

## 8. WIRELINE FORMATION TESTS

### Objectives

Between the top of the reservoir at 1364.5 m BDF and the final depth of 5035 m BDF three runs were made with the Schlumberger Repeat Formation Tester (RFT) at different stages during the drilling of the well. The objectives of these surveys were:

1. Confirm formation fluid pressures and pressure gradients obtained from RFT's in previous wells in block 31/2.
2. Assist in determining fluid contacts.
3. Obtain preliminary fluid samples.
4. Determine the vertical extent of the aquifer below the hydrocarbon bearing reservoir.

### Summary

The first RFT run covering the hydrocarbon bearing interval and the upper 265 metres of underlying aquifer established gas and water gradients of 0.058 and 0.45 psi/ft respectively (see Fig. I/8.1). An oil gradient could not be identified from the RFT pressures. It was not possible to accurately define the GOC because of lithological effects on the electrical logs, but the depths of 1572 m BDF is consistent with interpretations in other wells. The OWC was picked from logs at 1580 m BDF. The gas gradient line confirms the reservoir pressure of about 2280 psig at GOC.

The two other RFT runs, covering the interval down to 4969 m BDF indicate a change in pressure regime between 2713 and 3262 m BDF. This is identified by a shift of some 100 psi in reservoir pressure and a higher water gradient (0.46 psi/ft). (See Fig. I/8.2). This shift represents the downward extent of the aquifer beneath the reservoir.

The two observed water gradient lines intersect close to seabottom suggesting two hydrostatic pressure regimes.

### Operational Aspects

As in previous wells in block 31/2 cuttings and recovered cores from 31/2-4 had suggested the existence of an oil layer between the gas and water bearing parts of the reservoir. Subsequent electric logs indicated a gas/oil contact somewhere between 1567 and 1573 m BDF. A tight calcareous zone at this interval makes it impossible to accurately determine the GOC. However, the latter depth, 1572m BDF (1547 m s.s.), is consistent with observations in other wells. The oil/water contact was determined at 1580 m BDF which gives an 8 metre oil column.

Since 31/2-4 was a so-called "deep test" drilled to a total depth of 5035m BDF, information from the formations below the main reservoir could be obtained. Although electric logs had indicated these to be water bearing, the RFT was used to establish the general pressure regime and pressure barriers.

The first RFT run was made prior to setting the 13-3/8" casing (shoe at 1927 m BDF). It covered the hydrocarbon bearing reservoir and the upper part of the aquifer below. Twenty pressure readings were taken going down the hole from 1396.5 to 1845.5 m BDF (see Fig. I/8.1). The eight upper readings indicate a reasonable gas gradient of 0.058 psi/ft down to 1568.5m BDF. The gas gradient line indicate a reservoir pressure of 2278 psig at the GOC (1572 m BDF) which is consistent with the value of 2280 psig suggested by RFT's and build-ups in other wells in 31/2. On the way out of the hole the hole a preliminary gas sample was taken at 1566 m BDF. All pressure point below 1568.5 m BDF seem to fall on the water gradient line (0.45 psi/ft). There is no indication from the pressures of an oil gradient between the gas and water. However, with limited data available in the transition between the gas and water lines, the existence of an 8 metre oil gradient cannot be excluded.

The second RFT run was made prior to setting the 9-5/8" casing (shoe at 3983 m BDF) and covered the interval from 2142 to 3585.5 m BDF with 9 fluid pressure readings. The upper 6 pressure values extended the water gradient from the first run (0.45 psi/ft) down to 2713 m BDF (see Fig. I/8.2). The three remaining pressures (3262, 3402 and 3585.5 m BDF) belong to a different gradient line. A shift of some 100 psi occurs between 2713 and 3262 m BDF which might be explained by a change in lithology around 3226 m BDF.

In the third and last RFT run three more pressures were obtained over the interval 4303 to 4969 m BDF. These three points together with the three last readings from run 2 define a second gradient line of 0.46 psi/ft suggesting a more saline water than that of the aquifer immediately below the hydrocarbon reservoir. (see Fig. I/8.2).

It is interesting to note that the two water gradient lines intersect close to a seabottom at a pressure equivalent to seabottom pressure. This suggests that both pressures required are virtually hydrostatic.

OPERATOR AS NORSKE SHELL EXPLORATION & PRODUCTION

WELL NO. 31/2-4

# MATERIAL CONSUMPTION & COST ANALYSIS

$12\frac{1}{4}/17\frac{1}{2}$  HOLE DRILLED TO  Meters  Feet  
 $22\frac{1}{4}$  under reamed LINER SET AT  Meters Feet  
 ACTUAL AMOUNT OF HOLE DRILLED  Meters Feet DAYS ON INTERVAL

