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TBP-distillations of stock tank condensates 31/3-1 DST no. 1 and 2

STATOIL
EXPLORATION & PRODUCTION
LABORATORY

by
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1. INTRODUCTION AND SUMMARY

This report presents the results of two true boiling point distillations, performed on 4 000 ml samples of stock tank condensates from well 31/3-1 DST no. 1 and 2, by West Lab A/S. A total composition of the samples has been calculated by using TBP-data above C_{10}, and GC-data from analyses of the same samples below C_{10}. The GC-analyses are done by Statoil.

Both samples were distilled in one step from room temperature to 151.3 ^{o}C at atmospheric pressure. Condensate from DST 1 was fractionated from 72,0 ^{o}C to 194.4 ^{o}C at 26.6 mbar reduced pressure , DST 2 condensate from 70.7 ^{o}C to 166.7 ^{o}C. In both cases it was impossible to reach the end boiling point of the C_{19} fraction, because of the low content of heavy compounds. For DST 2 one could, in fact, only reach the C_{16} boiling point.

Table 1. Summary of some essential data of condensates 31/3-1 DST no. 1 and 2

	Condensate		C10+		C20+	C18+
	DST 1	DST 2	DST 1	DST 2	DST 1	DST 2
Density (15 ^{o}C, g/cm^3)	0.777	0.771	0.828	0.827	0.897	0.904
Molecular weight	118	116	161	155	321	296
% by weight of sample	100	100	35.223	28.468	1.576	1.263

2. EXPERIMENTAL

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 boiling point ranges between successive n-alkanes as given by Katz and Firoozabadi (Journ. Petr. Tech., Nov. 1978, 1650).

For gas chromatograghic single component analysis below C_{10}, a Chrompack WCOT Cp Sil 5 column (25 m x 0.22 mm i.d., filmthickness 0.14 µm) was used with helium as carrier gas, split injection and FI-detector. The temperature was programmed from -5 °C (2 min) to 40 °C with 2 °/min and from 40 °C to 300 °C with 8 °/min.

For GC analysis of collected fractions to check fraction overlap, a Chrompack WCOT Cp Sil 5 CB column (25 m x 0.23 mm i.d., 0.11 µm filmthickness) was used with helium, split injection, FI-detector and temp. programming 4 °/min from 10°C (4 min) to 300 °C.

Molecular weights were determined by freezing point depression using a Cryette cryoscope with benzene as referance substance.

Densities were measured using a Paar DMA 46 frequency densiometer thermostatted at 15 °C.

3. RESULTS

Table 2 (DST 1) and 7 (DST 2) give all compositional TBP-data and physical data of each fraction. Losses at the end of the distillations are supposed to be column hold up material, and are added to the C_{20+} (C_{18+}) fractions.

Table 3 and 8 give calculated density S of recovered distillate (also plotted in figure at the end of the chapter):

$$S = \frac{\text{cumulative weight}}{\text{cumulative volume}}$$

Table 4 and 9 give calculated molecular weights and densities. In both cases it is good agreement between calculated values. As usual for light condensates, the measured molecular weights and densities of the whole condensates are higher than the calculated ones, due to loss of light components during measurement. Of some reason the calculated C_{10+}-values are also slightly higher than the measured ones.

Table 5 and 10 give weight distributions and calculated overlap between fractions. % by weight overlap is assumed to be equal to area % overlap in gas chromatograms.

Table 6 and 11 give detailed compositions of the light ends (below C_{10}), determined by gas chromatography of the distilled stock tank condensates, using internal standard. These tables give calculated molecular weights and densities of fractions without overlap, based on the compositions.

4. COMMENTS

The table below gives a comparison between the compositional data from the TBP distillations of stock tank condensates and GC-analysis of single flash liquids from separator samples.

Table

	Distillation of stock tank condensate		GC-analysis of single flash liquids	
	DST 1	DST 2	DST 1*	DST 2*
MW cond.	118	116	126	112
ρ15 cond.	0.777	0.771	0.793	0.774
Wt % C_{10+}	35,222	28.467	51.227	36.480
MW C_{10+}	161	155	165	147
ρ15 C_{10+}	0.828	0.827	0.838	0.826

* bottle no. 83081703

** bottle no. 83081316

Two conclusions can be drawn from this:

1. There is a difference between the condensates from DST 1 and DST 2.

   Both TBP distillation and GC-analysis give a lighter DST 2 condensate. One explanation to this may be the different field sampling conditions. Separator pressure/temperature during DST 1 was 31.3 bar/31^{o}C, and during DST 2 26.9 bar/4.4^{o}C.

2. There are differences between the stock tank and single flash liquids.

   The difference is especially pronounced for DST 1 with C_{10+} weight %'s on 35.222 (dist.) and 51.227 (GC). The differences can not be explained by a loss of light compounds from the stock tank liquids caused by improper storage, as this would give an opposite effect. To trace an explanation will be just speculation.

Table 2. Data from TBP distillation of stock tank condensate 31/3-1 DST no. 1.

Fraction	Cut point (C,760 mmHg)	Actual head-temp.	% by weight of total oil	% by weight distilled
Gas	-	-	1.596	1.596
C 5	36.5	36.5	1.791	3.387
C 6	69.2	69.2	5.504	8.891
C 7	98.9	98.9	17.593	26.485
C 8	126.1	126.1	23.543	50.027
C 9	151.3	151.3	14.750	64.778
C 10+	> 151.3	> 151.3	35.223	100.001
C 10	176.2	72.0	9.512	74.290
C 11	200.4	91.9	6.776	81.066
C 12	217.9	106.2	3.961	85.027
C 13	236.0	121.6	3.670	88.696
C 14	255.1	137.7	2.838	91.535
C 15	271.1	151.1	2.203	93.738
C 16	290.1	166.4	2.211	95.949
C 17	303.2	178.0	1.054	97.003
C 18	318.2	191.3	1.119	98.122
C 19	322.3	194.4	0.302	98.424
C 20+	> 322.3	> 194.4	1.576	100.001

Table 2 cont.

Fraction	Density (g/cm3)	% by volume of total oil	% by volume distilled
Gas	0.552	2.226	2.226
C 5	0.626	2.203	4.429
C 6	0.672	6.301	10.731
C 7	0.750	18.054	28.785
C 8	0.755	23.993	52.777
C 9	0.780	14.564	67.341
C 10+	0.828	32.761	100.103
C 10	0.807	9.078	76.419
C 11	0.819	6.372	82.791
C 12	0.834	3.657	86.449
C 13	0.839	3.368	89.817
C 14	0.845	2.587	92.404
C 15	0.848	2.001	94.405
C 16	0.851	2.001	96.406
C 17	0.848	0.958	97.363
C 18	0.851	1.012	98.376
C 19	0.858	0.271	98.647
C 20+	0.897	1.353	100.000

Table 2 cont.

Fraction	Molecular weight	Mole%	Cumulative mole%
Gas	54.4	3.33	3.33
C 5	72.1	2.82	6.15
C 6	83.6	7.47	13.63
C 7	89.5	22.32	35.95
C 8	104.7	25.53	61.48
C 9	118.7	14.11	75.58
C 10+	161	24.85	100.43
C 10	133	8.12	83.71
C 11	148	5.20	88.91
C 12	161	2.79	91.70
C 13	174	2.40	94.10
C 14	187	1.72	95.82
C 15	200	1.25	97.07
C 16	211	1.19	98.26
C 17	230	0.52	98.78
C 18	243	0.52	99.31
C 19	252	0.14	99.44
C 20+	321	0.56	100.00

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

S = Cum. weight/cum. volume

Fraction	Cum. weight	Cum. volume	S	% by volume distilled
Gas	42.231	76.495	0.552	2.226
C 5	89.623	152.183	0.589	4.429
C 6	235.265	368.686	0.638	10.731
C 7	700.793	988.977	0.709	28.785
C 8	1323.740	1813.300	0.730	52.777
C 9	1714.040	2313.690	0.741	67.341
C 10	1965.740	2625.580	0.749	76.419
C 11	2145.040	2844.510	0.754	82.791
C 12	2249.840	2970.170	0.757	86.449
C 13	2346.940	3085.900	0.761	89.817
C 14	2422.040	3174.780	0.763	92.404
C 15	2480.340	3243.530	0.765	94.405
C 16	2538.840	3312.270	0.766	96.406
C 17	2566.740	3345.170	0.767	97.363
C 18	2596.340	3379.950	0.768	98.376
C 19	2604.340	3389.280	0.768	98.647

Table 4. Measured and calculated molecular weights and densities of condensate 31/3-1 DST no. 1.

	Oil	C 10+	C 20+
Measured MW	118	161	321
Calculated MW using C10+ MW	113		
Calculated MW using C20+ MW	114	164	
Measured density	0.777	0.828	0.897
Calculated density using C10+ density	0.769		
Calculated density using C20+ density	0.770	0.831	

Table 5. Weight distribution and % by weight overlap between uncorrected fractions of condensate 31/3-1 DST no. 1.

