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Title

TBP distillation of condensate from 15/9-15 DST 2

STATOIL
EXPLORATION & PRODUCTION
LABORATORY

by

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SUMMARY.

This report presents the results from a true boiling point distillation, performed on a 250 ml sample from a single flash of separator condensate, bottle no. 8207006 from 15/9-15 DST 2.

The sample was fractionated by distillation from room temperature to 331°C, the molecular weights and densities were measured at 15°C.
Representative data of the condensate are given in table 1.

Table 1.

Summary of representative data for condensate from 15/9-15 DST 2.

	Density at 15°C (g/cm^3)	Molecular Weight	Weight % of the condensate
Condensate	0.771	115	100
C_{10}^+	0.840	197	45.75
C_{20}^+	0.869	336	10.78

INTRODUCTION

Samples from 15/9-15 DST 2 of the fluid and the gas were analysed for the Sleipner license. A full true boiling point distillation and a reservoir composition analysis were performed.

The distillation was performed on a single flash of separator oil. The separate fractions from the distillation were characterised by gas chromatography, molecular weight and density.

2. METHODS AND EQUIPMENT.

2.1 Distillation.

TBP distillation was performed according to ASTM D-2892, with a Fisher HMS 500.

The fractions were collected according to the boiling point range of the various hydrocarbon groups (D.L.Katz and Firoozabadi, Journ. Petr. Tech., Nov. 1978, s. 1650).

From room temperature to 151.3°C the sample was fractionated at atmospheric pressure, the heavier fraction were separated at reduced pressure (12.5 mbar).

2.2 Compositional analysis.

Component analysis of the gas and the liquid fractions were performed using a Hewlet Packard 5880 gas chromatographic system.

Chromatographic conditions:

Column for the liquid: Chrompack 25m x 0.22mm WCOT, Cp sil 5 on fused silica, filmthickness 0.14 µ m.

Column for the gas: Chrompack 50m x 0.23mm WCOT, Cp sil 5 on fused silica, filmthickness 0.3 µ m

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

Detector: Flame ionisation, Nitrogen make up gas, temp. 320°C.

Injection: All glass splitter, with a packed "Jennings tube". Split ratio 1:80, temp. 310°C for the liquid. Temp. 200°C for the gas.

Temp. program: For the first fractions the injection temp. was 10°C, isothermal for 4 min., then 4°C/min. The injection temp. was 100°C for the C_{12}-C_{19} fractions. For the gas -30°C isothermal 4 min., then 8°C/min. to 160°C isothermal.

The chromatograms of the fractions are enclosed in the appendix.
Molecular weights were determined by freezing point depression using a Knauer molecular weight instrument, with benzene as a reference substance.

Densities were determined by Paar DMA 602 frequency densiometer.

Since the residue of C_{20}^{+} - fraction was very viscous, the density could not be measured directly. However, dilution of a C_{20}^{+} sample with toluene in a known ratio C_{20}^{+} fraction/toluene and measuring the density of this solution, the density of C_{20}^{+} could be calculated after the following equation:

$$\rho_{20^+} = \frac{g\ c_{20^+}}{\frac{g_s}{\rho_s} - \frac{g_t}{\rho_t}}$$

gC_{20}^{+} - the weight of C_{20}^{+}

gt - the weight of toluene

ρt - the density of toluene

gs - the weight of the solution

ρs - the density of the solution

In a series of measurements of C_{20}^{+} distillation fractions in this manner, we have found that to the measured values of the desities it should be added empirically 0.009 g/cm^3 to obtain a correct value of the density.

3. RESULTS.

The composition of the whole condensate from the TBP distillation is given in table 2.

The calculated density of the distillate

$$S = \frac{\text{Cum. weight}}{\text{Cum. volum}}$$

and % by volum distilled are given in table 3 whereas the calculated molecular weight and densities are given in table 4.

Table 5 gives the weight % of the fraction overlap of each cut. The gas chromatograms of each fractions are enclosed in the appendix.

The composition of the gas and the light end fractions determined by gas chromatography is given in table 6.

Table 2. Collected fractions and their densities and molecular weights from a TBP distillation of single flash oil from separator liquid 15/9-15 DST 2.

Hydrocarbon group	boiling ranges (^{o}C)	% by weight of fraction distillation	% by weight of total distilled	Density at 15^{o}C (g/cm^{3})	% by volum of condensate	Mol. weight
gass		0.560	0.560	0.465*	0.928	40*
C_5	<36.5	14.431	14.991	0.606*	18.360	65*
C_6	69.2	5.307	20.298	0.678	6.035	84*
C_7	98.9	11.267	31.565	0.747	11.629	91.2*
C_8	126.1	12.694	44.259	0.776	12.612	101
C_9	151.3	9.674	53.933	0.801	9.311	116
C_{10}^{+}	>151.3	45.748		0.840	41.975	198
C_{10}	174.6	6.575	60.508	0.809	6.266	133
C_{11}	196.4	4.233	64.741	0.808	4.040	146
C_{12}	216.8	3.544	68.285	0.819	3.337	160
C_{13}	235.9	3.880	72.165	0.840	3.561	176
C_{14}	253.9	3.572	75.737	0.850	3.240	187
C_{15}	271.1	3.587	79.324	0.856	3.231	200
C_{16}	287.3	2.456	81.780	0.862	2.196	212
C_{17}	303.0	3.215	84.995	0.844	2.937	230
C_{18}	317.0	2.119	87.114	0.844	1.936	243
C_{19}	331.0	1.796	88.910	0.853	1.624	256
C_{20}^{+}		10.780		0.869	9.565	336

Recovered	99.690%
loss	0.310%

* Calculated valus from the GC-composition.

Table 3: Cumulativ weight, cumulativ vol. and calculated $S = \frac{\text{cum.weight}}{\text{cum. vol.}}$ of destillate from from 15/9-15 DST 2.

