

Denne rapport  
tilhører



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Returneres etter bruk

PRODUCTION TESTS

NORWAY - BLOCK 31/2

SAMPLING AND ANALYSIS OF

GAS AND CONDENSATE.



SHELL INTERNATIONALE PETROLEUM MAATSCHAPPIJ B.V. - THE HAGUE

EXPLORATION AND PRODUCTION

PRODUCTION TESTS  
NORWAY - BLOCK 31/2  
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SUMMARY

Sampling and analysis of gas and condensate have been carried out during production testing of wells 31/2-2 and 31/2-3, offshore Norway.

This report describes the sampling and presents the results obtained from the analyses.

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## 1. INTRODUCTION

Production tests were carried out on gas from wells 31/2-3 and 31/2-2 (Offshore Norway) during 1980. During these tests, representatives from Shell laboratories were present in order to undertake specialised sampling exercises aimed at providing detailed information about the compositions of the well effluents.

Thornton Research Centre staff carried out phase separation tests to obtain empirical data on the phase behaviour of the gases and to determine detailed hydrocarbon compositions.

KSLA personnel determined the concentrations of hydrogen sulphide, other sulphur compounds, mercury, water, radon-222 and carbon dioxide in the gas and mercury, total sulphur and polonium-210 in produced condensate. This report presents the results obtained, by KSLA, from these determinations.

## 2. EXPERIMENTAL

The gas/condensate well effluent was separated in a high-pressure test separator and gas samples were taken from the gas outlet of the separator. Analyses for hydrogen sulphide, radon, water and mercury contents were carried out immediately on-site.

Additional samples, for the determination of other sulphur compounds, were taken in specially acid-treated glass containers and sent to the laboratory in Amsterdam for analysis.

Samples of produced condensate were taken in glass bottles either from the test separator or from the Thornton phase-separation equipment. These were also sent to Amsterdam for the determination of polonium and total sulphur contents.

### 3. RESULTS

The results obtained during the production tests are presented below. A survey is given in the table.

Throughout this section volumes of gas are considered at standard conditions (0 °C, 1.013 bar).

#### 3.1. Well 31/2-3

##### Production test 1

##### Perforated interval:

1535-1520 m (subsea level)

Date and time: 16/6/80, 06.00 h - 19/6/80, 07.00 h. The well was cleaned up before the actual production test started.

##### 3.1.1. First flow period

Date and time: 16/6/80, 06.00 h - 17.00 h.

stable flow at 06.00 h.

Output separator: ~5 MMSCF/d ( $142 \times 10^3$  m<sup>3</sup>/d)

Gas phase	Content	Sampling time, h
1. H <sub>2</sub> S	< 0.01 ml/m <sup>3</sup>	08.30
	0.04 ml/m <sup>3</sup>	09.00
	0.05 ml/m <sup>3</sup>	11.40
	0.05 ml/m <sup>3</sup>	13.30
	0.05 ml/m <sup>3</sup>	16.35
2. Hg	0.03 µg/m <sup>3</sup>	11.25-11.45
	0.10 µg/m <sup>3</sup>	13.15-13.30
	0.13 µg/m <sup>3</sup>	13.55-14.10
3. Rn	5.5 pCi/l	13.30

##### 3.1.2. Second flow period

Date and time: 18/6/80, 02.30 h-19/6/80, 07.00 h.

Output separator: ~5.5 MMSCF/d ( $156.10^3$  m<sup>3</sup>/d)

<u>Gas phase</u>	<u>Content</u>	<u>Sampling time, h</u>
1. H <sub>2</sub> S	0.09 ml/m <sup>3</sup>	13.05
	0.09 ml/m <sup>3</sup>	15.15
	0.09 ml/m <sup>3</sup>	16.30
	0.06 ml/m <sup>3</sup>	17.45
	0.09 ml/m <sup>3</sup>	21.00
	0.10 ml/m <sup>3</sup>	21.40
	0.10 ml/m <sup>3</sup>	23.20
	0.10 ml/m <sup>3</sup>	02.00
	0.10 ml/m <sup>3</sup>	02.30
	0.11 ml/m <sup>3</sup>	05.15
	0.10 ml/m <sup>3</sup>	06.10
2. Other sulphur compounds	<0.1 ml/m <sup>3</sup>	23.30
3. Hg	0.03 µg/m <sup>3</sup>	13.10-13.25
	0.01 "	15.20-15.30
	0.03 "	16.50-17.05
	0.01 "	21.05-21.20
	0.01 "	21.35-21.50
	0.01 "	23.50-00.10
	0.01 "	02.05-02.25
	0.01 "	05.20-05.45
	4. Rn	5.2 pCi/l
5. H <sub>2</sub> O	* 0.118 % (v/v)	10.45
	** 0.066 % (v/v)	17.00
	*** 0.092 % (v/v)	23.00
	**** 0.075 % (v/v)	05.00