DRILLING FLUID SYSTEM

MATERIAL	UNIT SIZE	PROG.	USED	VARIANCE ±	COST
Barite	M/T		230		25.760,00
KCl Brine	Mixing, storage, pumping charge				8.130,00
KCl for Brine make-up	50 kg		1600		21.472,00
KCl	50 kg		866		11.621,72
LF-5	25 kg		335		12.649,80
CMC Lo.vis	25 kg		116		5.278,00
Drispac Regular	50 lbs		175		20.702,50
S.A.P.P.	25 kg		1		62,79
Ancopol	25 kg		81		9.210,51
Caustic Soda	25 kg		156		1.490,58
Soda Ash	50 kg		52		781,04
Sodium Bicarbonate	50 kg		30		450,60
Drilling Detergent	200 l		12		1.911,00
Aluminium Stearate	25 kg		1		46,50
CMC Hi vis	25 kg		2		96,46
Note 1: Costs for this section include 1400 + barrels KCl/Polymer mud dumped prior to moving off location.					
Note 2: Rig off location 10/9 - 5/10. Well re-entered 8/10 but days on interval calculated from 5/10.					

COST/DAY  TOTAL COST FOR INTERVAL   
 COST/Mt. or Ft.  PROG. COST FOR INTERVAL   
 ENGR. COST  COST VARIANCE FOR INTERVAL

OPERATOR A/S NORSKE SHELL EXPLORATION & PRODUCTION

WELL NO. 31/2-4

# MATERIAL CONSUMPTION & COST ANALYSIS

12 1/4" HOLE DRILLED TO 1951 Meters CASING SET AT 1928 Meters  
 15 3/4" Feet Feet 13 3/8" Feet

ACTUAL AMOUNT OF HOLE DRILLED 671 Meters DAYS ON INTERVAL 54 Feet

DRILLING FLUID SYSTEM KCl/P) LYMER CONVERTING TO GEL/LIGNOSULPHONATE

MATERIAL	UNIT SIZE	PROG.	USED	VARIANCE ±	COST
BARITE	M/T		215		24,080.-
EUROPEAN BENTONITE	M/T		31		5,783.05
WYOMING BENTONITE	50 kg		94		1,069.25
CHROME LIGNOSULPHONATE	25 kg		315		4,299.75
KCl	50 kg		110		1,476.20
CMC Hi.Vis	25 kg		58		2,797.34
CMC Lo.Vis	25 kg		37		1,683.50
DRISPAC REGULAR	50 lb		80		9,464.-
LF-5	25 kg		121		4,568.96
CAUSTIC SODA	25 kg		93		888.62
SODA ASH	50 kg		11		165.22
SODIUM BICARBONATE	50 kg		51		766.02
DRILLING DETERGENT	200 l		2		318.50
ANCHOR DEFOAMER	45 imp.gall		1		159.25

COST/DAY \$ 1.065,18 TOTAL COST FOR INTERVAL \$ 57,519.66  
 COST/Mt. ~~xxx~~ \$ 85,72 PROG. COST FOR INTERVAL  
 ENGR. COST \$ 21.600,- COST VARIANCE FOR INTERVAL

OPERATOR A/S NORSKE SHELL EXPLORATION & PRODUCTION

WELL NO. 31/2-4

# MATERIAL CONSUMPTION & COST ANALYSIS

12 1/4" HOLE DRILLED TO 4029 Meters Feet 9 5/8" CASING SET AT 3982 Meters Feet

ACTUAL AMOUNT OF HOLE DRILLED 2078 Meters Feet DAYS ON INTERVAL 67

DRILLING FLUID SYSTEM DISPERSED LIGNOSULPHONATE

MATERIAL	UNIT SIZE	PROG.	USED	VARIANCE ±	COST
BARITE	M/T		106		11,872.-
EUROPEAN BENTONITE	M/T		28		5,223.40
CHROME LIGNOSULPHONATE	25 kg		393		5,364.45
CAUSTIC SODA	25 kg		336		3,210.48
SODA ASH	50 kg		7		105.14
CMC Hi.Vis	25 kg		134		6,462.82
CMC Lo.Vis	25 kg		141		6,415.50
DRISPAC REGULAR	50 lbs		130		15,379.-
LF-5	25 kg		116		4,380.16
SODIUM BICARBONATE	50 kg		4		60.08
DRILLING DETERGENT	200 l		4		637.-
B-FREE	45 imp.gall		4		2,875.60
CHROME LIGNITE	50 lbs		119		2,165.80
ALUMINIUM STEARATE	25 kg		1		45.50