Component	Cum. weight	Cum. vol.	Cum S = $\frac{\text{Cum.weight}}{\text{Cum.vol.}}$	% by volume of total distilled
gas	0.849	1.826	0.465	0.928
C_5	22.741	37.951	0.599	19.360
C_6	30.792	49.826	0.620	25.323
C_7	47.884	72.707	0.659	36.952
C_8	67.141	97.523	0.688	49.564
C_9	81.816	115.844	0.706	58.875
C_{10}	91.790	128.173	0.716	65.141
C_{11}	98.212	136.121	0.722	69.181
C_{12}	103.589	142.686	0.726	72.518
C_{13}	109.475	149.693	0.731	76.079
C_{14}	114.893	156.067	0.736	79.319
C_{15}	120.334	162.423	0.741	82.550
C_{16}	124.059	166.744	0.744	84.746
C_{17}	128.936	172.522	0.747	87.683
C_{18}	132.151	176.331	0.749	89.619
C_{19}	134.876	179.526	0.751	91.243

Table 4:

Cross checking of molecular weights and densities from destillation of 15/9-15-DST 2

	Condensate	C_{10}^+	C_{20}^+
Measured mol. weights		198	336
Calculated mol. weight using C_{10}^+ mol.weight	115,5		
Calculated mol. weight using C_{20}^+ mol.weight	115,3	196,3	
Measured densities (g/cm^3)	0.771	0.840	0.869
Calculated density (g/cm^3) using C_{10}^+ density	0.762		
calculated density (g/cm^3) using C_{20}^+ density	0.762	0.841	

Table 5.

Weight % fraction overlap of each cut from distillation.

Component	Weight % of the condensate	Weight % of fraction overlap
gas	0.560	98.8-1.2
C_5	14.431	84.5-15.5
C_6	5.307	5-82-13
C_7	11.267	3-81-16
C_8	12.694	5-93-2
C_9	9.674	6-86-8
C_{10}	6.575	5-85-10
C_{11}	4.233	7-81-12
C_{12}	3.544	12-74-14
C_{13}	3.880	10-78-12
C_{14}	3.572	9-80-11
C_{15}	3.587	11-78-11
C_{16}	2.456	10-83-7
C_{17}	3.215	12-67-21
C_{18}	2.119	6-75-19
C_{19}	1.796	9-75-76

Table 6

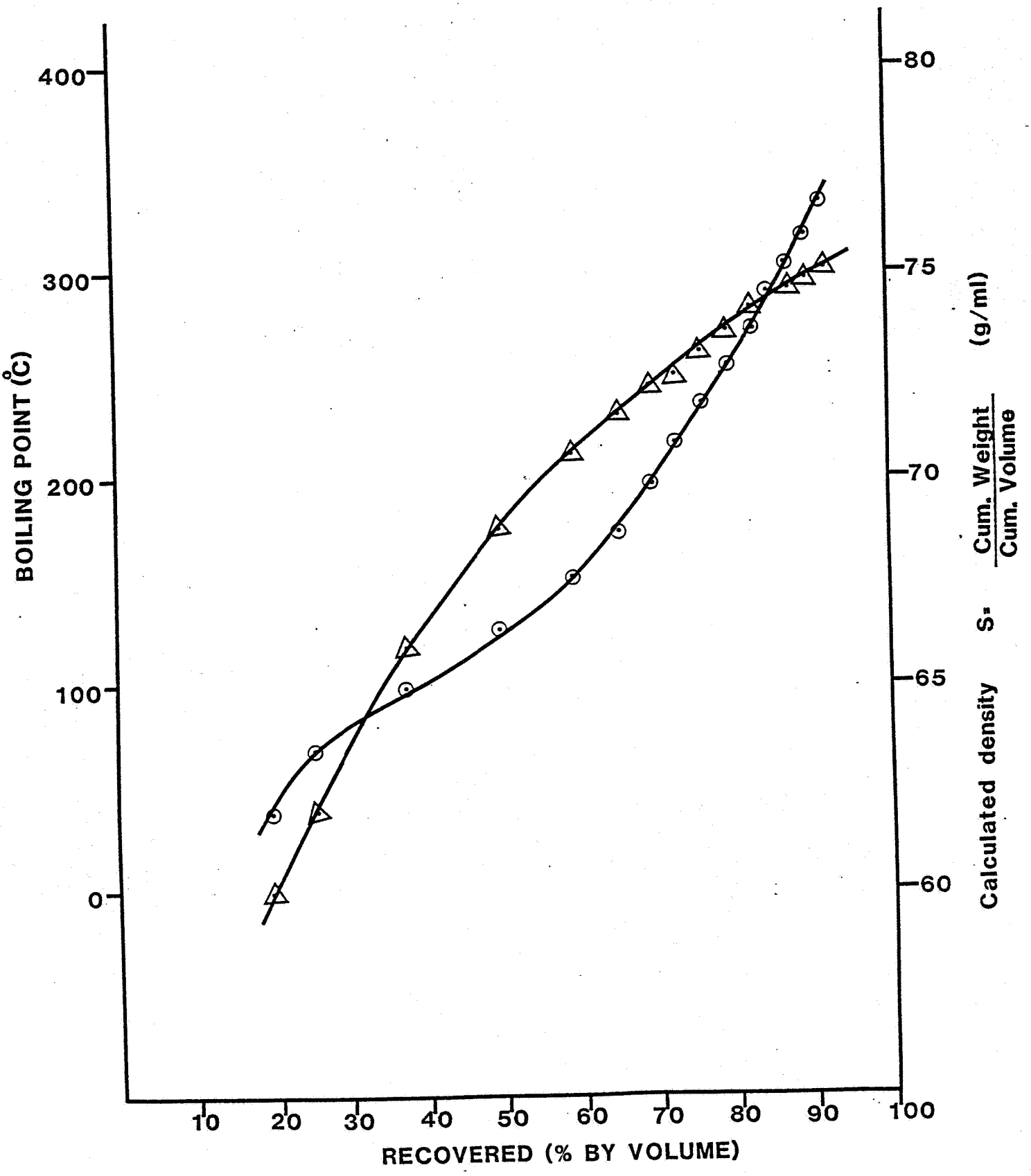
Total composition of the gas and the light-end fractions determined by G.C. Weight % of the condensate: 14.991%.

