



**statoil**

TBP distillation of condensate  
from 6407/1-3 DST no. 2

STATOIL  
EXPLORATION & PRODUCTION  
LABORATORY

by  
Hans Petter Rønningsen

March-84

LAB 84.

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## 1. INTRODUCTION AND SUMMARY

This report presents the results from a true boiling point distillation, performed on a 3748 ml sample of stock tank condensate from 6407/1-3 DST 2, by West LAB A/S.

The sample was fractionated from room temperature to 151.3°C at atmospheric pressure and from 179.8°C to 333.1°C at 26.6 mbar reduced pressure. The cut point temperatures according to Katz and Firoozabadi (Journ. Petr. Tech., Nov.-78, 1650) of fractions above C<sub>10</sub> had to be corrected by 0.5-4.3 degrees to obtain reasonably balanced n-alkane to n-alkane cuts.

Table 1. Summary of some essential data of condensate 6407/1-3 DST 2.

	Condensate	C <sub>10</sub> <sup>+</sup>	C <sub>20</sub> <sup>+</sup>
Density (15°C, g/cm <sup>3</sup> )	0.781	0.822	0.871
Molecular weight (g/mole)	146 *	193	335
% by weight of total sample	100	59.280	11.085

\* This is the measured value. It is reasonable to assume that the calculated value 137 (table 4) is more correct, because it is generally difficult to measure the correct molecular weight of light condensates directly.

## 2. EXPERIMENTAL

### 2.1 Distillation

The TBP distillation was performed according to ASTM D-2892 using a Kontes Martin MK IV-B fractionator system with a 24½ inches x 25 mm i.d packed column (15 theoretical plates).

Fractions were collected according to the boiling point ranges between successive n-alkanes as given by Katz and Firoozabadi. The light end fractions ( $C_{10}$ ) were separated at atmospheric pressure, the  $C_{10} - C_{19}^+$  fractions at reduced pressure (26.6 mbar = 20 mm Hg).

### 2.2 Gas chromatographic analysis

Single component analysis was performed on all light end fractions (gas to C9), using a Hewlett Packard 5880 gas chromatographic system.

Column for gas and cold trap fractions	:	Chrompack WCOT Cp sil 5 on fused silica, 50 m x 0.23 mm i.d., filmthickness 0.3 $\mu$ m.
Column for liquid fractions	:	Chrompack WCOT Cp sil 5 on fused silica, 25 m x 0.22 mm i.d., filmthickness 0.14 $\mu$ m.
Carrier gas	:	Helium, 23 cm/sec linear velocity at 50°C.
Detector	:	Flame ionization, nitrogen make-up gas, temp. 320°C

Injection : All glass splitter, with a packed "Jennings tube". Split ratio 1:100, temp. 310°C (liquid fractions) and 200°C (gas). 0.1 - 0.2  $\mu$ l liquid samples injected, 0.5 ml gas and cold trap fractions.

Temp. programs : Gas and cold temp:  
-30°C isothermal 4 min, then 8°/min to 160°C.  
C<sub>6</sub>-C<sub>10</sub>: -5°C 2 min, 2°/min to 40°C, 8°/min to 300°C.

C<sub>10</sub> - C<sub>19</sub> fractions were checked for fractions overlap, using a Perkin Elmer Sigma 300/Sigma 15 system.

Column : Chrompack WCOT Cp sil 5 CB on fused silica, filmthickness 0.11  $\mu$  m.

Carrier gas : Helium 22 cm/sec linear velocity at 10°C.

Detector : FID, helium make-up gas, temp. 350°C.

Injection : Split injection with glas liner, split ratio 1:90, temp. 350°C.

Temp. program : 10°C 4 min, 4°/min to 300°C.

### 2.3 Other measurements

Molecular weights were determined by freezing point depression using a Cryette cryoscope, with benzene as reference substance. The cryoscope was calibrated with tetradecane ( $n\text{-C}_{14}$ ).

Densities were measured using a Paar DMA 46 frequency densiometer thermostated at  $15^{\circ}\text{C}$ . The  $\text{C}_{20}^{+-}$ -fraction had to be measured at  $50^{\circ}\text{C}$  because of high viscosity. The measured density at  $50^{\circ}\text{C}$  was then corrected to  $15^{\circ}\text{C}$  according to API standard 2540 (Manual of Petroleum Measurement Standards, table 53A, First edition, august 1980).

