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Subtitle: Reservoir fluid analysis on two bottom hole sample from 31/2-2 oil zone.

RESERVOIR FLUID STUDY
FOR
SHELL WELL 31/2-2

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SUMMARY

This report presents results from a short PVT program and water analysis on 2 bottom hole samples from 31/2-2.

The sample were transfered by Statoil PVT laboratory. Sample no.1 contained about 14 cc of oil, while sample no.2 contained less than 1 cc of oil. Both samples contained water.

The oil from sample no.1 was subjected to a limited PVT analysis. The results seems resonable, allthough the oil properties are influenced by the presence of water to some extent which is difficult to quantity. The water analysis showed that both samples contained the same water, propably completion fluid.

1. INTRODUCTION

In a telex to Shell 31 July 1980 Statoil requested PVT samples from all wells in the 31/2 block for internal evaluation. Samples from 31/2-2 and 3 (both gas and oil zones) were received medio september. It turned out that the bottom hole sample from the oil zone in 31/2-2 (sample no.1) had zero opening pressure and contained mainly water with very small amounts of oil.

After discussion between representatives from both companies it was desided to let Statoil PVT Laboratory have an other bottom hole sample from the same zone (sample nr.2) to check the content.

This sampler contained approx. 14cm^3 of pressured oil and our laboratory was asked to carry out analysis "...to the extent that the size of the sample and your equipment allow". (Telex from Shell 15/10-80 - FOR 1510011).

2. SAMPLE DESCRIPTION

2.1 Schlumberger PSR tool, chamber D736, Sample nr.1 Sampling depth 1582

No sampling sheet followed the bottle. Opening pressure of bottle was 0 bar at ambient temperature. Injecting water on the back side of the piston caused a very rapid pressure increase in the bottle. Shaking the bottle caused no pressure drop. Concluded therefore that the bottle contained mainly water/mud.

When opening the sampling bottle it contained:

<	1 cc hydrocarbons
approx.	700 cc water
approx.	20 cc Hg

A conventional water analysis was performed.

2.2 Otis bottle 80023, Sample nr.2 Sampling depth 1587m

No sampling sheet followed the bottle. Opening pressure of the bottle was 47 bar at ambient temperature. The nature of pressure increase in the bottle while injecting mercury indicated that it only contained small amounts of hydrocarbons.

Bubblepoint determination at ambient conditions in the sampler gave approx. 110 bar.
The total amount of hydrocarbons were transfered to a visual PVT cell at a pressure of 200 bar, while the cell was kept at reservoir temp. (71.1^{o}C).

The sampling bottle contained:

approx: 14 cc hydrocarbons(at transfer conditions)
" : 3 cc mix mud/oil
" : 60 cc H_2O/filtrate
" : 590 cc Hg

A short PVT program was run on the small amount of hydrocarbons. A conventional water analysis was also performed.

3. METHODS AND EQUIPMENT

Water analysis was carried out according to conventional methods (ASTM) using atomic absorption and wet chemistry. Results were controlled for concistency by calculations.
Determination of bubble point was done in a Ruska Visual PVT Cell. Single flash to Standard condidions (15^oC and 1 atm), and measurement of GOR was done by using a Ruska Flash separator. Reservoir fluid composition was calculated from the flash experiment.

The gas was analysed both on a Hewlet Packard 5880 GC with packed column and TCD, and another of same fabrication using glas capillary column and FID.

Oil analysis was done on the latter instrument using internal standard. Molweight of oil was measured using the principle of freezing point depression.

4. RESULTS

Results of PVT analysis is found in table 1 in appendix. Water analysis from water found in both samplers are presented in table 2 in appendix.

5. DISCUSSION

5.1 PVT analysis

It is readily seen from the oil composition that the oil has lost most of the light ends, propably due to the large amount of water in the sampler.

However, the density is the same as measured on the rig. The molweight on whole oil (288) coresponds well to the type of oil and density found here.

The bubble point is lower than res. pressure which could be due to the sampling method. The reservoir fluid composition seems reasonable. A single flash computer run using this composition reproduced the observed GOR, oil density and gas gravity giving 53.6, 0.912 and 0.69 respectively (1). One should however not put too much emphasis on the composition from the sampler.

The uncertainty in a normal PVT analysis as experienced by our laboratory is stated in table 3.

In this analysis however the limits propably are much wider, due to small sample and contamination with filtrate and debree of various kind.

For this reason, Bo factor, compressibility above bubble point and density of reservoir fluid are not reported.