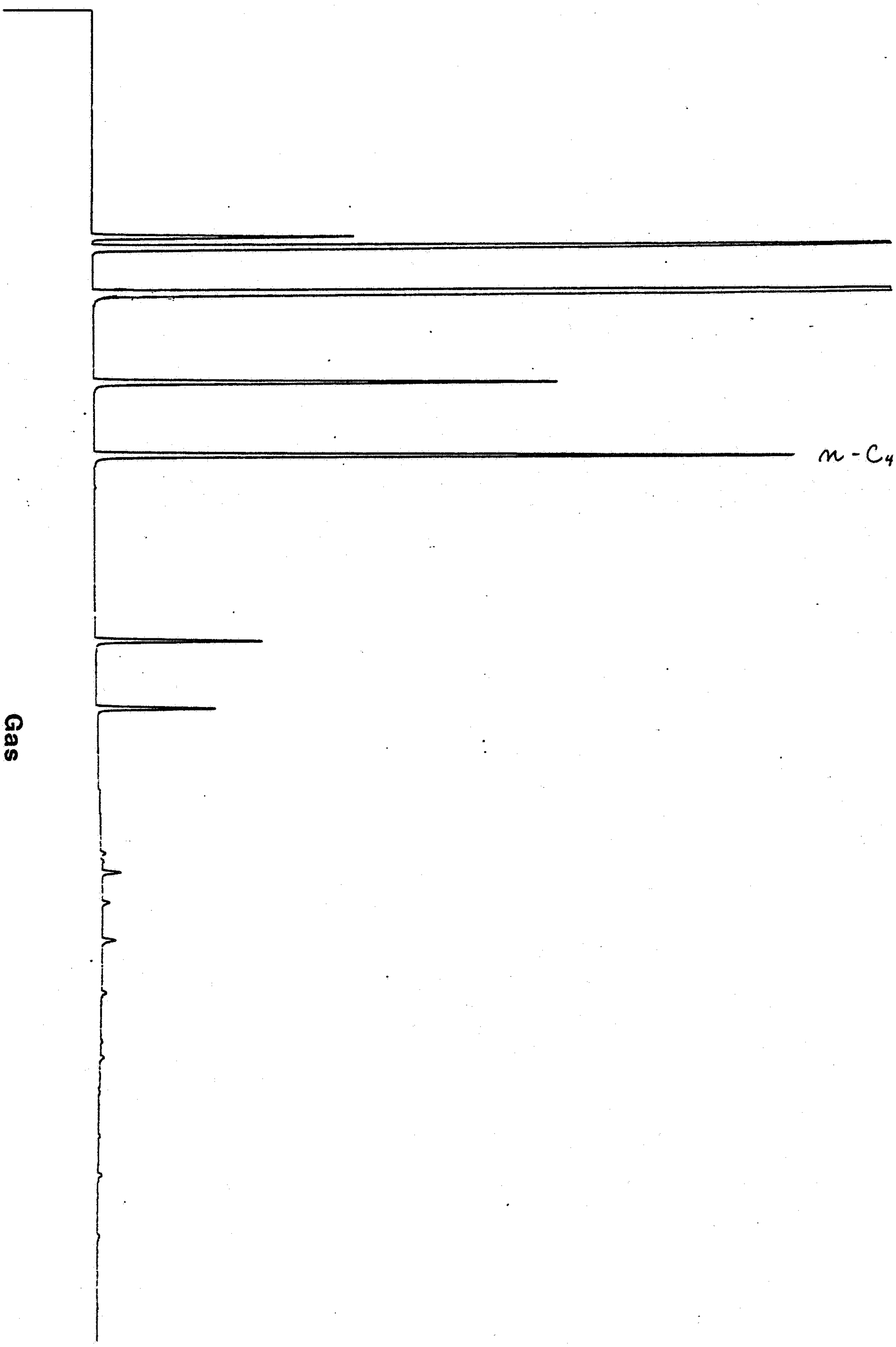
Hydrocarbon group	Weight % of condensate
C_1	0.028
C_2	0.206
C_3	1.594
i-C_4	1.118
n-C_4	3.330
i-C_5	2.984
n-C_5	3.486
C_6	1.773
C_7	0.439
C_8	0.032