Fraction	% by weight of total oil	% by weight overlap between fractions *
Gas	1.596	-
C 5	1.791	-
C 6	5.504	0 : 100 : 0
C 7	17.593	0 : 100 : 0
C 8	23.543	0 : 100 : 0
C 9	14.750	0 : 100 : 0
C 10	9.512	9 : 87 : 4
C 11	6.776	5 : 89 : 6
C 12	3.961	11 : 84 : 5
C 13	3.670	8 : 83 : 9
C 14	2.838	11 : 80 : 9
C 15	2.203	12 : 80 : 8
C 16	2.211	22 : 67 : 11
C 17	1.054	16 : 72 : 12
C 18	1.119	24 : 65 : 11
C 19	0.302	33 : 61 : 6

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

Table 6 . Detailed composition of the light end of stock tank condensate 31/3-1 DST no. 1.

Component	Weight%	Mole%	Vol%	MW	Density
Methane	0.000	0.00	0.000	16.04	0.2600
Ethane	0.035	0.13	0.075	30.07	0.3580
Propane	0.238	0.61	0.361	44.10	0.5076
i-butane	0.947	1.85	1.295	58.12	0.5633
n-butane	0.376	0.73	0.495	58.12	0.5847
2,2-dimethylpropane	0.041	0.06	0.053	72.15	0.5967
i-pentane	1.116	1.76	1.376	72.15	0.6246
n-pentane	0.634	1.00	0.774	72.15	0.6309
Hexanes total	5.504	7.47	6.301	83.6	0.672
Hexanes paraffines	4.776	6.30	5.528	86.1	0.665
Hexanes naphtenes	0.728	1.18	0.747	70.1	0.750
Heptanes total	17.593	22.32	18.054	89.5	0.750
Heptanes paraffines	3.208	3.64	3.602	100.2	0.685
Heptanes naphtenes	14.365	18.66	14.436	87.4	0.766
Heptanes aromatics	0.020	0.03	0.017	78.1	0.881
Octanes total	23.543	25.53	23.993	104.7	0.755
Octanes paraffines	5.545	5.51	6.067	114.2	0.703
Octanes naphtenes	17.503	19.41	17.491	102.4	0.770
Octanes aromatics	0.494	0.61	0.437	92.1	0.871
Nonanes total	14.750	14.11	14.564	118.7	0.780
Nonanes paraffines	5.548	4.91	5.921	128.2	0.721
Nonanes naphtenes	5.703	5.45	5.553	118.8	0.790
Nonanes aromatics	3.500	3.74	3.091	106.1	0.872

Table 7. Data from TBP distillation of stock tank condensate 31/3-1 DST no. 2.

Fraction	Cut point (C,760 mmHg)	Actual head-temp.	% by weight of total oil	% by weight distilled
Gas	-	-	1.165	1.165
C 5	36.5	36.5	1.374	2.539
C 6	69.2	69.2	5.328	7.867
C 7	98.9	98.9	19.904	27.771
C 8	126.1	126.1	28.035	55.805
C 9	151.3	151.3	15.727	71.532
C 10+	> 151.3	> 151.3	28.468	100.001
C 10	174.6	70.7	9.540	81.072
C 11	196.4	88.6	5.941	87.014
C 12	216.8	105.3	4.147	91.161
C 13	236.0	121.6	2.871	94.032
C 14	255.1	137.7	2.346	96.378
C 15	271.4	151.3	1.290	97.667
C 16	287.3	163.9	0.809	98.477
C 17	290.6	166.7	0.261	98.737
C 18	-	-	-	-
C 19	-	-	-	-
C 18+	> 291.6	> 166.7	1.263	100.000

Table 7 cont.

Fraction	Density (g/cm3)	% by volume of total oil	% by volume distilled
Gas	0.551	1.618	1.618
C 5	0.625	1.680	3.297
C 6	0.673	6.056	9.353
C 7	0.747	20.365	29.718
C 8	0.754	28.445	58.164
C 9	0.774	15.545	73.708
C 10+	0.827	26.335	100.044
C 10	0.807	9.044	82.753
C 11	0.820	5.543	88.296
C 12	0.835	3.800	92.095
C 13	0.841	2.612	94.707
C 14	0.847	2.119	96.826
C 15	0.854	1.155	97.982
C 16	0.861	0.719	98.701
C 17	0.864	0.231	98.931
C 18	—	—	—
C 19	—	—	—
C 18+	0.904	1.069	100.000

Table 7 cont.

Fraction	Molecular weight	Mole%	Cumulative mole%
Gas	54.4	2.37	2.37
C 5	72.1	2.11	4.48
C 6	83.5	7.06	11.53
C 7	89.6	24.58	36.11
C 8	104.8	29.59	65.71
C 9	120.0	14.50	80.21
C 10+	155	20.33	100.54
C 10	136	7.76	87.97
C 11	150	4.38	92.36
C 12	163	2.82	95.18
C 13	179	1.78	96.95
C 14	192	1.35	98.30
C 15	207	0.69	98.99
C 16	218	0.41	99.40
C 17	232	0.12	99.53
C 18	-	-	-
C 19	-	-	-
C 18+	296	0.47	100.00

Table 8. Cumulative weight and volume, % by volume distilled and calculated density S of recovered material.

S = Cum. weight/cum. volume

Fraction	Cum. weight	Cum. volume	S	% by volume distilled
Gas	34.411	62.453	0.551	1.618
C 5	74.997	127.306	0.589	3.297
C 6	232.375	361.117	0.643	9.353
C 7	820.300	1147.430	0.715	29.718
C 8	1648.400	2245.700	0.734	58.164
C 9	2112.940	2845.890	0.742	73.708
C 10	2394.740	3195.080	0.750	82.753
C 11	2570.240	3409.100	0.754	88.296
C 12	2692.740	3555.810	0.757	92.095
C 13	2777.540	3656.640	0.760	94.707
C 14	2846.840	3738.460	0.762	96.826
C 15	2884.940	3783.080	0.763	97.982
C 16	2908.840	3810.830	0.763	98.701
C 17	2916.540	3819.750	0.764	98.931

Table 9. Measured and calculated molecular weights and densities of condensate 31/3-1 DST no. 2.

	Oil	C 10+	C 18+
Measured MW	116	155	296
Calculated MW using C10+ MW	110		
Calculated MW using C18+ MW	111	159	
Measured density	0.771	0.827	0.904
Calculated density using C10+ density	0.765		
Calculated density using C18+ density	0.765	0.828	

Table 10. Weight distribution and % by weight overlap between uncorrected fractions of condensate 31/3-1 DST no. 2.

Fraction	% by weight of total oil	% by weight overlap between fractions *
Gas	1.165	-
C 5	1.374	-
C 6	5.328	0 : 100 : 0
C 7	19.904	0 : 100 : 0
C 8	28.035	0 : 100 : 0
C 9	15.727	0 : 100 : 0
C 10	9.540	4 : 90 : 5
C 11	5.941	6 : 90 : 4
C 12	4.147	10 : 84 : 6
C 13	2.871	5 : 91 : 4
C 14	2.346	10 : 83 : 7
C 15	1.290	10 : 81 : 9
C 16	0.809	7 : 74 : 19
C 17	0.261	13 : 79 : 8

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

Table 11 . Detailed composition of the light end of stock tank condensate 31/3-1 DST no. 2.

Component	Weight%	Mole%	Vol%	MW	Density
Methane	0.000	0.00	0.000	16.04	0.2600
Ethane	0.031	0.11	0.066	30.07	0.3580
Propane	0.156	0.39	0.235	44.10	0.5076
i-butane	0.735	1.40	0.998	58.12	0.5633
n-butane	0.243	0.46	0.318	58.12	0.5847
2,2-dimethylpropane	0.038	0.06	0.049	72.15	0.5967
i-pentane	0.893	1.37	1.094	72.15	0.6246
n-pentane	0.443	0.68	0.537	72.15	0.6309
Hexanes total	5.328	7.06	6.056	83.5	0.673
Hexanes paraffines	4.599	5.91	5.288	86.1	0.665
Hexanes naphtenes	0.729	1.15	0.743	70.1	0.750
Heptanes total	19.904	24.58	20.365	89.6	0.747
Heptanes paraffines	4.324	4.78	4.833	100.2	0.684
Heptanes naphtenes	15.560	19.78	15.516	87.0	0.767
Heptanes aromatics	0.019	0.03	0.016	78.1	0.881
Octanes total	28.035	29.59	28.445	104.8	0.754
Octanes paraffines	7.442	7.21	8.084	114.2	0.704
Octanes naphtenes	20.116	21.81	19.942	102.1	0.771
Octanes aromatics	0.477	0.57	0.419	92.1	0.871
Nonanes total	15.727	14.50	15.545	120.0	0.774
Nonanes paraffines	6.577	5.68	6.979	128.2	0.721
Nonanes naphtenes	5.982	5.52	5.787	119.8	0.790
Nonanes aromatics	3.167	3.30	2.778	106.1	0.872

