3.2 FMT Summary

One run with the FMT tool was made in the interval 3260 to 3329 m RKB in the Sandnes/Bryne formations. Only 9 out of 64 attampts were sucsessful. One segregated sample was taken at 3263.1 m RKB. The 2 3/4 gallon chamber contained mud and the 1 gallon chamber was empty due to plugging in the chamber line.

No gradients can be evaluated from the pressure plot.

The results of the pressure readings are listed below and plotted in figure 3.2.

Depth m RKB	Formation pressure KPa	Comments
3261.5	37010	Poor permeability
3263.5	36834	Poor permeability
3263.1	36807	Sample 2 3/4 gallon
3263.3	36800	Poor permeability
3263.5	36786	Poor permeability
3263.2	36793	Sample, 1 gallon
3277.5	36710	Poor permeability
3289.5	36731	Poor permeability
3296.5	36779	Poor permeability

Pressure readings from HP gauge.

3.4 Test Results

The well was perforated in the intervall 3258-3268 m RKB in the Sandnes Formation. The formation was confirmed oil bearing and dead oil was sampled when reverse circulating the test string after the buildup period. The production rate was very low due to low permeability.

Results:

Oil rate	:	4.6	Sm3/d
Flowing BHP	:	32475	kPa
Extrapolated BHP at gauge depth	:	36051	kPa
Extrapolated BHT at 3763 m RKB	:	36519	kPa
Bubblepoint pressure	:	3000	kPa at 10°C
Permeability	:	1	mD
Skin	:	- 0.94	
Radius of investigation	:	13	meters
Actual PI	:	0.0013	Sm3/d/kPa
Ideal PI	:	0.0011	Sm3/d/kPa
Flow Effency	:	122	%

STATOIL, VILDKAT 9/2-3

TOTAL MATERIALS CONSUMPTION

MATERIAL	UNIT	36"	26"	17 1/2"	12 1/4"	8 1/2"	UNIT COST	(NOK) TOT	TOT UNITS	PERCENT
BARITE	MT		67	50	229	285	536.38	338455.78	631	22.65
GYPSUM	KG			13150	7800		1.35	28282.50	20950	1.89
BENTONITE	MT	19	15			16	1596.51	79825.50	50	5.34
SODA ASH	KG	150	350			475	2.49	2427.75	975	0.16
LAMPAC LV	KG			13100	17400	3700	20.71	708282.00	34200	47.41
LAMPAC REG	KG			1850	4150	1675	20.71	158949.25	7675	10.64
OILEX	LTR			400	200	400	14.00	14000.00	1000	0.94
CAUSTIC	KG	300	275			1150	3.54	6106.50	1725	0.41
LIME	KG			420	1580	240	1.71	3830.40	2240	0.26
BICARBONATE	KG				1725	1350	3.18	9778.50	3075	0.65
BIOZAN	KG									
XANTHAN GUM	KG			50		75	55.12	6890.00	125	0.46
BORREWELL C	KG									
RESINEX	KG					4205	15.91	66901.55	4205	4.48
POLYDRILL	KG					1475	37.33	55061.75	1475	3.69
DESCO CF	KG					875	17.37	15198.75	875	1.02
NUT PLUG FINE	KG									
CaCl2	KG									
BASE OIL	M3									
DFL-HF	KG									
DWA	KG									
DV-22	KG									
VG-69	KG									
SWA	KG									
OIL MUD	M3									
TOTAL MATERIAL COST		31768.77	61729.13	363153.69	590536.20	446546.48		1493990.23		
Total Volume Built	M3	358	98	880	1041	463				
Average/m3 New Vol.	NOK	88.74	629.89	412.67	567.28	964.46				

M-I Norge A.S.
Magcobar/IMCO
A Dresser Halliburton Company
The Drilling Fluids Company

STATOIL, 9/2-3

Total Volumes Summary

36" Section	Volume Built	358 m^3
Gel Bentonite	Volume Transferred to 26"	233 m^3
	Volume Utilized	125 m^3
	Volume Utilized/Metre Drilled	2.02 m^3
26" Section	Volume Built	98 m^3
Gel Bentonite	Volume Transferred from 36"	233 m^3
	Volume Utilized	243 m^3
	Volume Dumped	88 m^3
	Volume Utilized/Metre Drilled	1.16 m^3
17 1/2" Section	Volume Built	880 m^3
Gyp Polymer	Volume Transferred to 12 1/4"	258 m^3
	Volume Utilized	622 m^3
	Volume Utilized/Metre Drilled	0.81 m^3
12 1/4" Section	Volume Built	1041 m^3
Gyp Polymer	Volume Transferred from 17 1/2"	258 m^3
	Volume Transferred to 8 1/2"	299 m^3
	Volume Utilized	1000 m^3
	Volume Utilized/Metre Drilled	0.48 m^3
8 1/2" Section	Volume Built	463 m^3
Polymer/Resinex	Volume Transferred from 12 1/4"	299 m^3
	Volume Transferred to Testing	246 m^3
	Volume Utilized	516 m^3
	Volume Utilized/Metre Drilled	2.43 m^3

U-624 . 5.