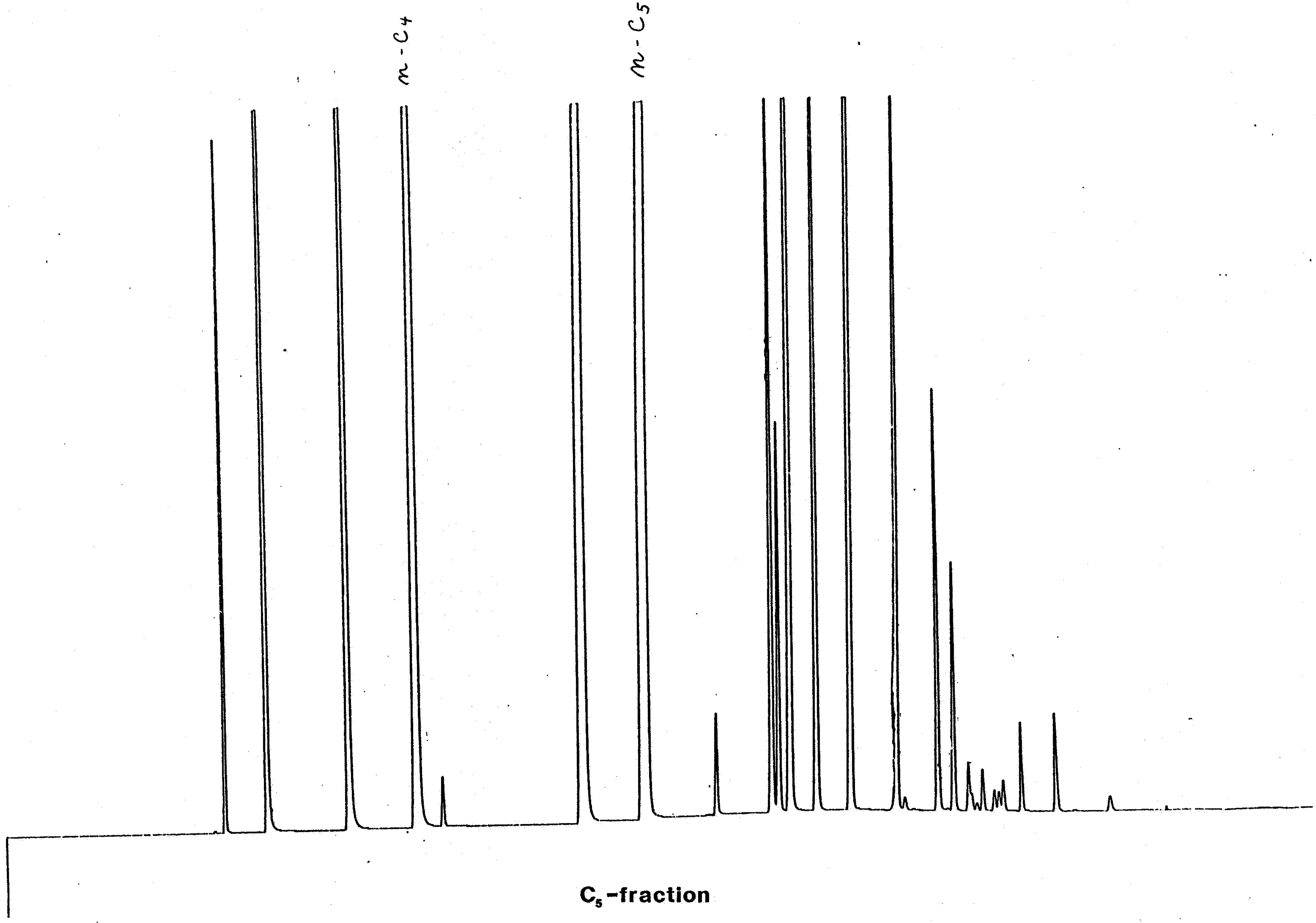
⊙ Boilingpoint VS. % by volume recovered

△ Calculated density of distillate recovered

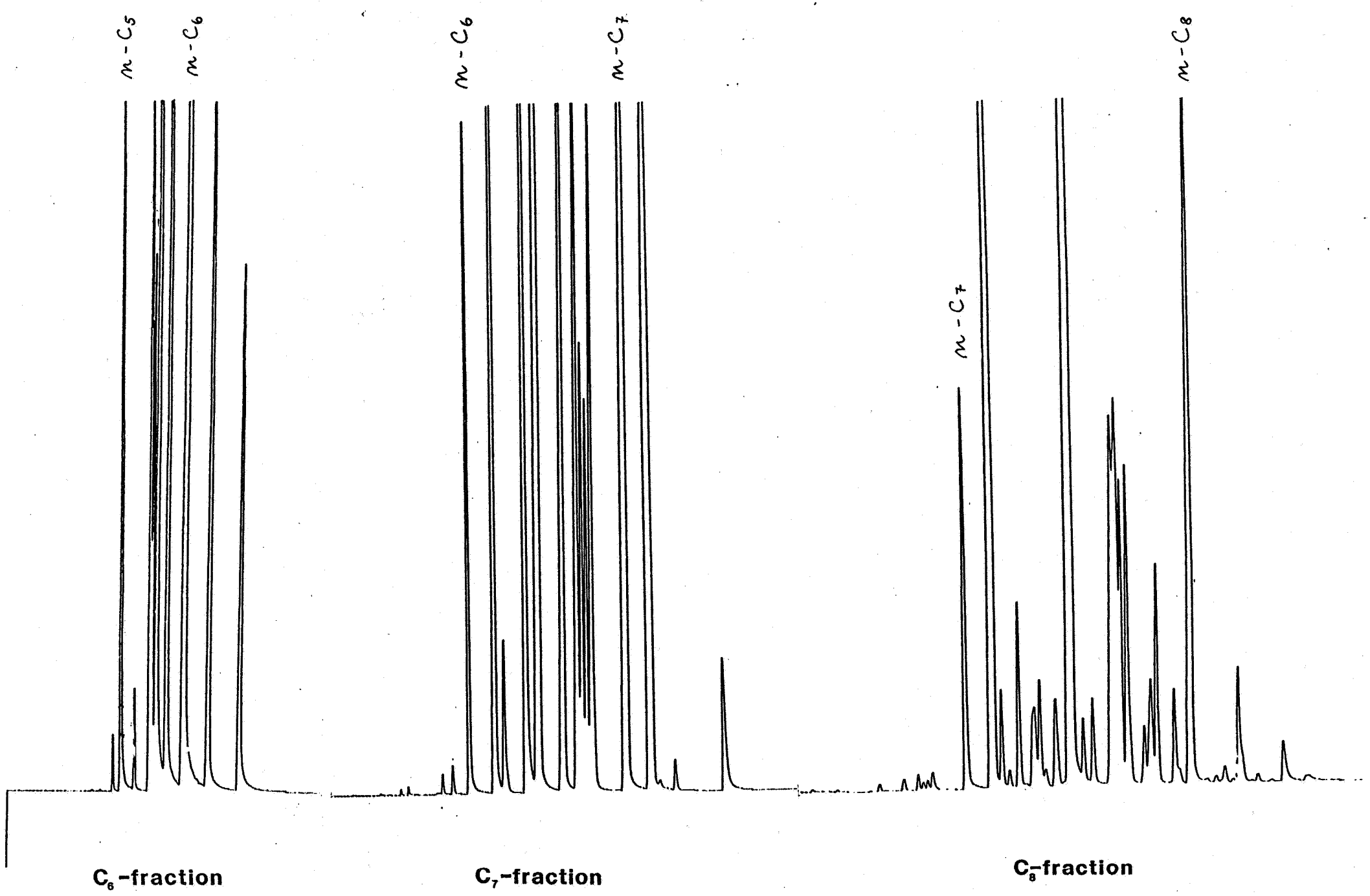
$S = \frac{\text{Cum. Weight}}{\text{Cum. Volume}}$ VS.% by volume recovered