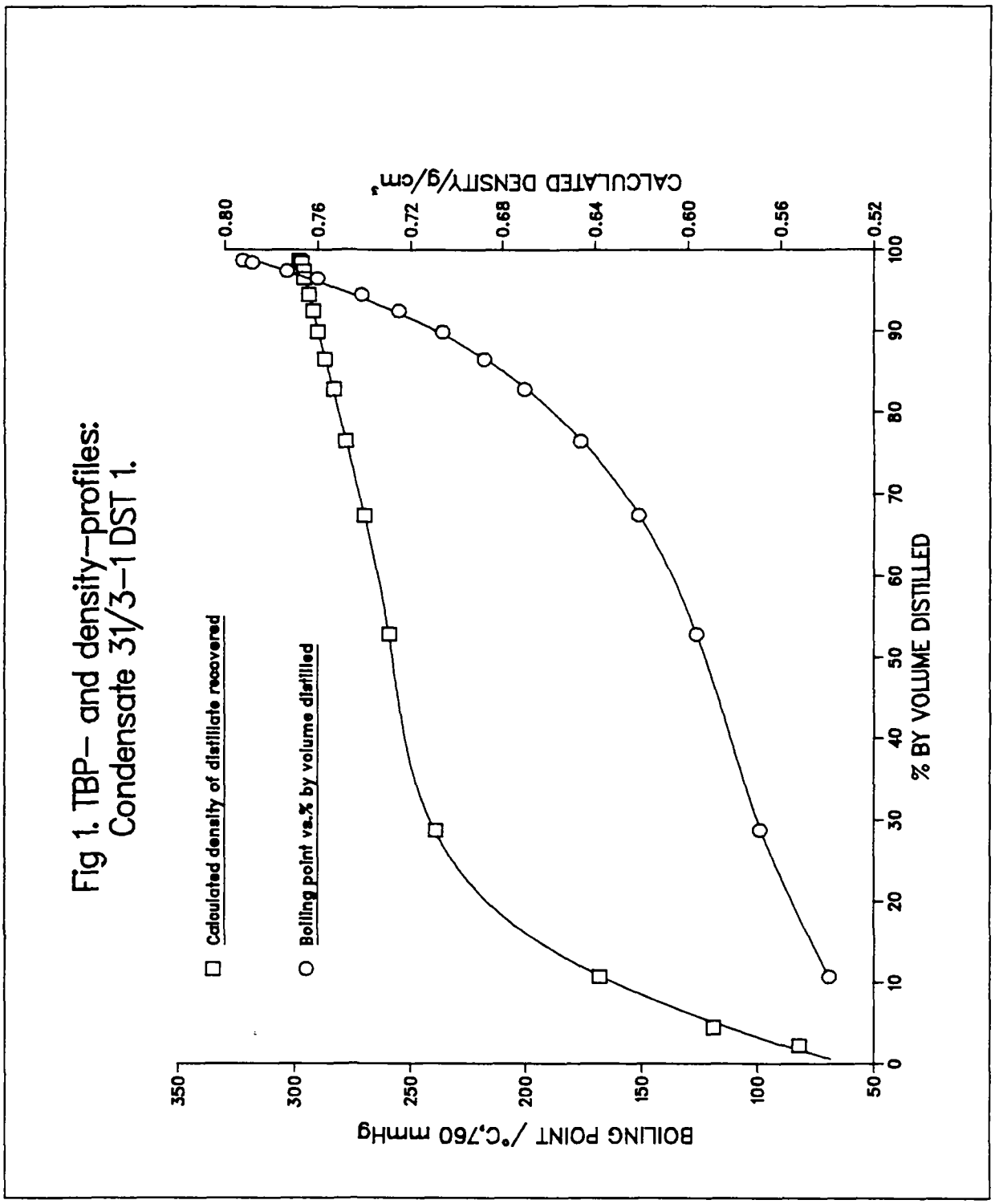


Fig 1. TBP– and density–profiles:
Condensate 31/3–1 DST 1.