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PRODUCTION LABORATORIES

Title

Wax and hydrocarbon analysis of well 9/2-3 DST 1

Requested by	Project	
Ingolf Jolma, UND OP		
Date	**Number of pages**	**No. of encs.**
14.03.90	23	0

Key words

Group type separation, wax, fingerprint, comparison of oils from 9/2-1 DST 3 and 9/2-3 DST 1.

Abstract

Essential data of the crude oil:

Molecular weight	:	209	g/gmole
Density	:	0.845	g/cc
Weight % C10+	:	82.96	
Wax content	:	11.0	wt %
Pour point	:-	2	°C
Asphaltenes	:	7.1	wt %
Saturates (C10+)	:	57.4	wt %
Aromatics (C10+)	:	31.5	wt %
Polars (C10+)	:	2.5	wt %

Prepared by

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Liv Aase Tau
A. Lisbeth Blilie

Lisbeth Blilie

Textoperator A. Lisbeth Blilie

Approved by

15/3-90 Knut K. Meisingset
Seksjonsleder

15/3-90 Magne Skarestad
Avdelingsleder

Some data of the sample:

Well	:	9/2-3
Test	:	DST 1
Depth (m RKB)	:	3258 - 3268
Date of sampling	:	30.01.90
Time of sampling	:	05.50
Bottle type	:	5l Salzkottner
Bottle labeled	:	Oil from revers circulation

TABLES

Table 1.Summary of essential data of crude oil 9/2-3 DST 1.

	Crude oil	C10+
Weight percent of crude oil	100	82.96
Molecular weight (g/gmole)	209	293 (a)
Density (g/cc)	0.845	0.885 (a)
Water content (wt %)	0.62	
Sulphur content (wt %)	0.40	
Wax content (wt%)		
Not purified	11.0	
Purified	- (b)	
Pentane insolubles (wt%)	7.1	8.6
Saturates (wt %)		57.4
Aromatics (wt %)		31.5
Polars (wt %)		2.5
Pristane/phytane	1.58	
Pristane/n-C17	0.71	
Phytane/n-C18	0.58	
Pour point (^{o}C)	- 2	
Wax app. temp. (^{o}C)	- (c)	

(a) Calculated from composition of the light end (C10-).

(b) Not possible to purify the precipitated wax, because the high content of asphaltenes.

(c) Not possible to detect the wax app. temp., because the sample contained some particle contamination.

Table 2. Composition of stabilized crude oil 9/2-3 DST 1 (gas chromatography).

Component (group)	Weight%	Molecular weight	Density
C1	0.00	16.0	0.260
C2	0.04	30.1	0.358
C3	0.68	44.1	0.508
i-C4	0.31	58.1	0.563
n-C4	1.19	58.1	0.585
2,2-DM-C3	0.00	72.2	0.597
i-C5	0.79	72.2	0.625
n-C5	1.08	72.2	0.631
Hexanes total	1.87	84.9	0.674
Hexanes paraffines	1.75	86.2	0.669
Hexanes naphthenes	0.12	70.1	0.750
Heptanes total	3.48	93.2	0.729
Heptanes paraffines	1.60	100.2	0.687
Heptanes naphthenes	1.75	88.8	0.762
Heptanes aromatics	0.13	78.1	0.884
Octanes total	4.27	107.0	0.753
Octanes paraffines	1.51	114.2	0.705
Octanes naphthenes	2.43	105.2	0.771
Octanes aromatics	0.33	92.1	0.871
Nonanes total	3.34	123.2	0.760
Nonanes paraffines	1.78	128.3	0.721
Nonanes naphthenes	1.16	122.5	0.792
Nonanes aromatics	0.40	106.2	0.867
Decanes plus	82.96 (*)	293	0.885

(*) Weight percent from distillation corrected for fraction overlap between C9 and C10.

Table 3. Characteristic ratios of some single components of crude oil 9/2-3 DST 1

Pristane/phytane	1.61
Pristane/n-C17	0.62
Phytane/n-C18	0.39
n-C17/n-C27	
CPI 1 (a)	1.06
CPI 2 (a)	0.94
2-MN / 1-MN	1.27
2,6+2,7- / 1,4+1,5+2,3-DMN	0.60
Biphenyl / 1+2-EN	0.41
Biphenyl / 3-M-biphenyl	0.47
MPI 1 (b)	0.75
MPI 2 (b)	0.76
Total C6/total C7	0.54
Total C7/total C8	0.81
Total C8/total C9	1.28
A (c)	0.16
B (c)	0.42
X (c)	0.47
C (c)	1.02
I (c) THOMPSON INDICES	1.11
F (c)	0.74
H (c)	21.13
U (c)	0.89
R (c)	2.11

(a) Definition of CPI 1 and CPI 2, see appendix C.