Gas condition

- \* temperature: 72 °F (22 °C)
- \*\* pressure : 475 psi (32.8 bar)  
temperature: 69 °F (21 °C)
- \*\*\* pressure : 475 psi (32.8 bar)  
temperature: 63 °F (17 °C)
- \*\*\*\* pressure : 465 psi (32 bar)  
temperature: 56 °F (13 °C)  
pressure : 476 psi (32.8 bar)

<u>Condensate</u>	<u>Content</u>	<u>Sampling time, h</u>
1. Hg	<0.01 mg/l	20.00
2. Total sulphur	48 mg/l	20.00
3. Po	<0.03 pCi/ml	20.00

3.2. Well 31/2-3

Production test 2

Perforated interval:

1410-1435 m (subsea level)

Date and time: 4/7/80, 1500 h - 8/7/80, 0600 h.

The well was cleaned up before the actual production test started.

3.2.1. First flow period

Date and time: 4/7/80, 1500 h -

6/7/80, 22.00 h.

Output separator: ~17 MMSCF/d ( $481 \times 10^3 \text{ m}^3/\text{d}$ )

<u>Gas phase</u>	<u>Content</u>	<u>Sampling time, h</u>
1. H <sub>2</sub> S	0.04 ml/m <sup>3</sup>	4/7/80 15.20
	0.06 ml/m <sup>3</sup>	15.37
	0.04 ml/m <sup>3</sup>	5/7/80 10.17
	0.06 ml/m <sup>3</sup>	6/7/80 19.20
	0.08 ml/m <sup>3</sup>	20.15
	0.08 ml/m <sup>3</sup>	21.06
2. Hg	0.01 µg/m <sup>3</sup>	6/7/80 20.10-20.30
	<0.01 µg/m <sup>3</sup>	21.05-21.30

3.2.2. Second flow period

Date and time: 7/7/80, 10.00-22.00 h.

Output separator: ~40 MMSCF/d ( $1133 \times 10^3 \text{ m}^3/\text{d}$ )

<u>Gas phase</u>	<u>Content</u>	<u>Sampling time, h</u>
1. H <sub>2</sub> S	0.10 ml/m <sup>3</sup>	10.41
	0.09 ml/m <sup>3</sup>	11.00
	0.08 ml/m <sup>3</sup>	13.44
	0.09 ml/m <sup>3</sup>	14.30
2. Hg	0.02 µg/m <sup>3</sup>	10.50-11.15
	<0.01 µg/m <sup>3</sup>	11.20-11.50
	<0.01 µg/m <sup>3</sup>	13.40-14.05
3. Rn	1.1 pCi/l	21.35
4. H <sub>2</sub> O*	0.090 % (v/v)	15.15-15.50

\* Gas conditions:

temperature : 62 °F (17 °C)

pressure : 330 Psi (22.8 bar)



<u>Condensate</u>	<u>Content</u>	<u>Sampling time, h</u>
1. Hg	<0.01 mg/l	15.10
2. Total sulphur	88 mg/l	15.10
3. Po	<0.03 pCi/ml	15.10

### 3.2.3. Third flow period

Date and time: 8/7/80, 00.00-05.00 h

Output separator: ~20 MMSCF/d ( $566 \times 10^3 \text{ m}^3/\text{d}$ )

<u>Gas phase</u>		<u>Sampling time, h</u>
1. H <sub>2</sub> S	0.06 ml/m <sup>3</sup>	00.00
	0.04 ml/m <sup>3</sup>	01.13
	0.06 ml/m <sup>3</sup>	02.20
	0.07 ml/m <sup>3</sup>	03.40
2. Other sulphur compounds	<0.1 ml/m <sup>3</sup>	01.45
3. Hg	0.02 g/m <sup>3</sup>	00.00-00.30
	0.06 g/m <sup>3</sup>	02.20-02.40
	0.05 g/m <sup>3</sup>	03.55-04.30
4. Rn	1.0 pCi/l	02.35
5. H <sub>2</sub> O	* 0.072 % (v/v)	01.13-01.45
	** 0.080 % (v/v)	03.00-03.45

#### Gas conditions

\* temperature: 100 °F (38 °C)  
pressure : 327 psi (22.6 bar)

\*\* temperature: 100 °F (38 °C)  
pressure : 325 psi (22.4 bar)

### 3.3. Well 31/2-2

#### Production test 3

#### Perforated interval:

1520-1529 m (subsea level)

Date and time: 21/9/80, 0800 h-22/9/80, 0200 h

The well was cleaned up before the actual production test started.

