

## 8.5. RESULTS AND CONCLUSIONS.

### 8.5.1 RFT Survey

- i The oil and water gradients established were identical to the previously measured values of respectively 0.325 and 0.443 psi/ft.
- ii The Haltenbanken and Drake Formations belonged to the same hydrostatic pressure regime.
- iii The average reservoir pressure was 2391 psia at datum (1630 m ss) and is within measurement accuracy of the previously established initial reservoir pressure of 2392 psia (at datum).
- iv A downhole oil sample was recovered: the bubble points measured on the shipping bottles were 600 psig at 60<sup>o</sup> F.

### 8.5.2 Water Zone Test

- i The well produced formation water at 1435 b/d from the interval 1675 - 1680 m ss in the Haltenbanken Formation using a gaslift system. The measured salinity was 23856 mg/l chlorides, 39546 mg/l total dissolved solids.
- ii Unfiltered seawater was injected at rates up to 13080 b/d for 10 hrs.
- iii Evaluation of the pressure fall-off survey indicated a kh product of 265 Darcy. ft (Horner analysis), equivalent to an effective water permeability of 5.7 Darcy for the 46 ft injection interval. (Note 5.2 vi below).
- iv The II decreased from an initial value of 120 - 130 to 65 b/d/psi at the end of the test. The skin increased from 2 to 45. The partial penetration skin was 6.
- v The evaluated initial reservoir pressure was 2392.4 psia at datum.
- vi Both the test responses and the long term injectivity indices may be better studied using a numerical single well model with a thermal simulator. In addition some coreplug flooding tests should be considered to investigate the injection pressure behaviour.

### 8.5.3 Oil Zone Test

- i The well produced up to a maximum of some 6200 stb/d of 40<sup>o</sup> API oil from the interval 1629 - 1635 m ss. The separator GOR was 160 scf/stb. Cumulative oil production amounted to 9,350 stb.
- ii The evaluated kh product was 141 D.ft, equivalent to an effective oil permeability of 2.9 Darcy for the drained interval of 15m. (Note 5.3 v below).
- iii) The average post gravel pack PI was some 49 stb/d/psi and the total skin was 18. The partial penetration skin was 5. The calculated ideal PI is 140 stb/d/psi (skin zero).

- iv The initial reservoir pressure calculated was 2392 psia at datum. The previously established value was also 2392 at datum.
- v The results given above are not as reliable as those reported in earlier Draugen well tests due to a continued clean-up effect during the flowperiod and due to erratic pressure gauge performance. In this case, the measured core data together with estimated relative permeability data, should be used to confirm the results.
- vi A single well model could give insight into the effect of reservoir layering and of the presence of significant quantities of edge and/or bottom water. However the erratic gauge data would always preclude a definitive evaluation.

#### 8.5.4 In-situ Stress Tests

- i The minimum in-situ horizontal stress measured was 2837 psia at 1127 m bdf.
- ii This result is somewhat higher than predicted from the Breckels and Van Eekelen correlation (Fig. 8.4.9). The use of this correlation will therefore lead to inclusion of excessive safety margins.
- iii) The maximum bottom hole injection pressure at datum and 160<sup>o</sup> F, assuming no fracturing to be allowed, can be estimated at 4000 psia. The impact of reservoir cooling on this maximum injection pressure should be investigated.