(b) Definition of MPI 1 and MPI 2, see appendix C.

(c) Definition of Thompsom indices, see appendix D.

Table 4. Distribution of n-alkanes in stabilized crude oil 9/2-3 DST 1 (weight percent of whole oil).

n-Cn		Weight percent
6	*	0.83
7	*	0.78
8	*	0.79
9	*	0.77
10	*	0.74
11	*	0.75
12		0.75
13		0.78
14		0.79
15		0.87
16		0.79
17		0.74
18		0.56
19		0.57
20		0.47
21		0.36
22		0.32
23		0.26
24		0.23
25		0.20
26		0.14
27		0.12
28		0.10
29		0.09
30		0.07
Sum		12.87

* These compounds are quantified from the whole oil chromatogram. The rest are taken from the C10+ paraffin-naphthene chromatogram. n-C12 to n-C30 are adjusted, so that n-C12 is exactly equal from the two sources.

FIGURES

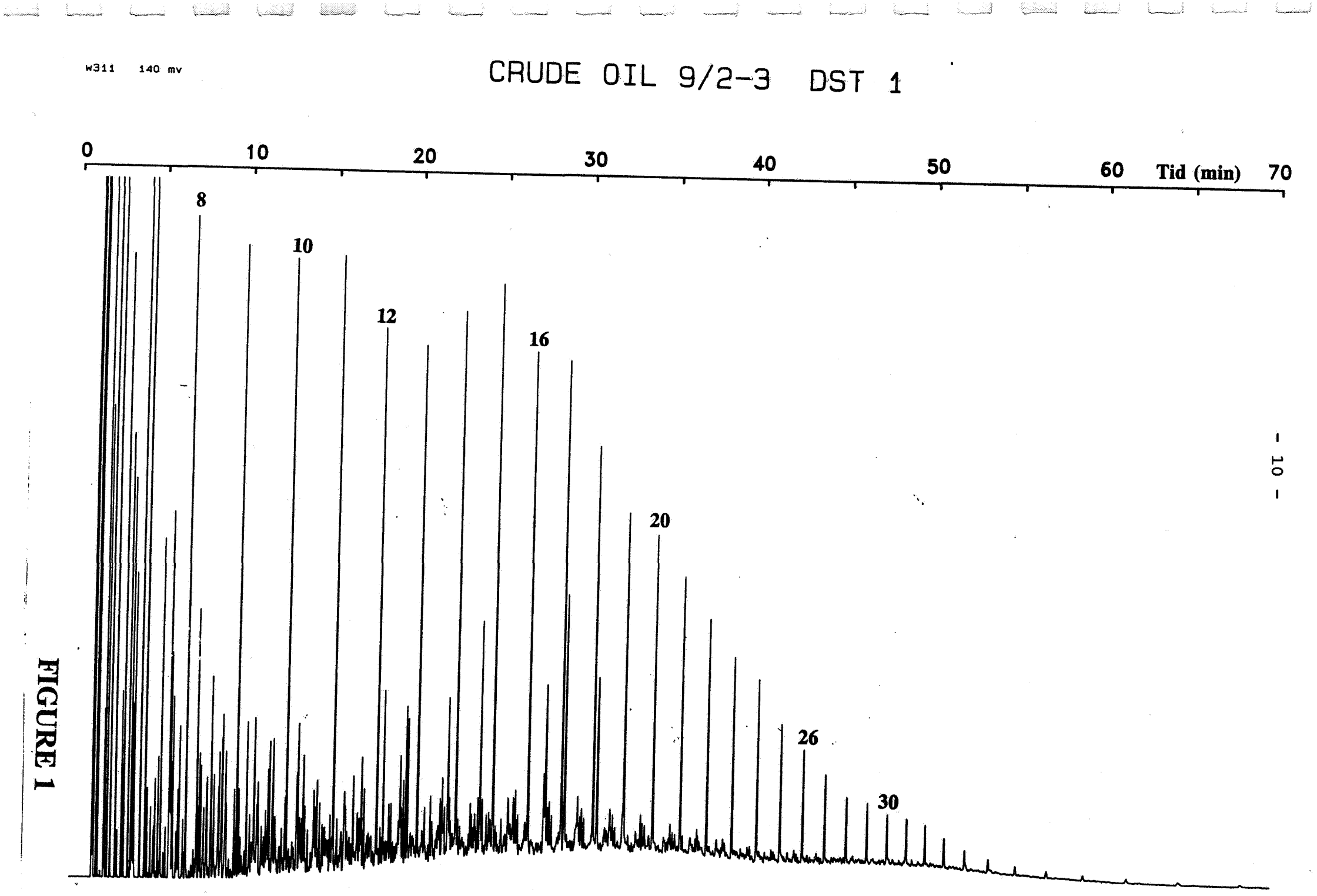
w311 140 mv
CRUDE OIL 9/2-3 DST 1
0
10
20
30
40
50
60
Tid (min)
70
8
10
12
16
20
26
30
- 10 -