Gas
n-C4



n-C4
n-C5
C5-fraction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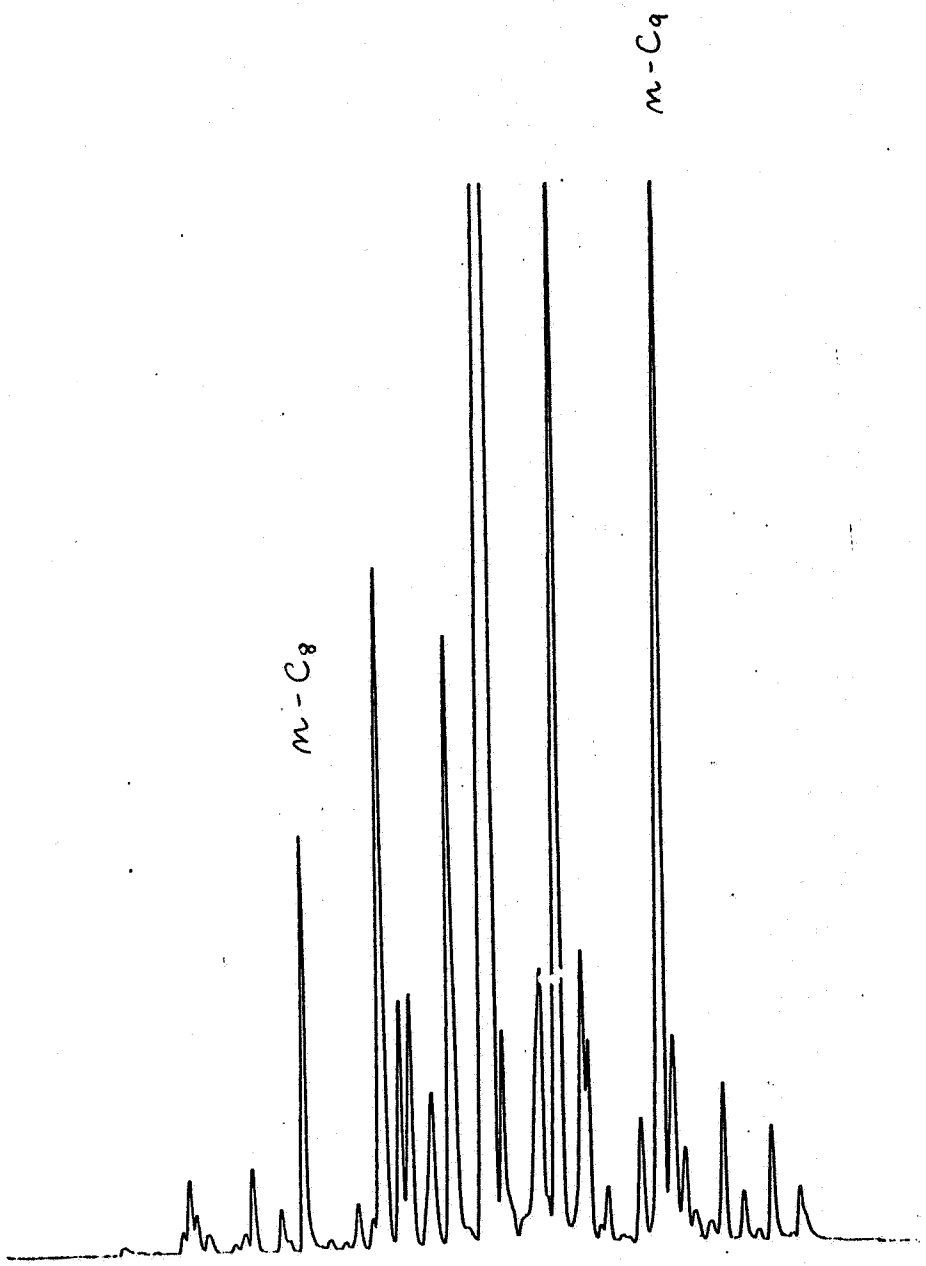
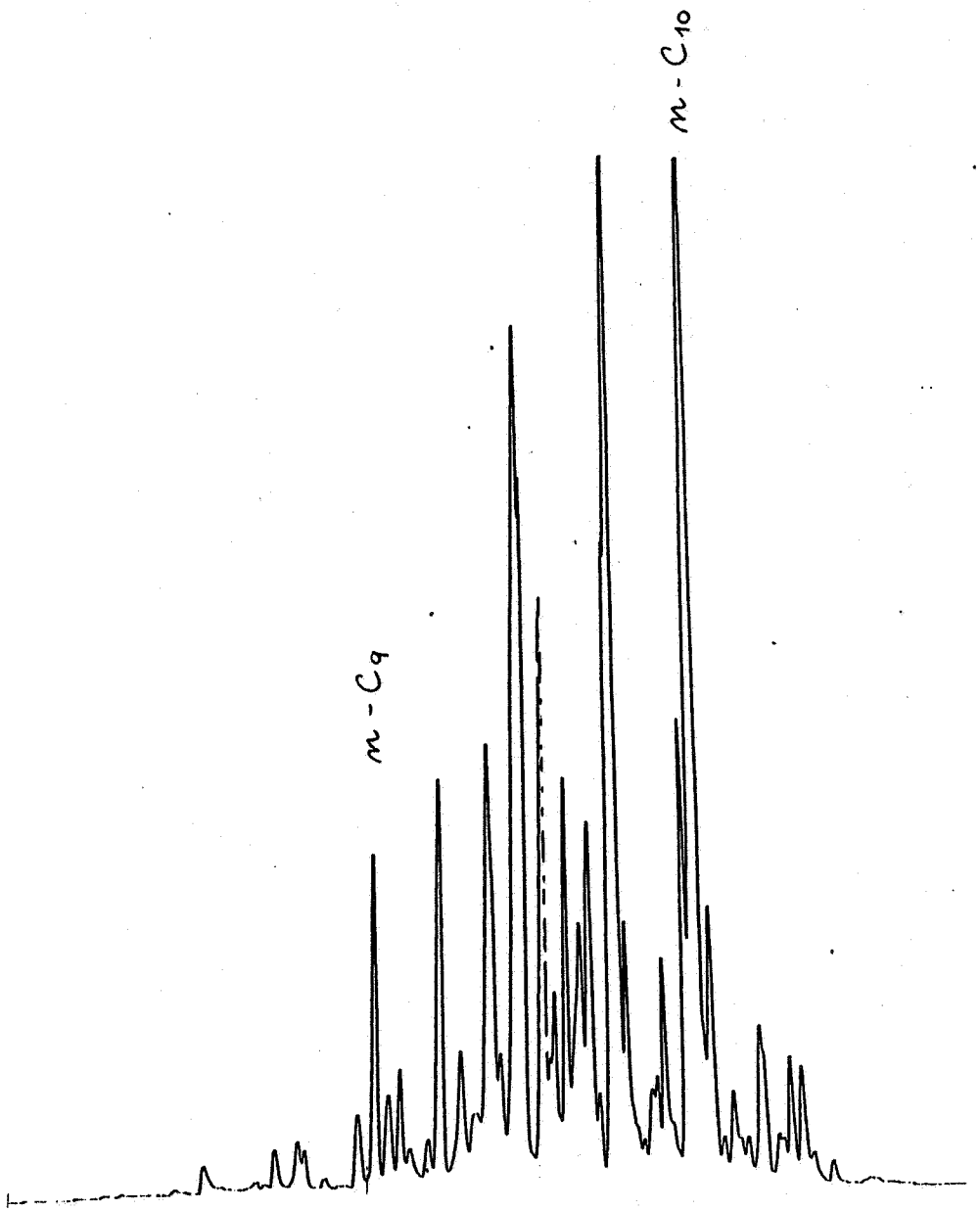
n-C7
n-C7
n-C8
C6-fraction
C7-fraction
C8-fraction



