	0.3
	18:00	0.28
	19:00	0.22
	20:00	0.27
	21:00	0.31
	22:00	0.3
	23:00	0.2
	24:00	0.19
	21.04.93	
	01:30	0.38
Shut in well.		

TRACE ELEMENTS IN WATER	
Client	STATOIL
Rig	Treasure Prospect
Field	Sleipner
Well	15/9 C-3 H
DST No.	1
Flow	Clean up

Sampling point: Separator

Date Time	Chloride (mg/l)	Density g/cm3, °C	pH	Tot.Alk (mg/l, C)	Ba + Sr (mg/l)	Sulfate (mg/l)	Cond mS/cm,C	Bicarbonate (mg/l, C)
4/17/93								
23:00	1080	999 23	6.8	580 22	< 5	< 5	3.20 21	354 22
	Sep.press:	60.3						
	Sep.temp:	75.2						
	Co2-cont:	N/A*						
* =No CO2 measurements reported due to damaged Draeger pump.								

TRACE ELEMENTS IN WATER	
Client	STATOIL
Rig	Treasure Prospect
Field	Sleipner
Well	15/9 -19SR
DST No.	1
Flow	Main Flow

Sampling point: Separator

Date Time	Chloride (mg/l)	Density g/cm3,°C	pH	Tot.Alk (mg/l, C)	Ba + Sr (mg/l)	Sulfate (mg/l)	Bicarbonate (mg/l)
20.04.93							
5:00	540	.998 21	6.3	983 21			600
	Sep.press:	60.3					
	Sep.temp:	55.5					
	Co2-cont:	9.5 vol %					
20.04.93							
16:45	200		6.5	660	< 5	<5	200
	Sep.press:	56.6					
	Sep.temp:	Gas 63.1	Oil 74.2				
	Co2-cont:	9.0 vol%					

4. DISCUSSION

4.1. Gas analyses

The concentration of hydrogen sulphide was lower during the Clean-up flow then the Main flow, both Dräger tubes and GC-measurements showed the same tendency. This could have been caused by the different flow rates and / or degree of H_2S saturation of the steel surfaces of the test equipment

The Hydrogen Sulphide measurements performed with the Jerome and reported in the Field report have not been included in the final report. Results reported in the field are considered suspect due to problems encountered during recalibration of the sensor. The " Gold film sensor" saturated with H_2S could not be regenerated due to contamination of the "Zero air" filter. The flow system is designed to ensure that only uncontaminated "Zero air" passes over the sensor during the thermal desorption cycle, therefore this prevented sensor regeneration.

The Dräger measurements on H2S and CO2 at the end of Clean-up flow from 20:00 hrs. and forward to 23:30 hrs. reported in Field report are also left out in the final report due to Dräger pump failure.

4.2. Oil analyses

Water in oil

No comments.

4.3. Water analyses

The analyses performed on-site are done on condensed water .

During the Clean-up flow and the first part of the Main flow the water were sampled in 2 rounds due to very small amounts of water. The samples were taken with approximately 4 hrs. intervals and stored for filtration and analyses for another 6 hours.

The last sample on the Main flow was filtered and analysed at once at 16:45 hrs.and is therefore the most representative analyses.