FIGURE 1

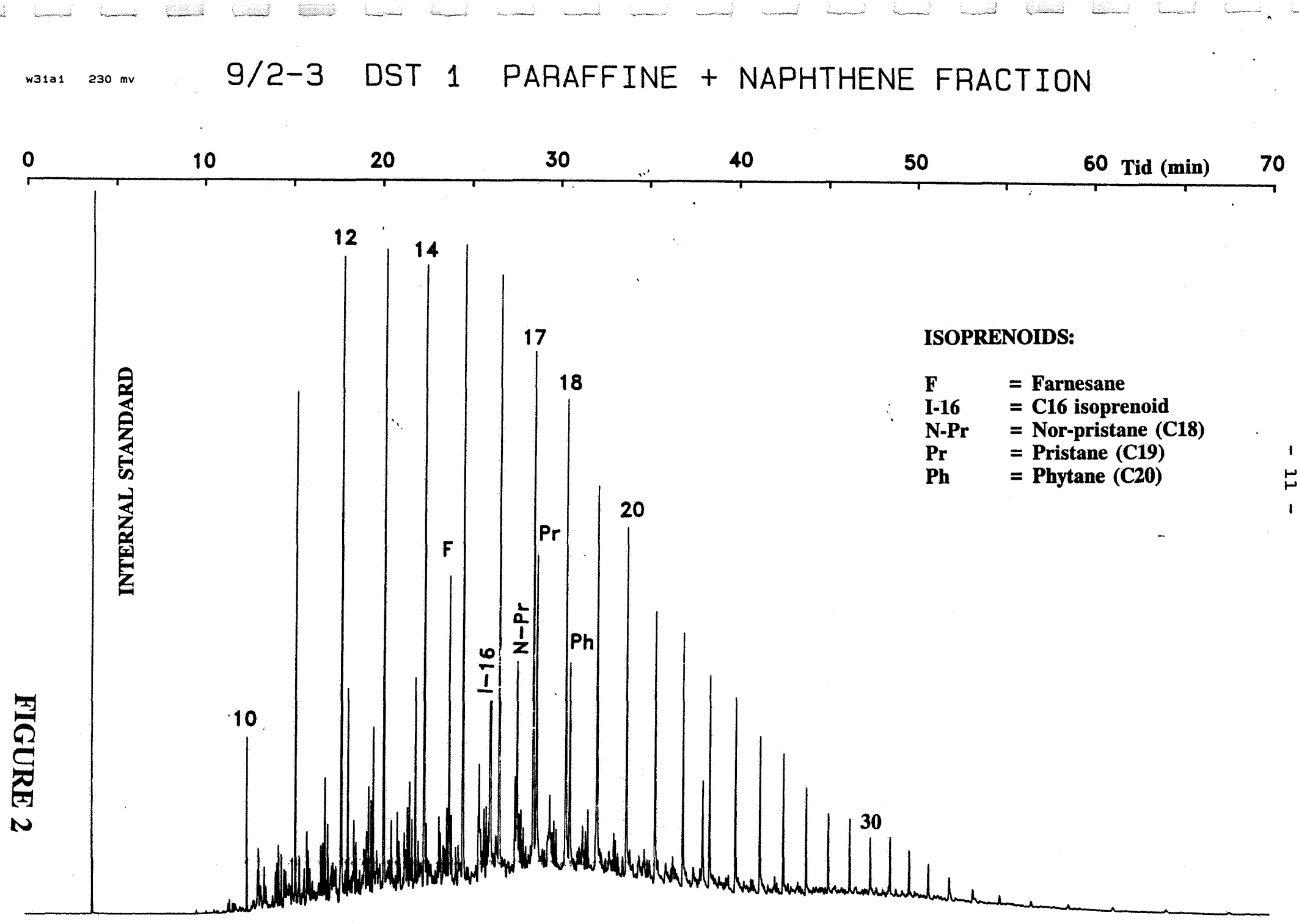
w31a1 230 mv
9/2-3 DST 1 PARAFFINE + NAPHTHENE FRACTION
0
10
20
30
40
50
60
Tid (min)
70
INTERNAL STANDARD
10
12
14
F
I-16
N-Pr
17
Pr
18
Ph
20
30
ISOPRENOIDS:
F = Farnesane
I-16 = C16 isoprenoid
N-Pr = Nor-pristane (C18)
Pr = Pristane (C19)
Ph = Phytane (C20)