Table 8.3.1

WELL: 6407/9-4  
 Fluid Samples PT-1A and PT-1B  
 Interval 1675 - 1680 m ss

Sample No.	Sample Type	Volume	Remarks
Shell Research 1	Formation Water	25 ltr.	
" " 2	" "	"	
" " 3	Seawater	"	
" " 4	" "	"	
IDF 1	Formation Water	"	
Norske Shell 1	Formation Water	"	
" " 2	" "	"	
" " 3	" "	"	
" " 4	" "	"	
" " 5	" "	"	
" " 6	" "	"	
" " 7	" "	"	
" " 8	" "	"	
" " 9	" "	"	
" " 10	" "	"	
" " 11	" "	"	
" " 12	" "	"	
" " 13	Chalk Mud	"	
" " 14	Brine	"	
" " 15	Seawater	"	
" " 16	Formation Water	"	
" " 17	" "	"	
A1	Formation Water	1 ltr	Refrigerated
A2	Added 1.5ml 6M HCl	"	" , PH=2
A3	Added 1.1ml 4M H <sub>2</sub> SO <sub>4</sub>	"	" , PH=2
A4	Added 2ml 6M HNO <sub>3</sub>	"	" , PH=2
B1	Formation Water	1 ltr	Refrigerated
B2	Added 1.6ml 6M HCl	"	" , PH=2
B3	Added 1.05ml 4M H <sub>2</sub> SO <sub>4</sub>	"	" , PH=2
B4	Added 2ml 6M HNO <sub>3</sub>	"	" , PH=2

Whilst sampling formation water pH=7, T=52<sup>0</sup>F.

TABLE 8.3.4

WELL 6407/9-4  
PT-2 SAMPLES COLLECTED

NO	TEST	TIME	DATE	NATURE	S.G. at 60°F	SAMPLING POINT	CONTAINER DECR./VOLUME	NO	REMARKS
1	PT-2E	12.55 13.50	28-8-85	OIL	0.819	SEPARATOR OIL LINE	55/gal. BBL-DRUM	N/A	BULK SAMPLE
2	PT-2E	13.51 15.10	28-8-85	OIL	0.819	SEPARATOR OIL LINE	55/gal. BBL-DRUM	N/A	BULK SAMPLE
3	PT-2E	14.08 14.35	28-8-85	OIL	0.820	SEPARATOR OIL LINE	PVT OIL BOTTLE 675cc	811514	COMPANION TO SAMPLE No 4 GAS
4	PT-2E	14.08 14.35	28-8-85	GAS	0.808	SEPARATOR GAS LINE	PVT GAS BOTTLE 20 litre	1034	COMPANION TO SAMPLE No 3 OIL
5	PT-2E	15.01 15.35	28-8-85	OIL	0.820	SEPARATOR OIL LINE	PVT OIL BOTTLE 675 cc	811416	COMPANION TO SAMPLE No 6 GAS
6	PT-2E	15.01 15.35	28-8-85	GAS	0.808	SEPARATOR GAS LINE	PVT GAS BOTTLE 20 litre	1031	COMPANION TO SAMPLE No 5 OIL
7	PT-2E	15.11 15.48	28-8-85	OIL	0.820	SEPARATOR OIL LINE	55/gal. BBL-DRUM	N/A	BULK SAMPLE
8	PT-2E	15.55 16.35	28-8-85	OIL	0.860	SEPARATOR OIL LINE	PVT OIL BOTTLE 675cc	811512	COMPANION TO SAMPLE No 9 GAS
9	PT-2E	15.55 16.35	28-8-85	GAS	0.818	SEPARATOR GAS LINE	PVT GAS BOTTLE 20 litre	1035	COMPANION TO SAMPLE No 8 OIL
10	PT-2F	23.28	30-8-85	BOTTOM HOLE	-	1627 m bdf	LEUTERT 675cc	810827	SHIPPING PRESSURE 460 psig at 56°F
11	PT-2F	23.28	30-8-85	BOTTOM HOLE	-	1627 m bdf	LEUTERT 675cc	811509	SHIPPING PRESSURE 520 psig at 56°F
12	PT-2F	23.28	30-8-85	BOTTOM HOLE	-	1627 m bdf	LEUTERT SAMPLER		SAMPLE LEFT IN SAMPLER
12							LEUTERT 675cc	TX23-674	TRANSFERRED AT S.O.S. BASE 24/9/85. SHIPPING PRESS. 600 PSIG AT 59°F