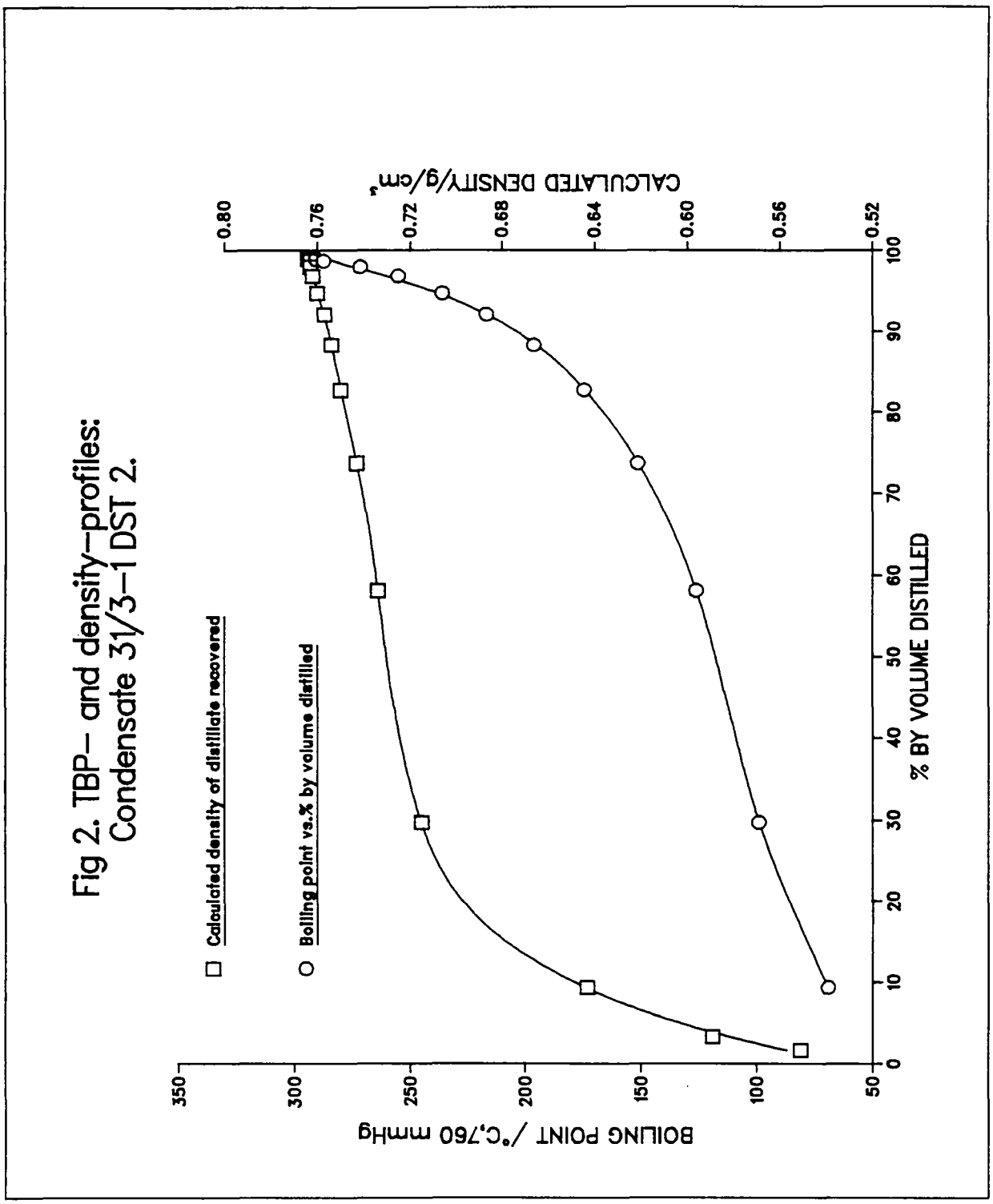
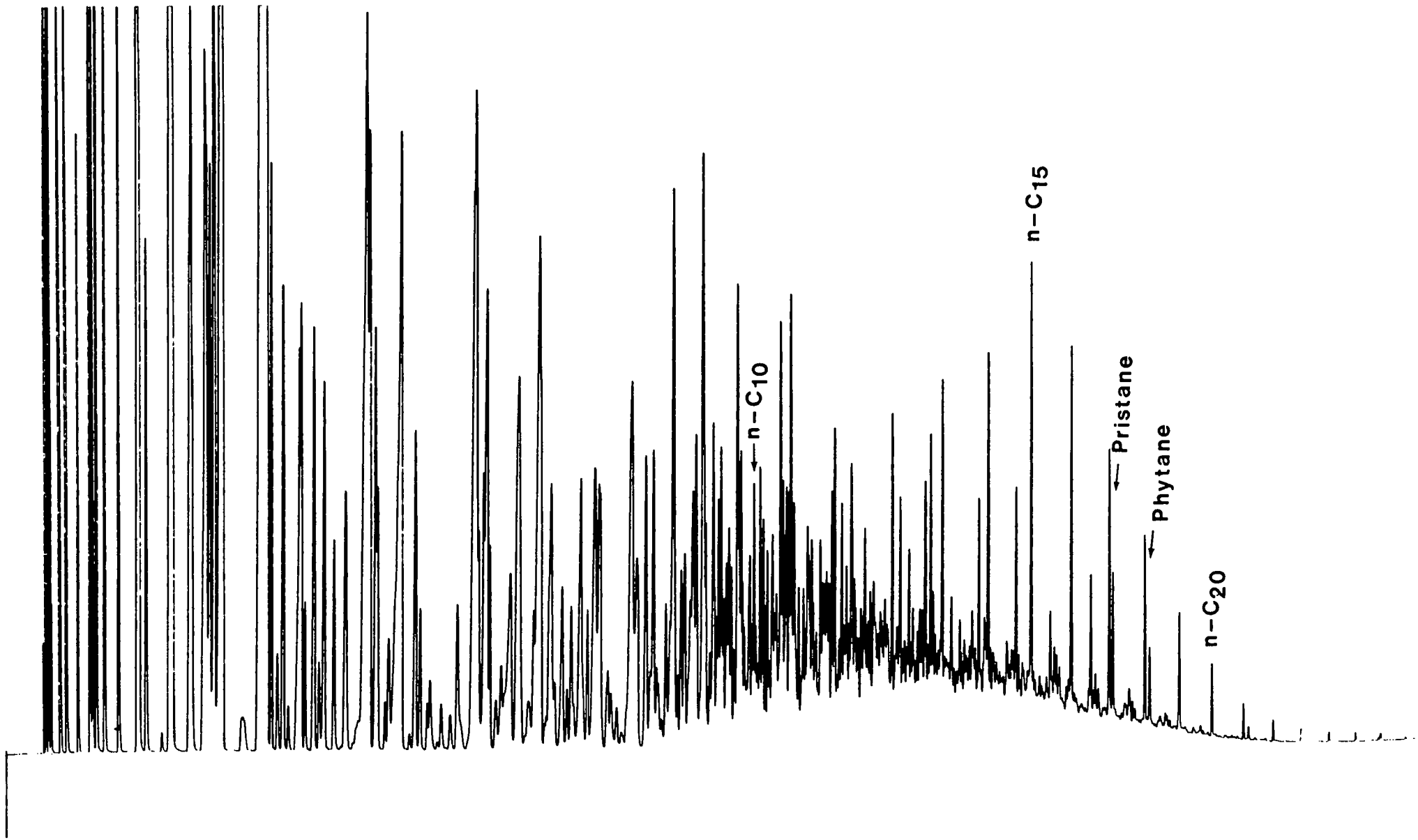
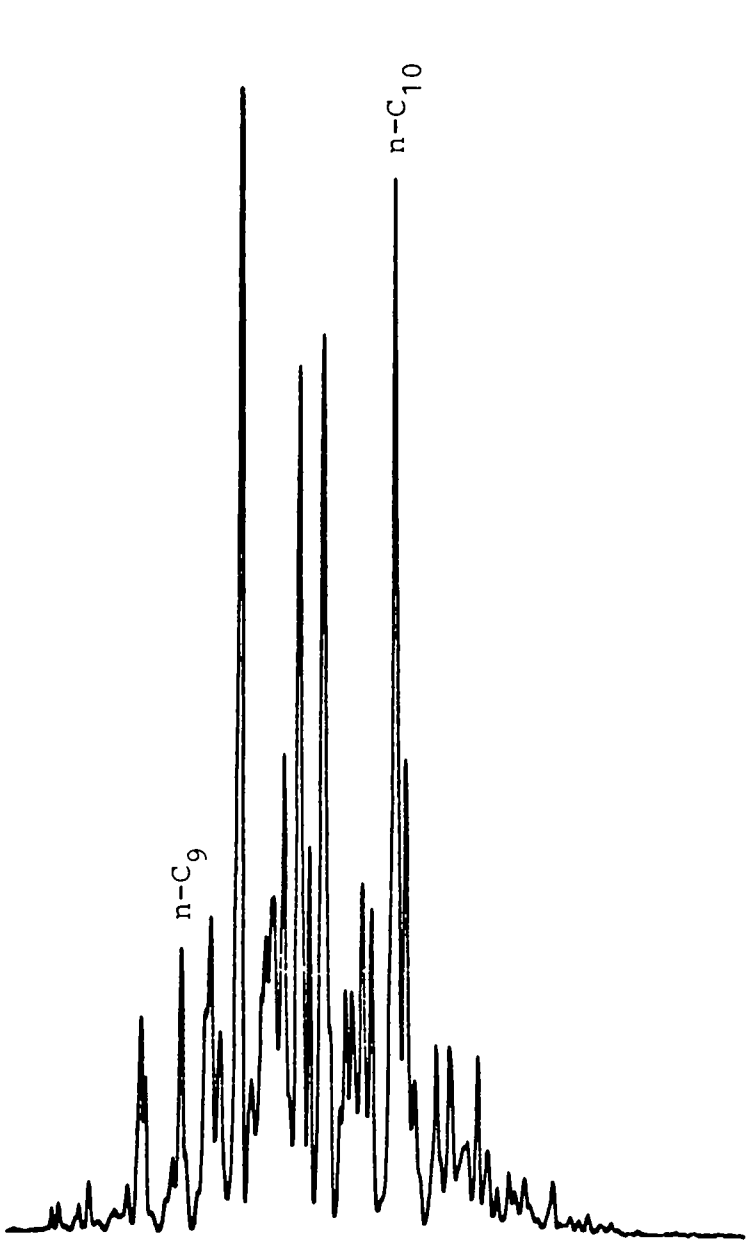