FIGURE 2

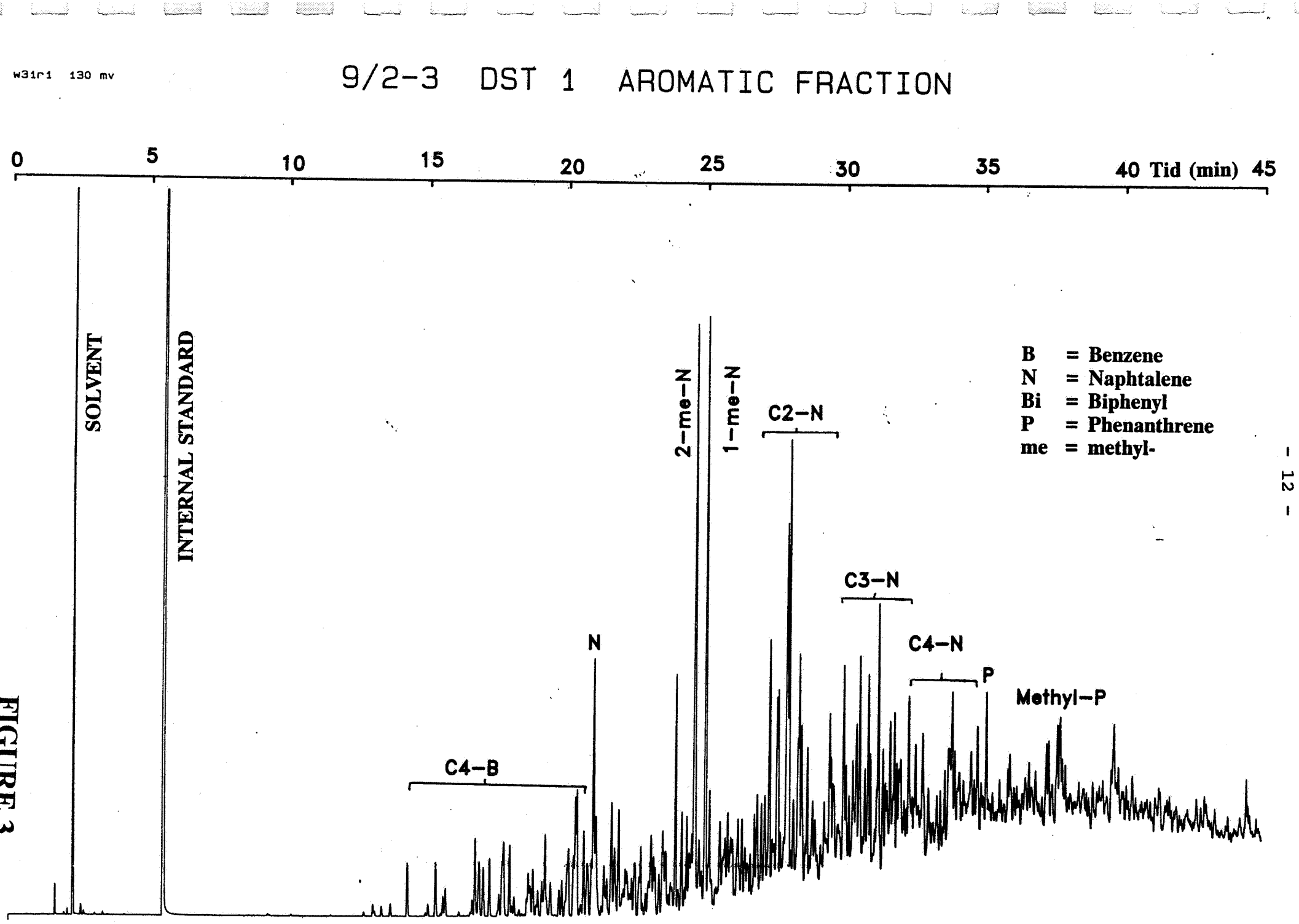
w31r1 130 mv
9/2-3 DST 1 AROMATIC FRACTION
0
5
10
15
20
25
30
35
40 Tid (min) 45
SOLVENT
INTERNAL STANDARD
2-me-N
1-me-N
C2-N
C3-N
C4-N
N
P
Methyl-P
C4-B
B = Benzene
N = Naphtalene
Bi = Biphenyl
P = Phenanthrene
me = methyl-