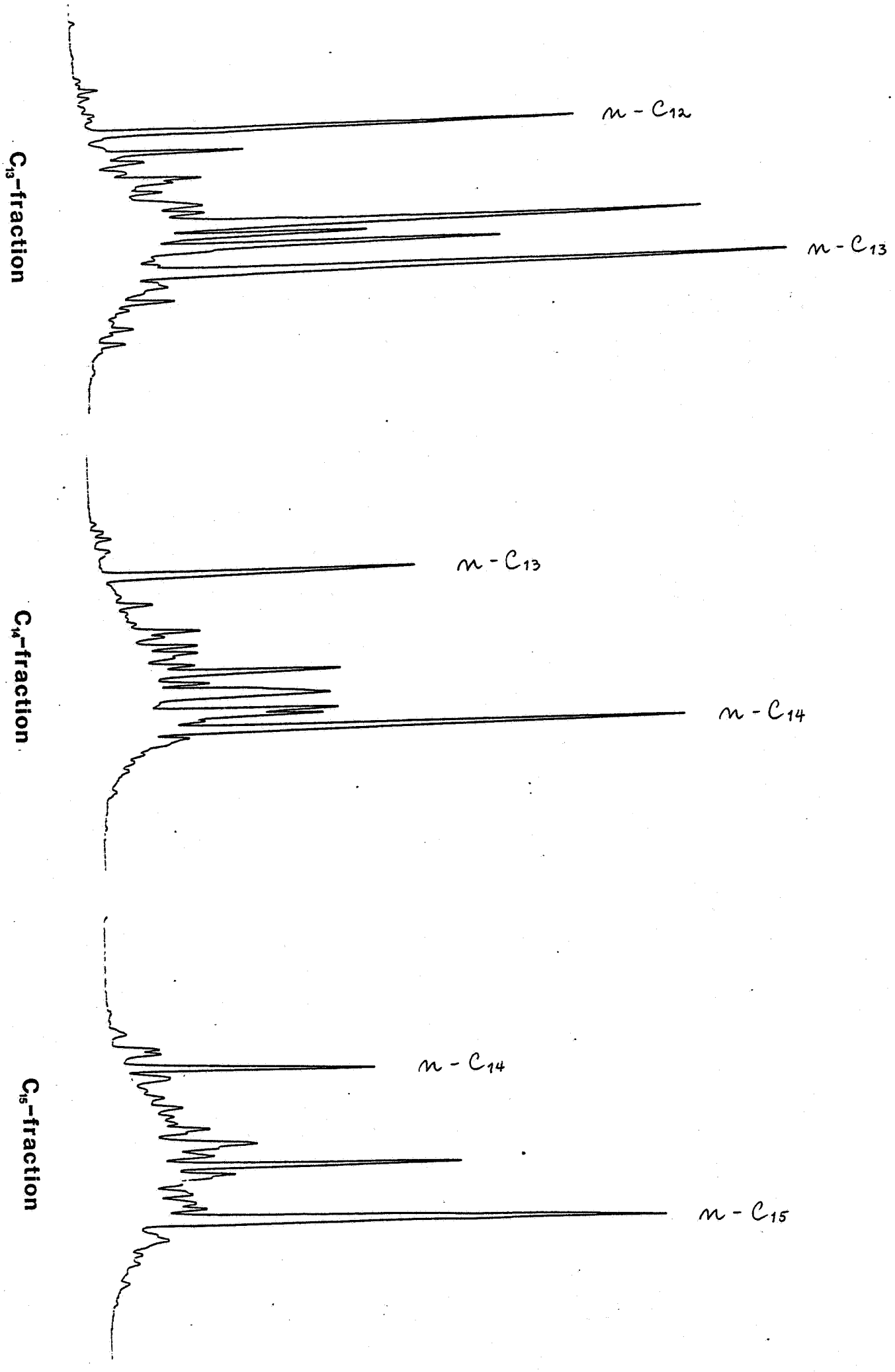
C_9-fraction

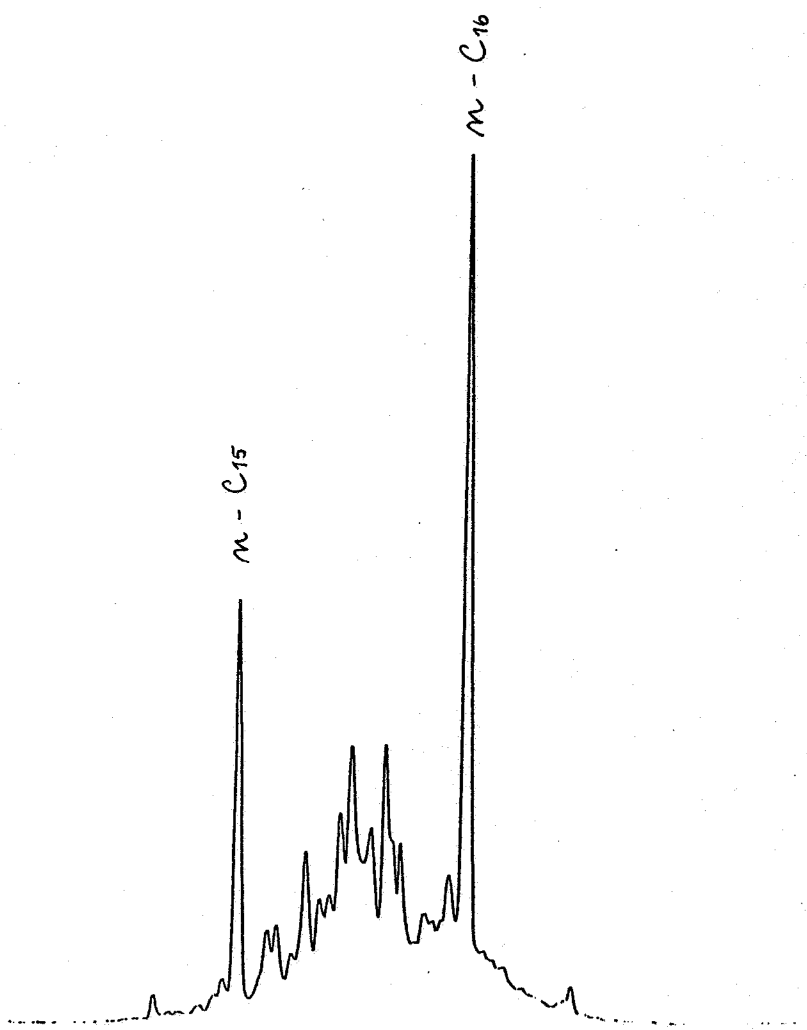


C_{10}-fraction

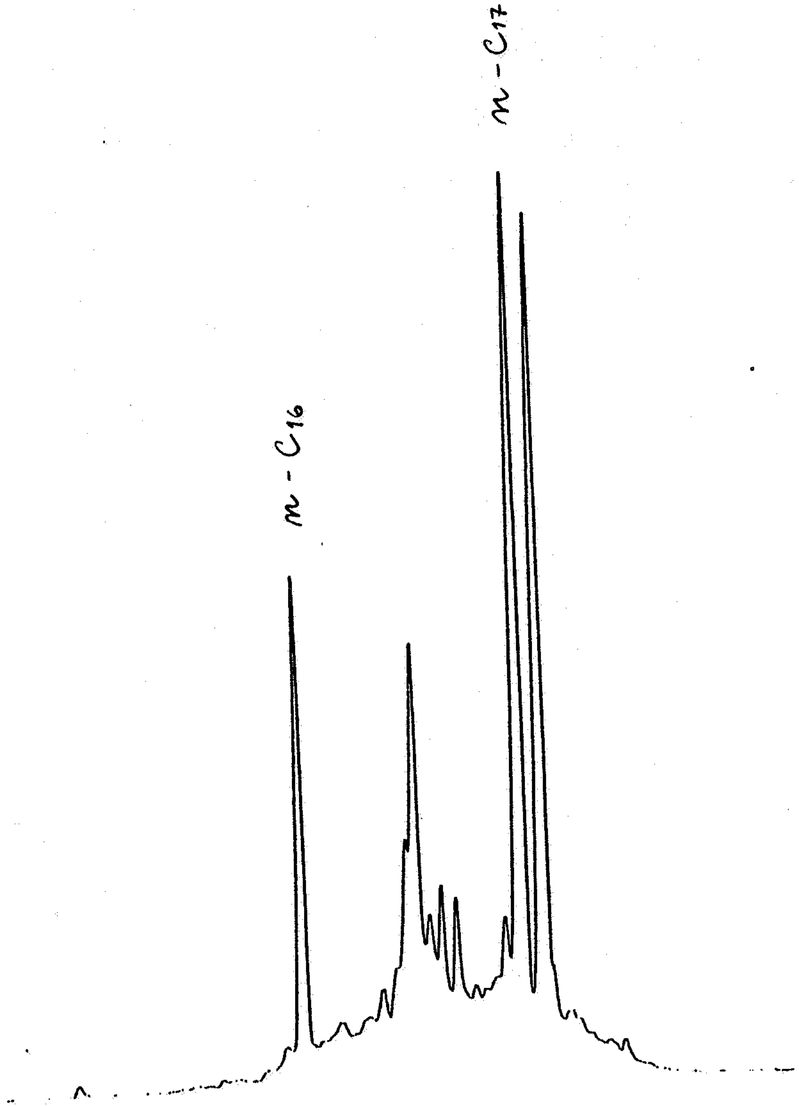