Fig 2. TBP– and density–profiles:
Condensate 31/3–1 DST 2.

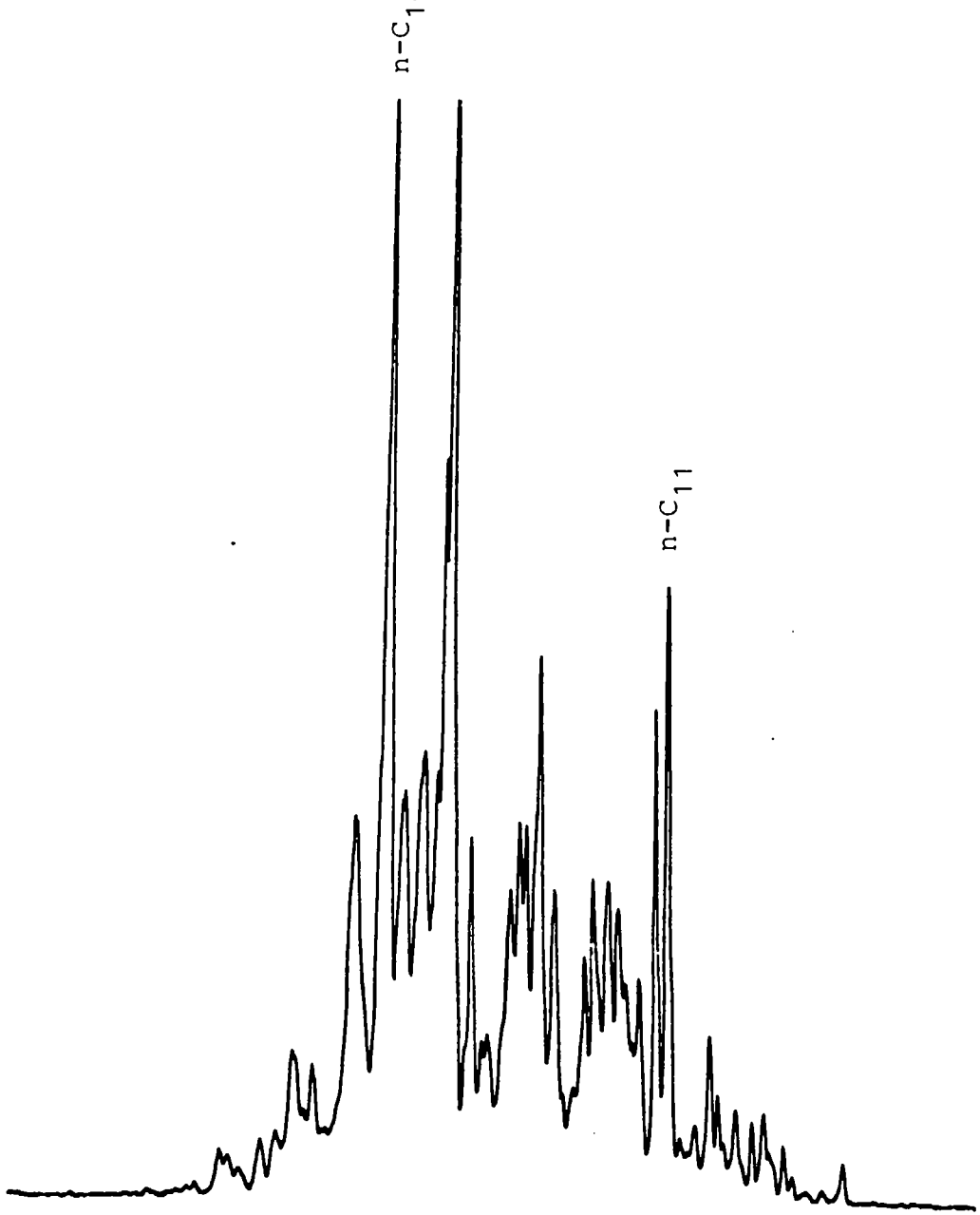
A P P E N D I X



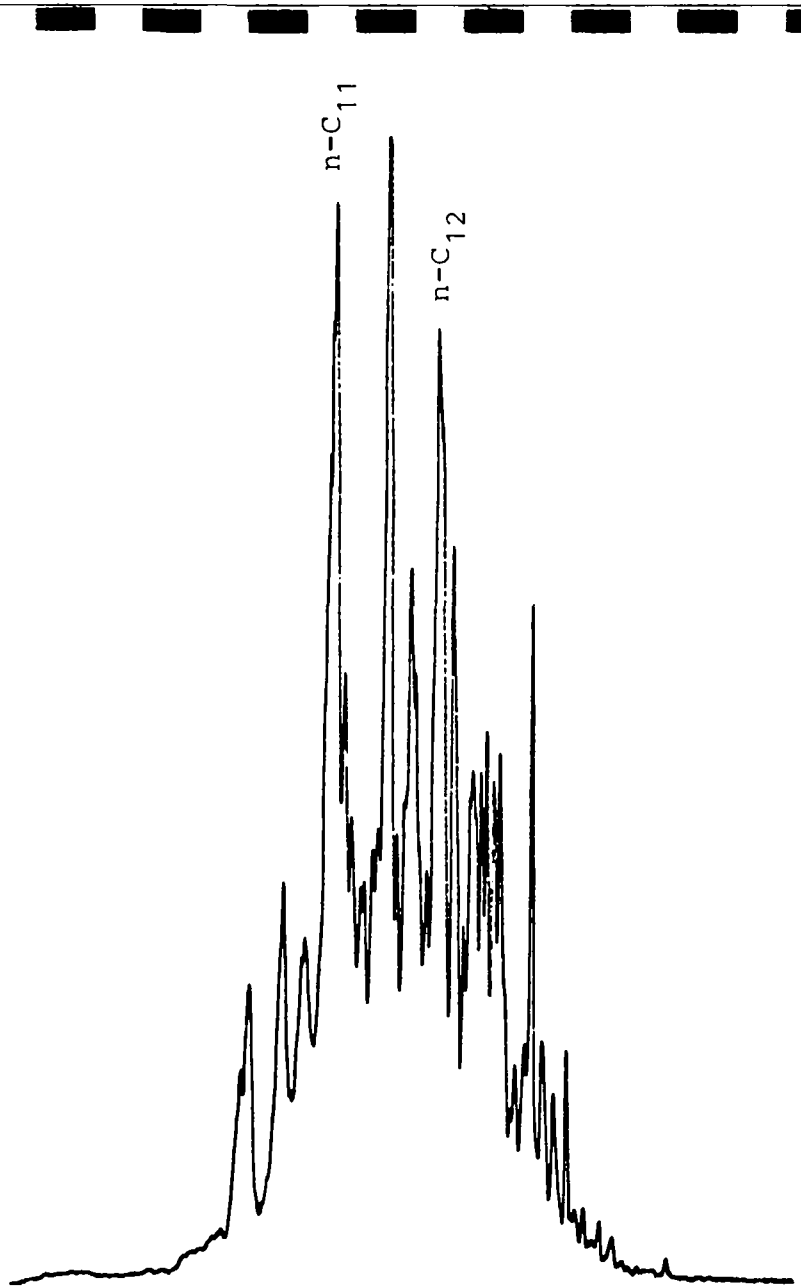
Condensate 31/3-1 DST no.1



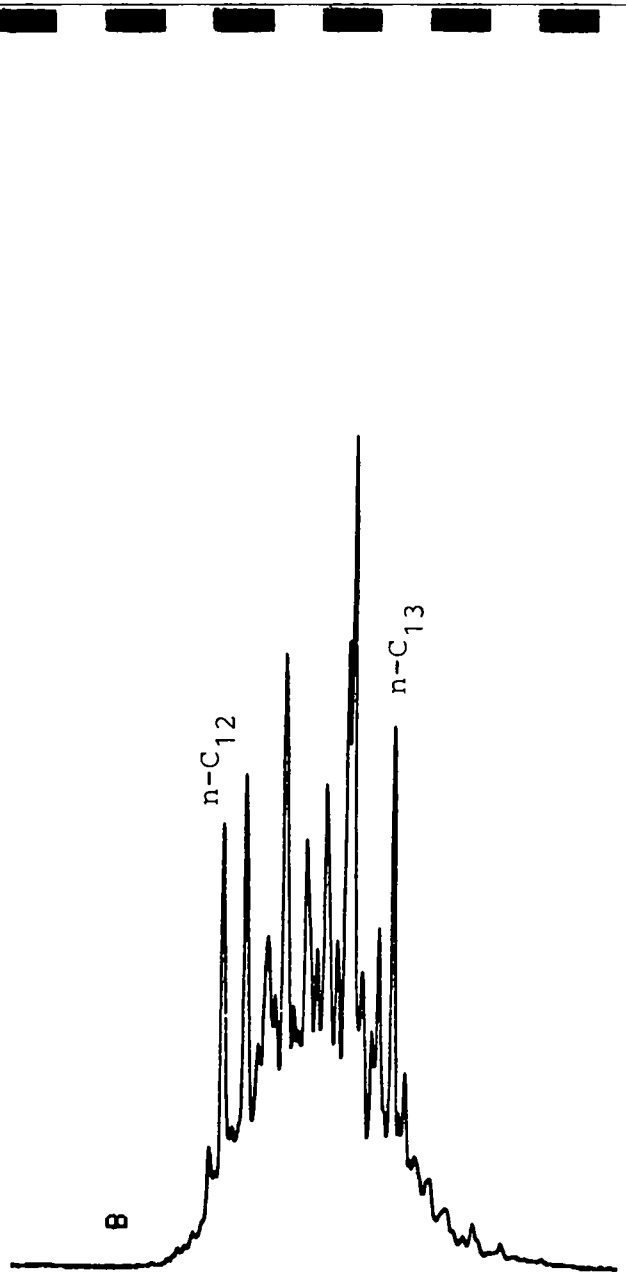
C_{10}-fraction