FIGURE 3

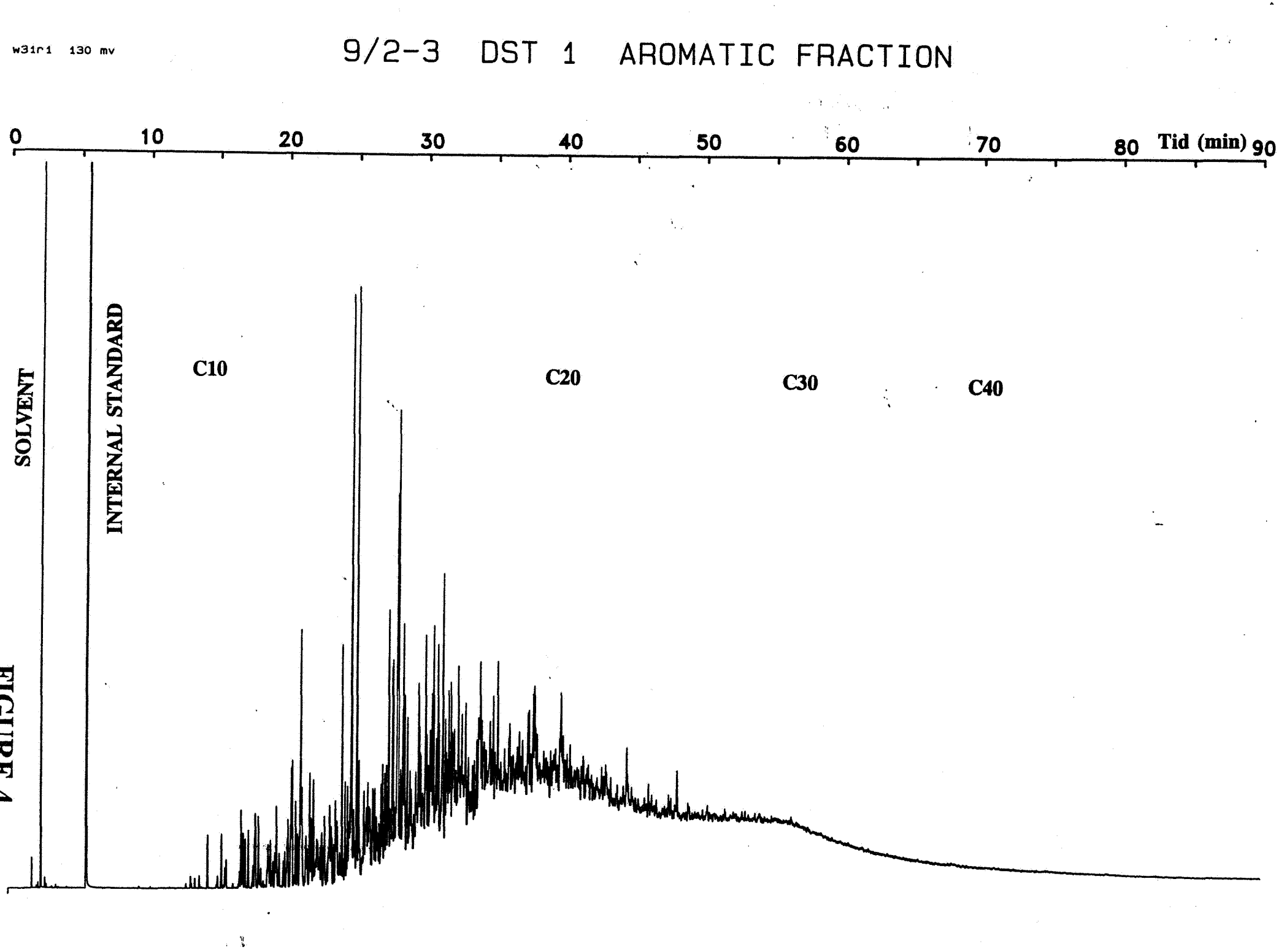
w31r1 130 mv
9/2-3 DST 1 AROMATIC FRACTION
0
10
20
30
40
50
60
70
80
Tid (min)
90
SOLVENT
INTERNAL STANDARD
C10
C20
C30
C40

FIGURE 4

APPENDICES

APPENDIX A

Table A.1. Detailed composition of light end of stabilized crude oil 9/2-3 DST 1 (weight percent of crude)