C_{11}-fraction

C_{12}-fraction

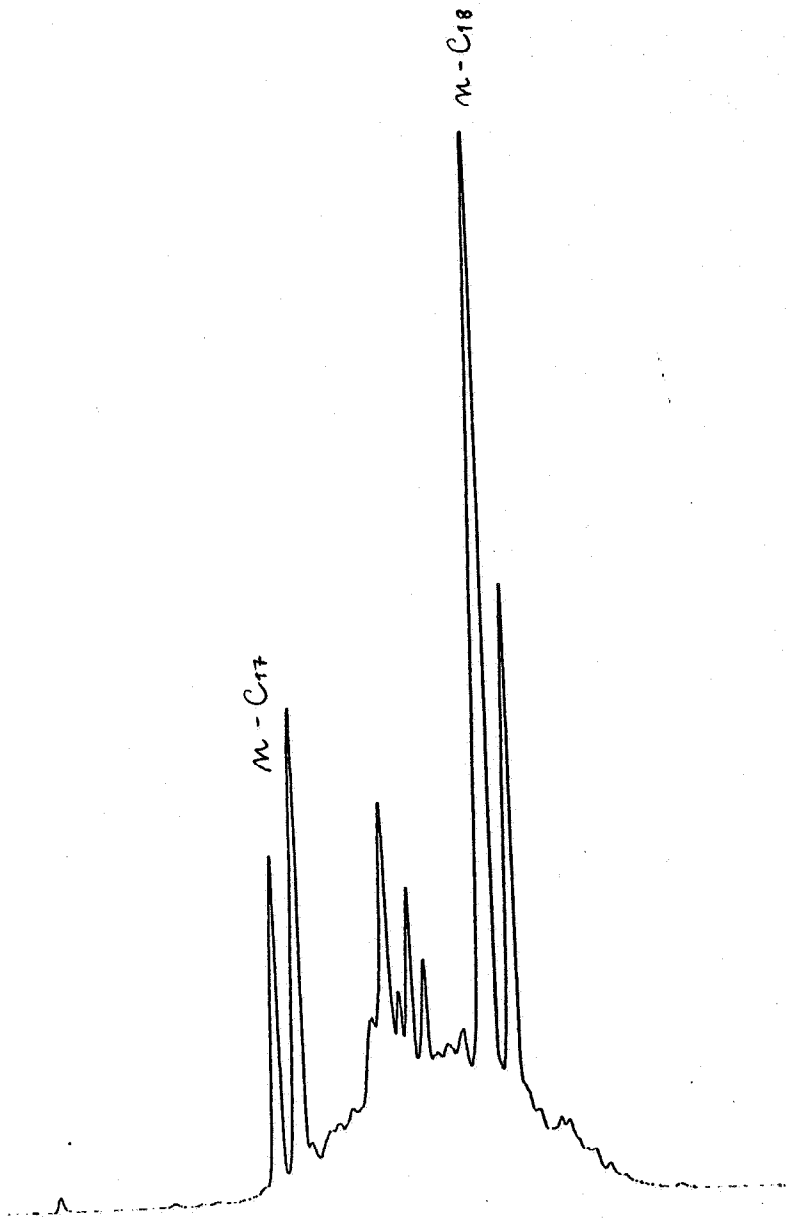

n - C12
n - C13
C13-fraction
n - C13
n - C14
C14-fraction