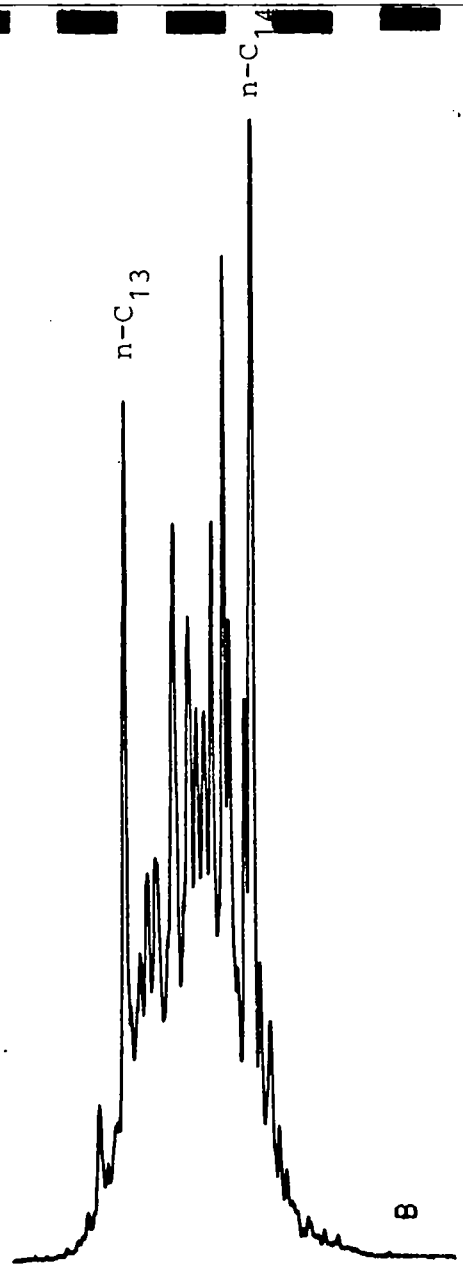
C_{11}-fraction



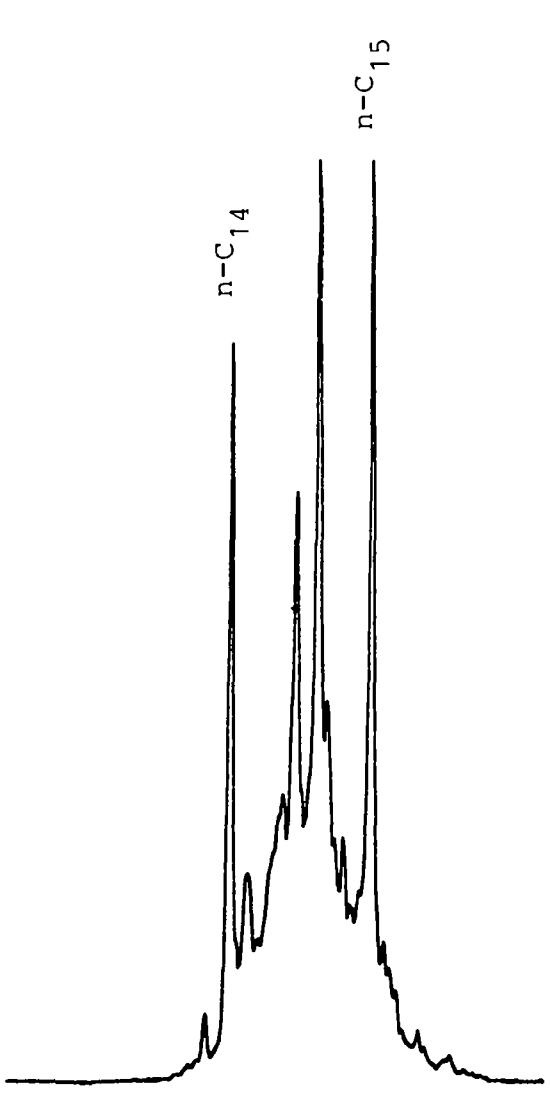
C_{12}-fraction



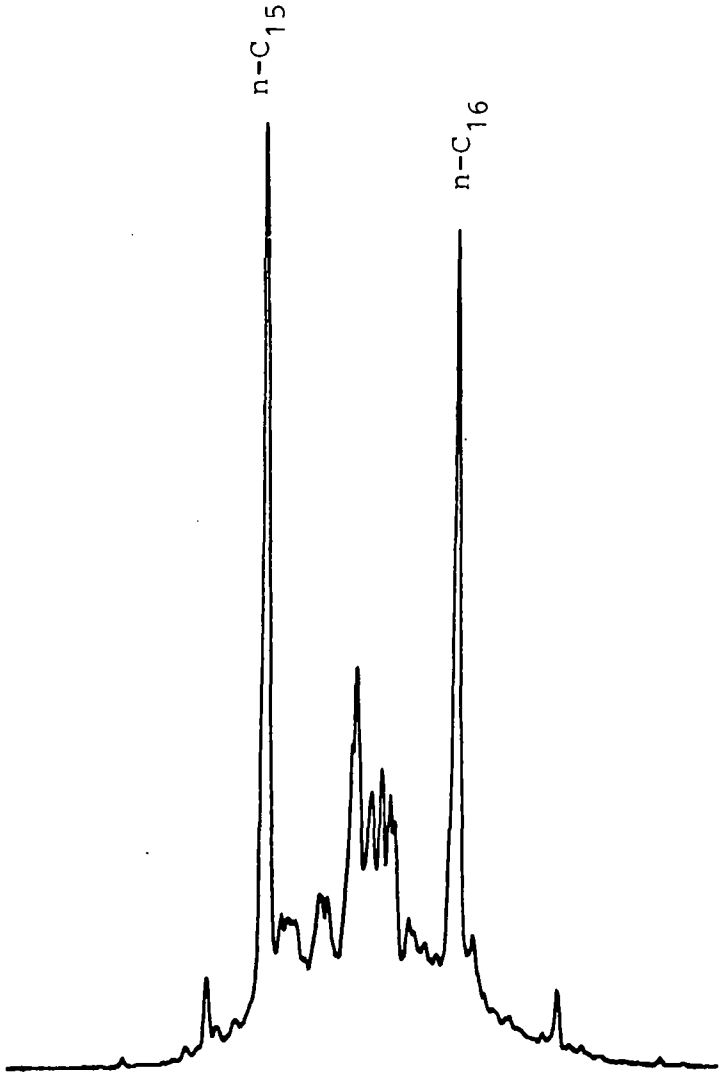
C_{13}-fraction



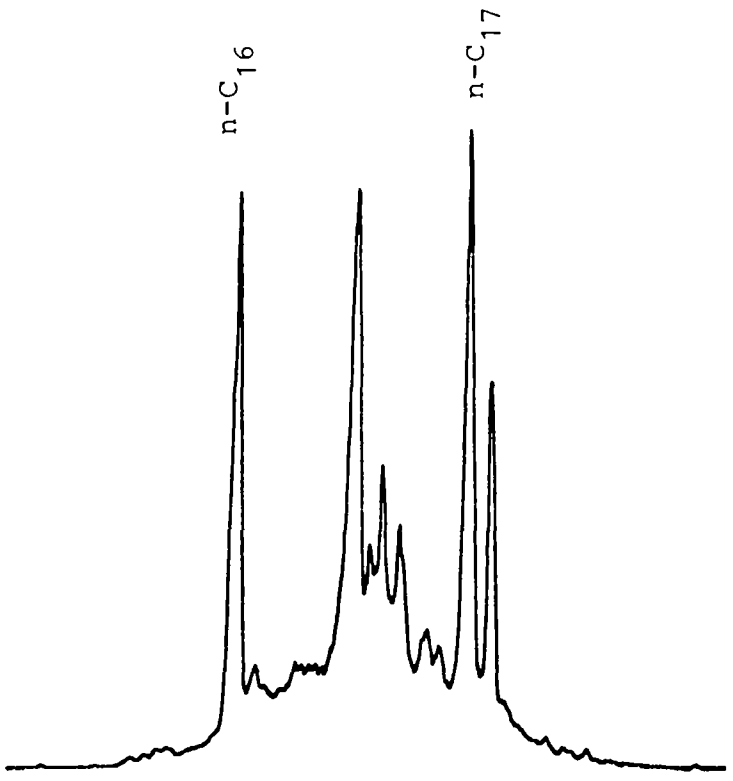
C_{14}-fraction