Component	Weight%	Molecular weight	Density
C1	0.00	16.0	0.260
C2	0.04	30.1	0.358
C3	0.68	44.1	0.508
i-C4	0.31	58.1	0.563
n-C4	1.19	58.1	0.585
2,2-DM-C3	0.00	72.2	0.597
i-C5	0.79	72.2	0.625
n-C5	1.08	72.2	0.631
2,2-DMC4	0.01	86.2	0.654
Cy-C5	0.12	70.1	0.750
2,3-DM-C4	0.05	86.2	0.666
2-M-C5	0.53	86.2	0.658
3-M-C5	0.33	86.2	0.669
n-C6	0.83	86.2	0.664
M-Cy-C5	0.59	86.2	0.753
2,4-DM-C5	0.04	100.2	0.677
Benzene	0.13	78.1	0.884
Cy-C6	0.52	84.2	0.783
2-M-C6	0.37	100.2	0.683
1,1-DM-Cy-C5	0.00	98.2	0.759
1-cis,2-DM-Cy-C5	0.00	98.2	0.777
3-M-C6	0.34	100.2	0.692
1-cis,3-DM-Cy-C5	0.17	98.2	0.749
1-trans,3-DM-Cy-C5	0.15	98.2	0.753
1-trans,2-DM-Cy-C5	0.32	98.2	0.756
n-C7	0.79	100.2	0.688
Unspecified C7	0.07	100.2	0.680
M-Cy-C6	1.07	98.2	0.774
1,1,3-TM-Cy-C5	0.10	112.2	0.753
E-Cy-C5	0.08	98.2	0.753
2,2,3-TM-Cy-C5	0.04	114.2	0.720
2,5-DM-C6	0.05	114.2	0.698
2,4-DM-C6	0.11	114.2	0.705
3,3-DM-C6	0.01	114.2	0.714
1-trans,2-cis-3-TM-Cy-C5	0.12	112.2	0.758
Toluene	0.33	92.1	0.871
1,1,2-TM-Cy-C5	0.07	112.2	0.777

table A.1 cont.

Component	Weight%	Molecular weight	Density
2,3-DM-C6	0.02	114.2	0.716
2-M-C7	0.36	114.2	0.702
3-M-C7	0.00	114.2	0.710
1-cis-3-DM-Cy-C6	0.49	112.2	0.770
1-trans-4-DM-Cy-C6	0.12	112.2	0.767
Unspecified naphthene	0.03	112.2	0.770
Unspecified naphthene	0.04	112.2	0.770
Unspecified naphthene	0.04	112.2	0.770
DM-Cy-C6	0.10	112.2	0.770
1-trans-2-DM-Cy-C6	0.18	112.2	0.780
n-C8	0.79	114.2	0.707
Unspecified C8	0.14	114.2	0.700
Unspecified naphthene	0.00	126.2	0.790
2,2-DM-C7	0.01	128.3	0.714
2,4-DM-C7	0.00	128.3	0.719
1-cis-2-DM-Cy-C6	0.09	112.2	0.800
E-Cy-C6 + 1,1,3-TM-Cy-C6	0.36	118.0	0.790
Unspecified naphthene	0.14	126.2	0.790
3,5-DM-C7	0.07	128.3	0.726
2,5-DM-C7	0.01	128.3	0.721
Ethylbenzene	0.01	106.2	0.871
Unspecified naphthene	0.09	126.2	0.790
Meta + para-xylene	0.37	106.2	0.866
4-M-C8	0.09	128.3	0.724
2-M-C8	0.13	128.3	0.717
Unspecified naphthene	0.04	126.2	0.790
Unspecified naphthene	0.18	126.2	0.790
Unspecified naphthene	0.01	126.2	0.790
Ortho-xylene	0.01	106.2	0.884
3-M-C8	0.07	128.3	0.724
1-M,3-E-Cy-C6	0.15	126.2	0.800
1-M,4-E-Cy-C6	0.09	126.2	0.790
Unspecified naphthene	0.02	126.2	0.790
n-C9	0.77	128.3	0.721
Unspecified C9	0.63	128.3	0.720

Explanation of the abbreviations:

Cy-	Cyclo-
D	Di-
E	Ethyl-
M	Methyl-
T	Tri-

APPENDIX B

A brief description of the analytical methods.

1.Gas chromatography of the light end is performed on a Chrompack CP Sil 5 column (50m x 0.23 mm i.d., 0.4 um filmthickness). The temperature is programmed as follows:

10 °C 2 min
3 °C/min to 115 °C
10 °C/min to 300 °C
300 °C 60 min

Injector (split) : 300 °C
Detector (FID) : 350 °C

2.Gas chromatograms of whole oils, aromatics and paraffines/naphthenes are recorded using a Cp Sil 5 CB column (25 mm x 0.23 mm i.d., 0.13 um filmthickness) and FI-detector. The following temperature programs are used:

A. Whole oils/paraffines-naphthenes:

10 °C 2 min
6 °C/min to 300 °C

B. Aromatics:

10 °C 2 min

6 °C/min to 85 °C

4 °C/min to 300 °C

Injector(split): 320 °C

Detector : 350 °C

3.Molecular weights are determined by freezing point depression of benzene (Cryette, Precision Instr.), except for C4 - C9 which are calculated from GC-composition. Precision of the method is about 1.5 % (RSD) for residues and about 1 % for lower fractions.