## 3. RESULTS

Table 2 gives all compositional data from the TBP distillation and physical data of each collected fraction. A loss of 0.693 %, as calculated by adding all fractions at the end of the distillation, has been added to the  $\text{C}_{20}^{+-}$ -fraction.

Table 3 gives the calculated density  $S$  of recovered distillate (see also figure at the end of this chapter):

$S$  = cumulative weight/cumulative volume. Total % by volume distilled is also given in this table.

Table 4 gives calculated molecular weights and densities compared to measured values.

Table 5 gives the weight distribution and calculated % overlap between collected fractions. % by weight overlap is assumed to be equal to area % overlap in gas chromatograms. Response factors are not used.

Table 6 gives a more detailed composition of the light end part. All chromatograms of gas and cold trap fractions, C<sub>6</sub>, C<sub>7</sub>, C<sub>8</sub>, C<sub>9</sub> and partly C<sub>10</sub>, have been combined to calculate "ideal" fractions without overlap. Below C<sub>6</sub>, every single compound is reported. In C<sub>6</sub>, C<sub>7</sub>, C<sub>8</sub> and C<sub>9</sub> some abundant aromatics and naphtenes are reported in addition to the total cuts. In this table, "C<sub>x</sub> rest" means "C<sub>x</sub> total" minus the reported aromatics/naphtenes.

In addition to corrected wt %'s, corrected molecular weights and densities have been calculated, assuming these properties to be additive. Weight %'s have been calculated using theoretical, relative FID response factors.

Table 7 gives characteristic ratios involving C<sub>19</sub> and C<sub>20</sub> isoprenoid hydrocarbons.

Table 8 gives PNA-distribution of corrected fractions below C<sub>10</sub>, as determined by GC, using response factors.



Table 2. Data from TBP distillation of stock tank condensate 6407/1-3 DST 2.

Fraction	Cut point ( C,760 mmHg)	Actual head- temp.	% by weight of total oil	% by weight distilled
Gas	-	-	0.030	0.030
Cold trap	36.5	36.5	5.018	5.049
C 6	69.2	69.2	4.588	9.638
C 7	98.9	98.9	9.914	19.553
C 8	126.1	126.1	12.453	32.006
C 9	151.3	151.3	8.341	40.348
C 10+	> 151.3	> 151.3	59.280	99.628
C 10	179.8	75.0	9.003	49.351
C 11	198.7	90.5	5.916	55.267
C 12	220.5	108.5	6.506	61.774
C 13	236.4	122.0	4.749	66.523
C 14	257.8	140.0	6.131	72.654
C 15	273.5	153.0	4.005	76.659
C 16	290.5	166.8	3.613	80.272
C 17	304.9	179.5	3.254	83.527
C 18	318.7	191.8	2.923	86.451
C 19	333.1	204.1	2.463	88.915
C 20+	> 333.1	> 204.1	11.085	100.000

Table 2 cont.

Fraction	Density (g/cm <sup>3</sup> )	% by volume of total oil	% by volume distilled
Gas	0.430	0.055	0.055
Cold trap	0.616	6.353	6.409
C 6	0.679	5.270	11.680
C 7	0.736	10.505	22.185
C 8	0.755	12.863	35.049
C 9	0.773	8.415	43.465
C 10+	0.822	56.241	99.706
C 10	0.784	8.956	52.421
C 11	0.793	5.818	58.239
C 12	0.803	6.318	64.558
C 13	0.818	4.527	69.086
C 14	0.822	5.816	74.902
C 15	0.830	3.763	78.666
C 16	0.837	3.366	82.032
C 17	0.834	3.043	85.076
C 18	0.836	2.727	87.804
C 19	0.846	2.270	90.074
C 20+	0.871	9.925	100.000

Table 2 cont.

Fraction	Molecular weight	Mole%	Cumulative mole%
Gas	36	0.11	0.11
Cold trap	67	10.25	10.37
C 6	82	7.66	18.03
C 7	92	14.75	32.78
C 8	107	15.93	48.72
C 9	122	9.36	58.08
C 10+	193	42.05	100.13
C 10	136	9.06	67.14
C 11	152	5.32	72.47
C 12	165	5.39	77.87
C 13	179	3.63	81.50
C 14	192	4.37	85.87
C 15	210	2.61	88.49
C 16	222	2.22	90.71
C 17	238	1.87	92.59
C 18	254	1.57	94.16
C 19	259	1.30	95.46
C 20+	335	4.53	100.00