3.3.1. First flow period

Date and time: 21/9/80, 0800-1800 h  
 Output separator: 29.0 MMSCF/d ( $821 \times 10^3 \text{ m}^3/\text{d}$ )

<u>Gas phase</u>	<u>Content</u>	<u>Sampling time, h</u>
1. H <sub>2</sub> S	0.04 ml/m <sup>3</sup>	11.00
	0.04 ml/m <sup>3</sup>	11.30
	0.04 ml/m <sup>3</sup>	13.45
	0.05 ml/m <sup>3</sup>	16.00
2. Other sulphur compounds	0.1 ml/m <sup>3</sup>	15.00
3. CO <sub>2</sub>	0.4 % (v/v)	11.30
	0.4 % (v/v)	13.45
	0.4 % (v/v)	16.00
4. Hg	0.040 µg/m <sup>3</sup>	11.15-11.45
	0.009 µg/m <sup>3</sup>	12.30-13.00
	0.014 µg/m <sup>3</sup>	15.00-15.30
5. * H <sub>2</sub> O	0.215 % (v/v)	13.40-14.05
	0.239 % (v/v)	14.50-15.05

\* Gas conditions:

temperature: 75 °F (24 °C)  
 pressure : 285 psi (19.7 bar)

6. Rn 1.3 pCi/l 16.30

<u>Condensate</u>	<u>Content</u>	<u>Sampling time, h</u>
1. Hg	<0.01 mg/l	17.00
2. Total sulphur	137 mg/l	17.00
3. Po	<0.03 pCi/ml	17.00

3.3.2. Second flow period

Multi-rate sequential test

Date and time: 21/9/80, 1930 h-22/9/80, 0200 h

Output separator

~31 MMSCF/d ( $875 \times 10^3 \text{ m}^3$ )	19.45-21.23
~42 MMSCF/d ( $1184 \times 10^3 \text{ m}^3$ )	21.24-22.21
~50 MMSCF/d ( $1405 \times 10^3 \text{ m}^3$ )	21.24-02.00

<u>Gas phase</u>	<u>Content</u>	<u>Sampling time, h</u>
1. H <sub>2</sub> S	0.06	20.45
	0.06	22.00
	0.10	23.40
	0.09	24.00
	0.10	01.30
	0.10	01.45
2. CO <sub>2</sub>	0.4 % (v/v)	20.45
	0.4 % (v/v)	22.00
	0.4 % (v/v)	24.00
	0.4 % (v/v)	01.45
3. Hg	0.001 μg/m <sup>3</sup>	20.50-21.20
	0.020 μg/m <sup>3</sup>	23.40-00.10
	0.017 μg/m <sup>3</sup>	01.15-01.45
4. H <sub>2</sub> O	* 0.082 % (v/v)	21.45-22.05
	** 0.132 % (v/v)	22.15-22.35
	*** 0.136 % (v/v)	00.15-00.30

Gas conditions:

- \* temperature: 56 °F (13 °C)  
pressure : 437 psi (30.2 bar)
- \*\* temperature: 59 °F (15 °C)  
pressure : 445 psi (30.7 bar)
- \*\*\* temperature: 48 °F (9 °C)  
pressure : 470 psi (32.4 bar)

4. REMARKS

During production test 3 the water concentration measured in the separator gas was higher than the corresponding saturation concentration. This is probably indicative of the presence of free water in the gas.

TABLE

	Gas Well 31/2-3						Gas Well 31/2-2	
	Production test						Production test	
	1		2		3		First flow	Second flow
<u>Gas phase</u>	First flow	Second flow	First flow	Second flow	Third flow	First flow	Second flow	
1. H <sub>2</sub> S, ml/m <sup>3</sup>	0.05	0.10	0.08	0.09	0.06	0.04	0.10	
2. Other sulphur compounds, ml/m <sup>3</sup>	<0.1	<0.1			<0.1	<0.1		
3. CO <sub>2</sub> , % (v/v)								
4. Hg, µg/m <sup>3</sup>	0.13	0.01	0.01	<0.01	0.05	0.02	0.02	
5. Rn, pCi/l	5.5	5.2		1.1	1.0	1.3		
6. H <sub>2</sub> O, % (v/v)		0.09		0.09	0.08	0.23	0.12	
<u>Condensate</u>								
1. Hg, mg/l		<0.01		<0.01		<0.01		
2. Total sulphur, mg/l		48		88		137		
3. Po, pCi/ml		<0.03		<0.03		<0.03		