C_{15}-fraction

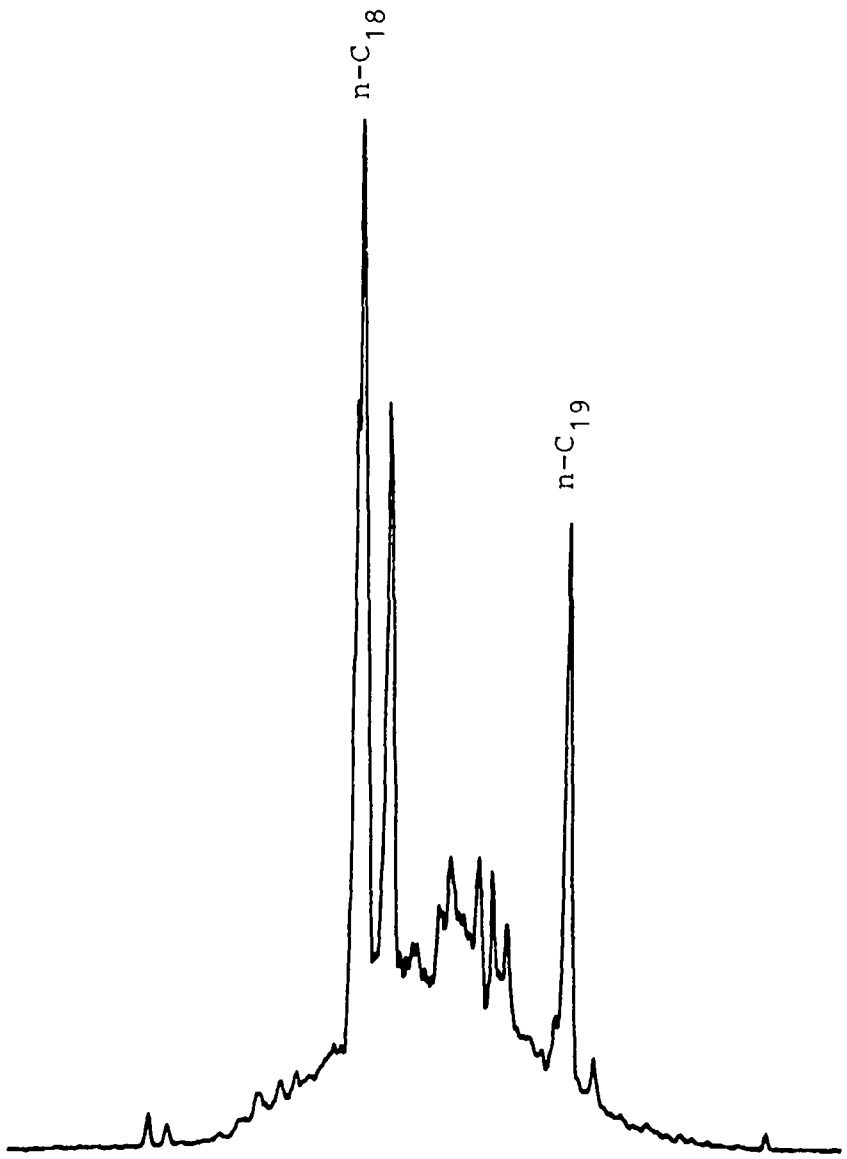


C_{16}-fraction

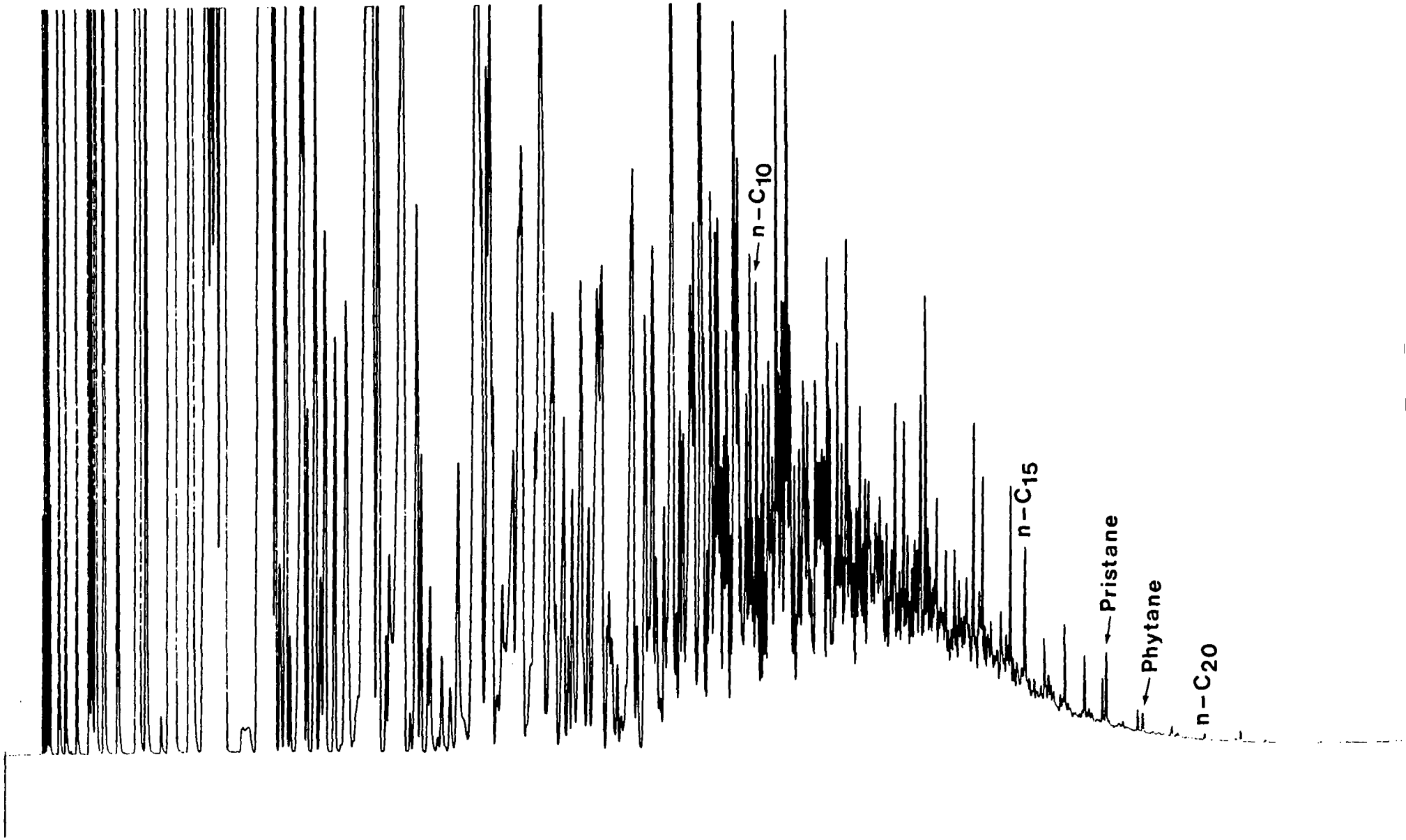


C_{17}-fraction

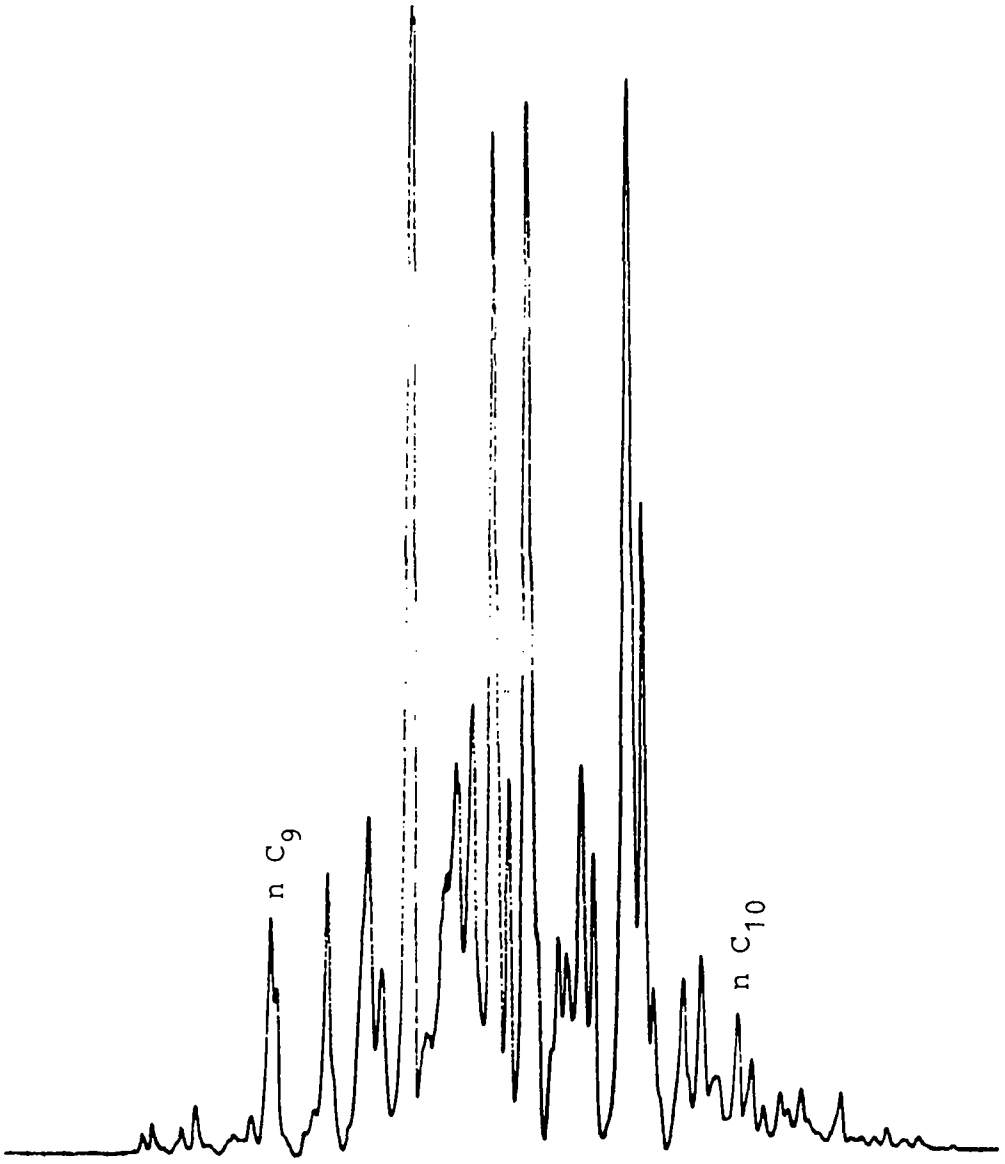
C_{18}-fraction



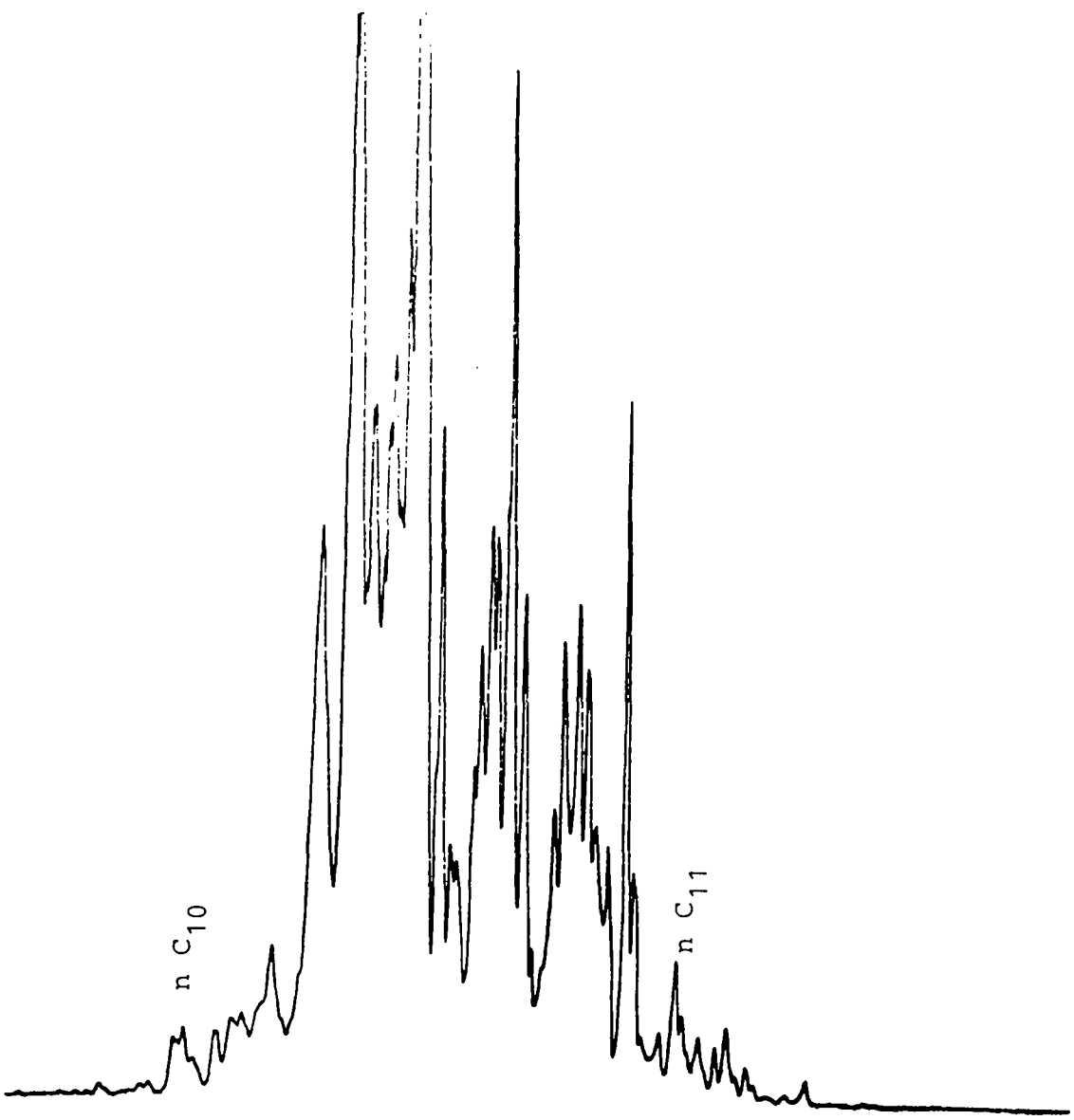
C_{19}-fraction