n - C14
n - C15
C15-fraction



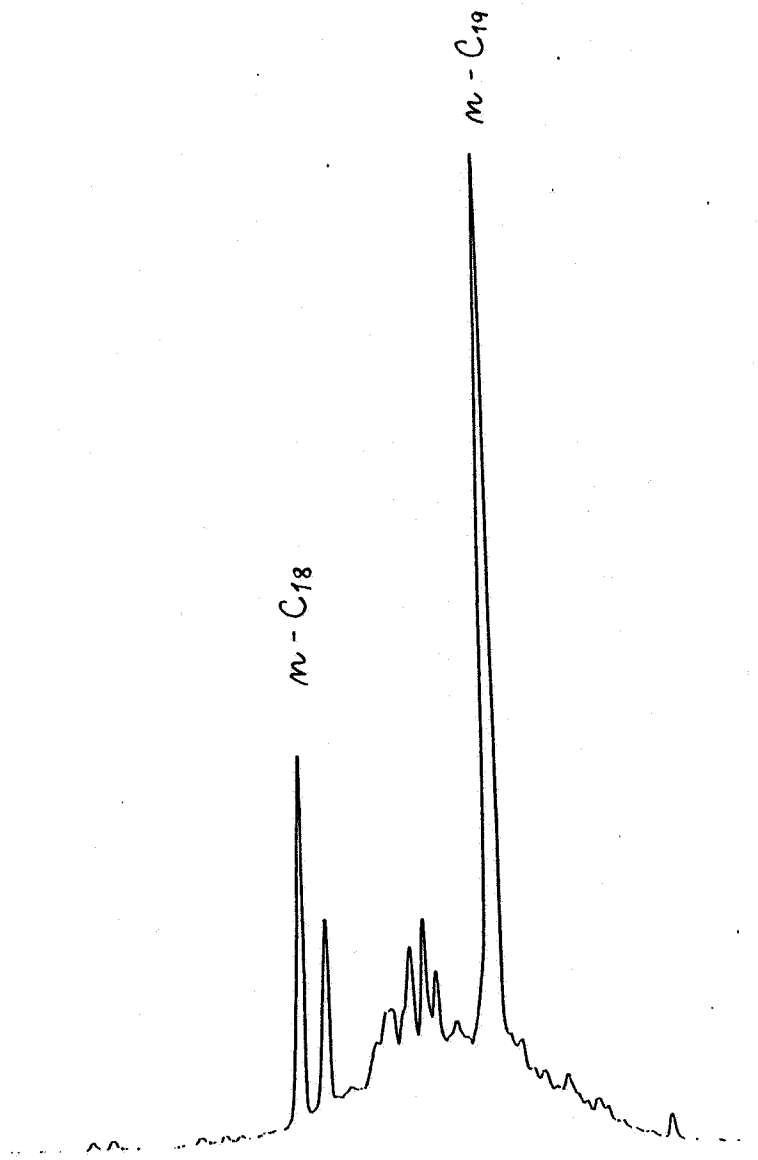
C_{16}-fraction



C_{17}-fraction



C_{18}-fraction



C_{19}-fraction