Table 3. Cumulative weight and volume, % by volume distilled and calculated density S of recovered material

$$S = \text{Cum. weight/cum. volume}$$

Fraction	Cum. weight	Cum. volume	S	% by volume distilled
Gas	0.900	2.093	0.430	0.055
Cold trap	148.000	240.892	0.614	6.409
C 6	282.500	438.977	0.643	11.680
C 7	573.100	833.814	0.687	22.185
C 8	938.100	1317.260	0.712	35.049
C 9	1182.600	1633.560	0.723	43.465
C 10	1446.500	1970.160	0.734	52.421
C 11	1619.900	2188.830	0.740	58.239
C 12	1810.600	2426.310	0.746	64.558
C 13	1949.800	2596.480	0.750	69.086
C 14	2129.500	2815.100	0.756	74.902
C 15	2246.900	2956.540	0.759	78.666
C 16	2352.800	3083.070	0.763	82.032
C 17	2448.200	3197.450	0.765	85.076
C 18	2533.900	3299.970	0.767	87.804
C 19	2606.100	3385.310	0.769	90.074

Table 4. Measured and calculated molecular weights and densities of condensate 6407/1-3 DST 2.

	Oil	C 10+	C 20+
Measured MW	146	193	335
Calculated MW using C10+ MW	136		
Calculated MW using C20+ MW	137	195	
Measured density	0.781	0.822	0.871
Calculated density using C10+ density	0.779		
Calculated density using C20+ density	0.779	0.822	

Table 5. Weight distribution and % by weight overlap between uncorrected fractions of condensate 6407/1-3 DST 2.

Fraction	% by weight of total oil	% by weight overlap between fractions *			
Gas	0.030				
Cold trap	5.018				
C 6	4.588	13	:	74	:
C 7	9.914	10	:	78	:
C 8	12.453	8	:	89	:
C 9	8.341	3	:	93	:
C 10	9.003	12	:	83	:
C 11	5.916	7	:	87	:
C 12	6.506	15	:	76	:
C 13	4.749	8	:	86	:
C 14	6.131	19	:	72	:
C 15	4.005	8	:	85	:
C 16	3.613	15	:	75	:
C 17	3.254	14	:	69	:
C 18	2.923	14	:	72	:
C 19	2.463	15	:	75	:

\* Calculated on basis of area% from GC-reports  
(response factors have not been used)

Table 6. Total composition and physical properties of gas, light end fractions (< C10) and C10+, as determined by GC.

Compound/ fraction	Wt% of total oil	Wt% of fraction	MW	Mole% of total oil	Density
Methane	0.001	-	16.0	0.015	-
Ethane	0.011	-	30.1	0.050	0.358
Propane	0.113	-	44.4	0.351	0.508
i-butane	0.220	-	58.1	0.518	0.563
n-butane	1.089	-	58.1	2.565	0.585
2,2-dimethyl- propane	0.009	-	72.2	0.018	0.597
i-pentane	1.473	-	72.2	2.794	0.625
n-pentane	2.530	-	72.2	4.800	0.631
C6 total	4.543	100.000	84.8	7.328	0.668
C6 rest	4.235	93.220	86.1	6.727	0.711
Cyclopentane	0.308	6.780	70.1	0.601	0.750
C7 total	9.558	100.000	91.7	14.253	0.739
C7 rest	5.583	58.412	99.6	7.667	0.704
Methylcyclo- pentane	1.248	13.057	84.2	2.030	0.753
Benzene	0.952	9.960	78.1	1.668	0.884
Cyclohexane	1.774	18.560	84.2	2.886	0.783
C8 total	11.716	100.000	105.3	15.222	0.756
C8 rest	6.777	57.844	113.7	8.157	0.721
Methylcyclo- hexane	2.716	23.182	98.2	3.786	0.774
Ethylcyclo- pentane	0.246	2.100	98.2	0.343	0.771
Toluene	1.975	16.857	92.1	2.934	0.871
C9 total	9.966	100.000	121.5	11.225	0.761
C9 rest	7.381	74.062	127.4	7.929	0.734
Ethylcyclo- hexane	0.524	5.258	112.2	0.639	0.782
Ethylbenzene	0.722	7.245	106.2	0.931	0.871
m+p-xylene	0.941	9.442	106.2	1.214	0.867
o-xylene	0.395	3.963	106.2	0.510	0.884
C10	8.616	100.000	137.3	8.589	0.795
C10+	58.893	100.000	193.9	41.569	0.824

Table 7. Characteristic isoprenoid hydrocarbon ratios  
of condensate 6407/1-3 DST 2. \*

	Ratio
n-C 17/pristane	1.14
n-C 18/phytane	1.25
Pristane/phytane	1.32

\* Peak height ratio from GC.