4.Densities of liquid fractions are measured using a Paar DMA 62 frequency densiometer, thermostatted at 15 °C. Precision of the method is +/- 0.0002 g/cc.
Densities of the C4 - C9 fractions are calculated from the GC-compositions.

5.Water content (wt%) is determined by Karl Fischer titration.

6.Sulphur content is determined by X-ray fluorescence (LAB-X 2000, Oxford Analytical).

7.Wax content is determined by a modified UOP method 46-64, described by Burger et al. (Journ. Petr. Tech., June 1981,

1075), the acetone precipitation technique. The wax is precipitated with acetone at -25 °C and filtrated. The precipitate is purified by elution through a short silica cartridge.

8. Pour point is determined according to ASTM D-97 (1980).

9. Wax appearance temperature is determined by polarization microscopy (due to optical anisotropy wax crystals have the ability to rotate polarized light). The sample is cooled slowly after first being heated to 70 °C.

10. Pentane insolubles (asphaltenes) are precipitated with pentane (1:40 vol:vol) and filtrated through a 0.45 um filter.

11. Hydrocarbon group type analysis of C10+ (and C20+) fractions are performed by preparative liquid chromatography using a combination of cyanosilane column to trap polar compounds (resins) and a silica column to separate aromatics from paraffines/naphthenes (saturates). The columns are connected in series. The saturates are eluted first with hexane. Both columns are then backflushed with hexane to elute the aromatics. At last, the strongly retained, polar material is backflushed from the cyano-column with tetrahydrofurane.
The solvent is removed by vacuum evaporation, and the fractions quantified by weighing. Residual hexane is determined by GC with internal standard, and corrected for.
Further fractionation of the aromatics according to number of

aromatic carbons, may be done on an aminosilane column eluted with hexane.

APPENDIX C

Definition of Carbon Preference Indices:

$$CPI\ 1 = 1/2\ [(C25 + C27 + C29 + C31 / C24 + C26 + C28 + C30) + (C25 + C27 + C29 + C31 / C26 + C28 + C30 + C32)]$$

$$CPI\ 2 = 2 \times (C27 / C26 + C28)$$

Definition of Methyl Phenanthrene Indices:

$$MPI\ 1 = \frac{1.5\ (2\text{-}MP + 3\text{-}MP)}{P + 9\text{-}MP + 1\text{-}MP}$$

$$MPI\ 2 = \frac{3\ (2\text{-}MP)}{P + 9\text{-}MP + 1\text{-}MP}$$

APPENDIX D

Definition of Thompson indices:

A: Benzene / n-C6

B: Toluene / n-C7

X: (meta+para xylen) / n-C8

C: (n-C6 + n-C7) / (Cy-C6 + M-cy-C6)

I: (2-M-C6 + 3-M-C6) / (1-cis,3-DM-Cy-C5 + 1-trans,3-DM-Cy-C5
+ 1-trans,2-DM-Cy-C5)

F: n-C7 / M-Cy-C6

H: (100 * n-C7) / (Cy-C6 + 2-M-C6 + 1,1-DM-Cy-C5 + 3-M-C6 +
1-cis,3-DM-Cy-C5 + 1-trans,3-DM-Cy-C5 +
1-trans,2-DM-Cy-C5 + n-C7 + M-Cy-C6)

U: Cy-C6 / M-Cy-C5

R: n-C7 / 2-M-C6

APPENDIX E

Table E.1. Tabulation of some properties of the crude oils from 9/2-1 DST 3 and 9/2-3 DST1.

	9/2-1 DST 3	9/2-3 DST 1
Molecular weight (g/gmole)	192	209
Density (g/cc)	0.830	0.845
Weight% C10+ *	78.87	82.96
Mol. weight C10+ (g/gmole) *	278	293
Density C10+ (g/cc) *	0.875	0.885
Weight% asphaltenes	1.7	7.1
Pour point (^{o}C)	+ 12	- 2
Weight% water	0.3	0.6
Total C6/total C7	0.54	0.54
Total C7/total C8	0.83	0.81
Total C8/total C9	1.39	1.28
A **	0.14	0.16
B **	0.41	0.42
X **	0.43	0.47

cont.

Table E.1 cont.

C **	1.14	1.02
I **	1.01	1.11
F **	0.82	0.74
H **	22.65	21.13
U **	0.79	0.89
R **	2.32	2.11
Pristane/Phytane	1.59	1.61
Pristane/n-C17	0.71	0.62
Phytane/n-C18	0.53	0.39
2-MN /1-MN	1.30	1.27
2,6+2,7- / 1,4+1,5+2,3-DMN	0.75	0.60
Biphenyl / 1+2-EN	0.21	0.40
Biphenyl / 3-M-biphenyl	0.39	0.47

* These data for 9/2-1 are taken from distillation (experimental values).
These data for 9/2-3 are calculated from composition of light end.

** Definition of indexes, see appendix D.