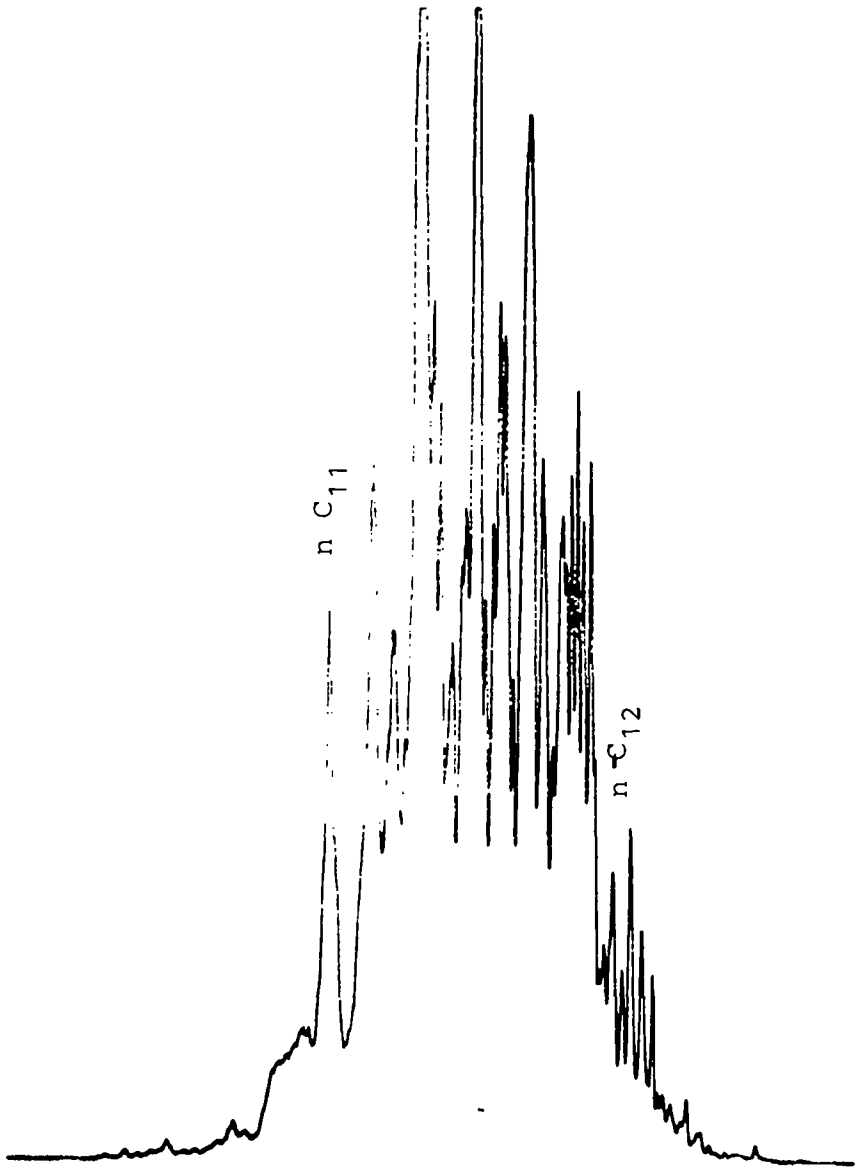
Condensate 31/3-1 DST no.2



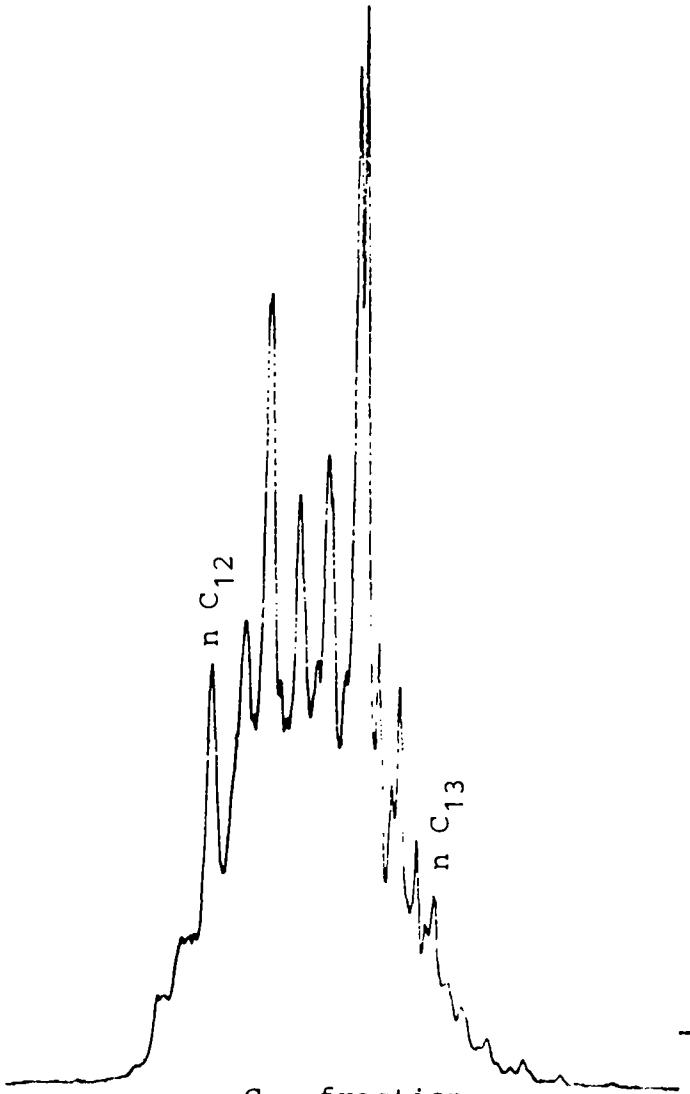
C_{10}-fraction



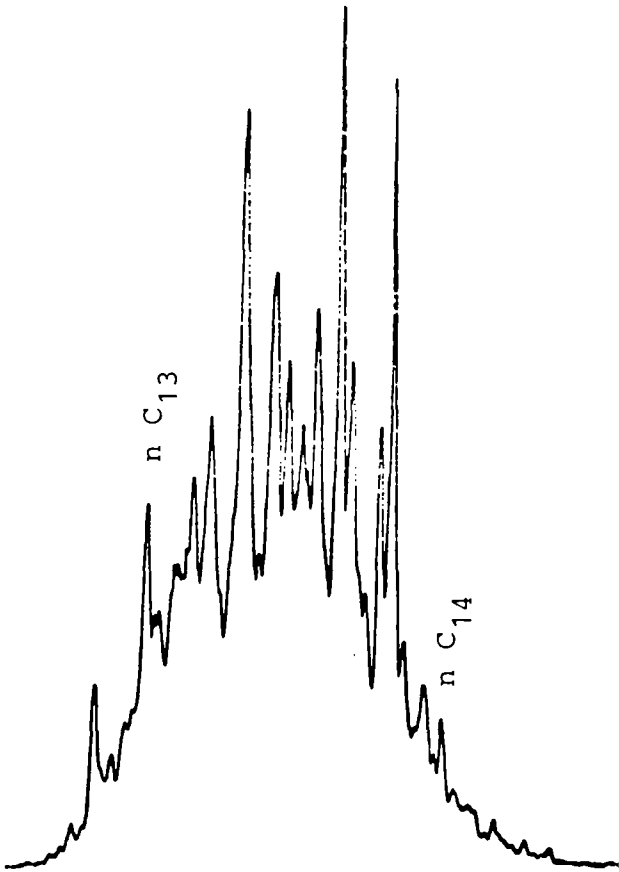
C_{11}-fraction



C_{12}-fraction



C_{13}-fraction



C_{14}-fraction