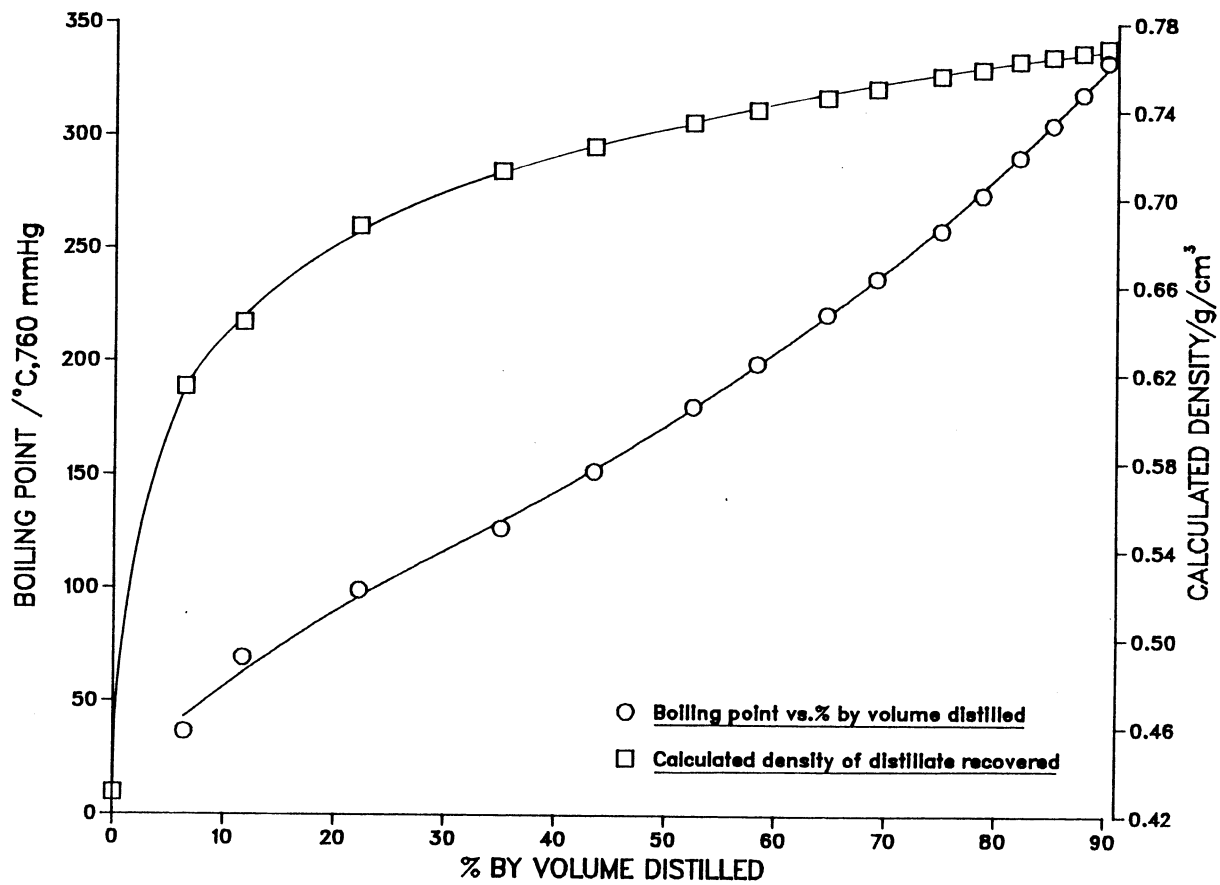
Table 8. PNA-distribution of corrected light end  
fractions (% by weight).

Fraction	Paraffines	Naphtenes	Aromatics
C 6	93.2	6.7	0.0
C 7	45.8	44.1	9.9
C 8	42.1	41.0	16.8
C 9	58.1	21.1	20.6



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Fig 1. TBP- and density-profiles:  
Condensate 6407/1-3,DST 2.



APPENDIX

GAS CHROMATOGRAMS

17

6407/1-3 DST 2

n-C<sub>10</sub>

n-C<sub>20</sub>