COST/DAY \$ 958,16 TOTAL COST FOR INTERVAL \$ 64,196.93

COST/Mt. or Ft. \$ 30.89 PROG. COST FOR INTERVAL

ENGR. COST \$ 15,200,- COST VARIANCE FOR INTERVAL

OPERATOR A/S NORSE SHELL EXPLORATION & PRODUCTION

WELL NO. 31/2-4

# MATERIAL CONSUMPTION & COST ANALYSIS

8 1/2" HOLE DRILLED TO 5035 Meters Feet CASING SET AT Meters Feet

ACTUAL AMOUNT OF HOLE DRILLED 1006 Meters Feet DAYS ON INTERVAL 38

DRILLING FLUID SYSTEM GYPSUM/LIGNOSULPHONATE

MATERIAL	UNIT SIZE	PROG.	USED	VARIANCE ±	COST
BARITE	M/T		45		5,040.-
EUROPEAN BENTONITE	M/T		27		5,036.85
CHROME LIGNOSULPHONATE	25 kg		392		5,350.80
CHROME LIGNITE	50 lbs		320		5,824.-
CMC Lo.Vis	25 kg		198		9,009.-
CMC Hi.Vis	25 kg		64		3,086.72
XC-POLYMER	50 lbs		15		3,820.64
DRISPAC REGULAR	50 lbs		18		2,129.40
GYPSUM	40 kg		656		4,040.96
CAUSTIC SODA	25 kg		329		3,143.60
SODA ASH	50 kg		88		1,321.76
SODA ASH	30 kg		129		1,161.-
SODIUM BICARBONATE	50 kg		9		135.18
LF-5	25 kg		148		5,588.48
ANCHOR DEFOAMER	45 imp.gall		1		159.25
ALUMINIUM STEARATE	25 kg		5		227.50
NUT PLUG	25 kg		8		96.48

COST/DAY \$ 1.451,88 TOTAL COST FOR INTERVAL \$ 55,171.62

COST/Mt. of Ft. \$ 55.87 PROG. COST FOR INTERVAL

ENGR. COST \$ 15.200,00 COST VARIANCE FOR INTERVAL

OPERATOR AS NORSE SHELL EXPLORATION & PRODUCTION

WELL NO 31/2-4

# TOTAL CONSUMPTION & COST ANALYSIS

TOTAL DEPTH  Meters Feet  
 TOTAL HOLE DRILLED  Meters Feet  
 TOTAL DAYS

MATERIAL	UNIT SIZE	PROG.	USED	VARIANCE ±	COST
BARITE	M/T		692		77.504,00
EUROPEAN BENTONITE	M/T		146		27.236,30
WYOMING BENTONITE	50 kg		94		1.069,25
KCl			2576		34.569,92
KCl	Mixing, storage, pumping			charge	8.130,00
CAUSTIC SODA	25 kg		972		9.287,46
SODA ASH	50 kg		170		2.558,50
SODA ASH	30 kg		129		1.161,00
SODIUM BICARBONATE	50 kg		94		1.411,88
CHR.LIGNOSULPHONATE	25 kg		1100		15.015,00
CHROME LIGNITE	50 lbs		439		7.989,80
CMC Lo Vis	25 kg		492		22.386,00
CMC Hi Vis	25 kg		258		12.443,34
DRISPAC REGULAR	50 lbs		403		47.674,90
LF-5	25 kg		15		27.187,20
XC POLYMER	50 lbs		15		3.820,65
GYPSSUM	40 kg		656		4.040,96
LIME	25 kg		656		46,44
AL.STEARATE	25 kg		7		318,50
DRILLING DETERGENT	200 l		18		2.866,50
ANCHOR DEFOAMER	45 imp.gal.		2		318,50

CONT'D..

COST/DAY  TOTAL COST FOR INTERVAL   
 COST/Mt. or Ft.  PROG. COST FOR INTERVAL   
 ENGR. COST  COST VARIANCE FOR INTERVAL



OPERATOR AS NORSE SHELL EXPLORATION AND PRODUCTION

WELL NO. 31/2-4

# TOTAL CONSUMPTION & COST ANALYSIS

CONT'D

TOTAL DEPTH  Meters  
Feet

TOTAL HOLE DRILLED  Meters  
Feet

TOTAL DAYS

MATERIAL	UNIT SIZE	PROG.	USED	VARIANCE ±	COST
NUT PLUG	25 kg		8		96,48
FREE PIPE	45 imp.gal		4		2.875,60
S.A.P.P.	25 kg		1		62,79
ANCOPOL	25 kg		81		9.210,51

COST/DAY

TOTAL COST FOR INTERVAL

COST/Mt. or Ft.

PROG. COST FOR INTERVAL

ENGR. COST

COST VARIANCE FOR INTERVAL



OPERATOR A/S NORSKE SHELL EXPLORATION AND PRIDUCTION

WELL NO. 31/2-4

# MATERIAL CONSUMPTION & COST ANALYSIS

HOLE DRILLED TO  Meters Feet  CASING SET AT  Meters Feet  
ACTUAL AMOUNT OF HOLE DRILLED  Meters Feet DAYS ON INTERVAL

DRILLING FLUID SYSTEM

MATERIAL	UNIT SIZE	PROG.	USED	VARIANCE ±	COST
BARITE	M/T		96		10,752.-
EUROPEAN BENTONITE	M/T		36,75		6,855.71
CAUSTIC SODA	25 kg		28		267.54
SODA ASH	50 kg		6		90.12

COST/DAY  TOTAL COST FOR INTERVAL   
COST/Mt. or Ft.  PROG. COST FOR INTERVAL   
ENGR. COST  COST VARIANCE FOR INTERVAL