5.2 Water analysis

The water analysis from the two bottom hole samplers shows that they contain nearly similar water. (Table no.2) From the information on mud filtrate, heavy brine and formation water given to us by Shell, (mudfiltrate

approx. 14.000 ppm NaCl, heavy brine approx. 200.000 ppm CaCl, formation water approx. 70.000 ppm NaCl) we conclude that this water is a mixture of mudfiltrate and heavy brine.

Comparison of measured and calculated values show that the analysis are consistent.

Comparison of calculated and measured results.

Bottle I.D.	Otis no. 80023	Schlumberger PSR tool
Measured dissolved solids (ppm)	101.830	102.810
By summation (ppm)	101.870	103.370
Sum cation/anion (epm)	1808/1809	1840/1820
Calculated equivalent NaCl (ppm) (2)	94.680	97.576
Corresponding resistivity (ohm meters)	0.084	0.082
Measured resistivity(ohm meters) at 20°C	0.092	0.092
Calculated density (3) at 20°C	1.0850	1.0852
Measured density at 20°C	1.0852	1.0846

CONCLUSION

Even though the sample was in a bad state the results of analysis performed resembles closely those obtained on bottom hole sample from 31/23.

REFERENCES

1. Standing ref

JPT FORUM vol xxx1 sep 1979, P1193. A set of eqn. for cumputing equlibrium Ratios of a crude oil/natural gas system at pressures below 1000 psia.

2. Equivalent NaCl concentration

The variable multipliers method was used to calculate the equivalent NaCl concentration. This method is described in Schlumberger Log luterpretation Charts Gen8. "Resistivities of filtrates and formation waters"

3. Claculated densities

Density = weight of solution pr. liter solution = weight of solutes + weight of solvent pr. liter solution. The weight of solute is known from the chemical analysis. The weight of soluvent pr. liter solution is the weight of,one liter of solvent minus the weight of the solvent displaced by the solutes.

The latter can be found in "Concentrative Properties of Aqueous Solutions" in Handbook of Physics and Chemistry for each of the solutes present.

Table 1. Composition of reservoir fluid from single flash of BHS from 31/2-2, Sample no. 1

Components	Oil wt%	Oil mole%	Gas mole%	Res. Fluid mole%
Nitrogen	0	0	0.06	0.03
Carbondioxid	0	0	0.69	0.29
Methane	0	0	83.72	35.85
Ethane	0	0	10.52	4.50
Propane	0	0	1.98	0.85
iso-butane	0	0	1.69	0.72
n-butane	0	0	0.30	0.13
iso-pentane	0	0	0.28	0.12
n-pentane	0	0	0.17	0.07
Hexanes	0.02	0.08	0.32	0.18
Heptanes +	99.98	99.92	0.27	57.26
	100.00	100.00	100.00	100.00

C_{7+} mol wt.	:	299
C_{7+} density (g/cm^3)	:	0.9149
Bubble pt., (Bar)	:	132
Gor, (SM^3/M^3) (1)	:	56
ρo, density of oil, *(g/cm^3)	:	0.9092
Y_s, gravity of gas (1)	:	0.69
Mol weight stock tank oil	:	288
Bottle No.	:	Otis 80023

Table 2. Water analysis from bottom hole samples 31/2-2

Bottle I.D	Otis 80023	Schlumberger PSR tool
ph	3.9	3.8
Density 15°C	1.0852	1.0846
Resistivity at 20°C (ohm meter)	0.092	0.092
Dissolved solids ppm	101.830	102.810
Na "	5.710	6.180
Ca "	29.490	30.150
Mg "	280	280
K "	1.290	1.290
Sr "	600	600
Cl "	63.770	64.080
So_4 "	660	770
Ba "	< 10	< 10
Fe "	67	16

Table 3.

(1) γg, GOR, Bo, ρ res. fluid from single flash of oil from reservoir condition to 1 atm., 15°C.

(2) Bo is M^3 of reservoir fluid pr. M^3 of stock tank fluid at 1 atm., 15°C.

(3) Average compressibility to oil between saturation pressure and initial reservoir pressure.

Error limits on reported values:

Bubblepoint	: +	0.5 BAR
GOR	: +	0.3 SM^3/M^3, 1.7 SCF/BBL
BO	: +	3×10^{-3} M^3/M^3
ρ res. fluid	: +	2×10^{-3} g/cm^3)
ρ oil	: +	2×10^{-4} g/cm^3)
γ gas	: +	1×10^{-2}
M	: +	10 g/g mole

Composition : C_1, C_2 + 1% decreasing to about + 7% for components having reported values less then 1 mole%.