

Table B11

FILE: 12570021 SQ4

A1

RESULT OF SYNGAS OPERATION

RUN NO. 12570-02
 CATALYST CO/X11-TC123 80 CC 37.4 G AFTER USE:56.0 G (+18.6 G)
 FEED H2:CO OF 65:35 @ 400 OR 833 CC/MIN (CAT#12524-18)

RUN & SAMPLE NO.	12570-02-42	570-02-43	570-02-44	570-02-45	570-02-46
FEED H2:CO:AR	65:35: 0	65:35: 0	65:35: 0	64:36: 0	64:36: 0
HRS ON STREAM	1186.75	1211.75	1236.75	1255.75	1303.75
PRESSURE, PSIG	500.00	500.00	500.00	500.00	500.00
TEMP. C	239.00	239.00	239.00	240.00	240.00
FEED CC/MIN	400.00	400.00	400.00	833.00	833.00
HOURS FEEDING	20.50	25.00	25.50	19.00	48.00
EFFLNT GAS LITER	180.10	224.80	233.90	567.60	1470.90
GM AQUEOUS LAYER	58.93	73.16	75.61	60.60	124.22
GM OIL	44.61	52.43	54.02	38.96	90.01
MATERIAL BALANCE					
GM ATOM CARBON %	98.24	98.45	101.08	98.73	99.52
GM ATOM HYDROGEN %	91.74	92.30	93.55	81.88	80.12
GM ATOM OXYGEN %	89.32	91.40	93.65	98.86	96.17
RATIO CHX/(H2O+CO2)	1.1815	1.1406	1.1463	0.9952	1.1467
RATIO X IN CHX	2.3082	2.3208	2.3273	2.2998	2.3000
USAGE H2/CO PRODT	1.9492	1.9818	1.9793	2.1371	2.0049
FEED H2/CO FRM EFFLNT	1.7342	1.7411	1.7188	1.4744	1.4312
RESIDUAL H2/CO RATIO	1.4098	1.3932	1.3484	1.2219	1.2254
RATIO CO2/(H2O+CO2)	0.0206	0.0212	0.0218	0.0056	0.0065
K SHIFT IN EFFLNT	0.0296	0.0301	0.0301	0.0069	0.0081
SPECIFIC ACTIVITY SA	1.3324	1.3036	1.3453	0.9887	0.9438
CONVERSION					
ON CO %	60.15	59.11	58.71	27.59	26.41
ON H2 %	67.61	67.28	67.60	39.99	36.99
ON CO+H2 %	64.88	64.30	64.33	34.98	32.64
PRDT SELECTIVITY, WT %					
CH4	9.15	9.77	10.16	8.99	8.95
C2 HC'S	1.24	1.22	1.21	1.11	1.40
C3H8	1.97	2.12	2.14	1.98	1.98
C3H6=	0.88	0.93	0.93	1.80	2.02
C4H10	2.05	2.20	2.17	2.07	2.11
C4H8=	1.20	1.28	1.26	1.93	2.16
C5H12	2.20	2.39	2.32	2.20	2.37
C5H10=	0.61	0.65	0.63	1.09	1.36
C6H14	2.03	2.19	2.32	2.20	3.10
C6H12= & CYCLO'S	0.15	0.20	0.21	0.42	0.88
C7+ IN GAS	2.92	3.05	3.33	4.86	6.05
LIQ HC'S	75.60	74.01	73.31	71.35	67.64
TOTAL	100.00	100.00	100.00	100.00	100.00
SUB-GROUPING					
C1 -C4	16.49	17.52	17.88	17.89	18.62
C5 -420 F				23.75	28.02
420-700 F				29.11	27.46
700-END PT				29.25	25.91

Table B11 (continued)

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A1

CS--END PT	83.51	82.48	82.12	82.11	81.38
ISO/NORMAL MOLE RATIO					
C4	0.0214	0.0208	0.0216	0.0000	0.0000
C5	0.0366	0.0386	0.0380	0.0306	0.0194
C6	0.2164	0.2153	0.1897	0.1589	0.1479
C4*	0.0790	0.0741	0.0796	0.0333	0.0460
PARAFFIN/OLEFIN RATIO					
C3	2.1391	2.1666	2.2031	1.0520	0.9342
C4	1.6508	1.6551	1.6630	1.0358	0.9410
C5	3.4882	3.5789	3.5696	1.9655	1.6959
SCHULZ-FLORY DISTRBTN					
ALPHA (EXP(SLOPE))	0.7222	0.7281	0.7380	0.8915	0.8803
RATIO CH4/(1-A)**2	1.1854	1.3220	1.4804	7.6301	6.2470
ALPHA FRM CORRELATION				0.8022	0.8020
ALPHA (EXPTL/CORR)				1.1113	1.0976
WXC4 FRM CORRELATION				24.8126	24.8556
WXC4 (EXPTL/CORR)				0.3623	0.3601
LIQ HC COLLECTION					
PHYS. APPEARANCE	OIL WAX	OIL WAX	OIL WAX	OIL WAX	OIL WAX
DENSITY					
N, REFRACTIVE INDEX					
SIMULT'D DISTILAIN					
10 WT % @ DEG F				372.00	348.00
16				409.00	406.00
50				636.00	613.00
84				916.00	903.00
90				999.00	983.00
RANGE(16-84 %)				507.00	497.00
WT % @ 420 F				18.20	21.10
WT % @ 700 F				59.00	61.70

Table B12

FILE: 1257002J 5Q4

A1

RESULT OF SYNGAS OPERATION

RUN NO.	12570-02				
CATALYST	CO/X11-TC123 80 CC 37.4 G AFTER USE:56.0 G (+18.6 G)				
FEED	H2:CO OF 64:36 @ 400 CC/MN OR 300 GHSV (CAT#12524-18)				
RUN & SAMPLE NO.	12570-02-47	570-02-48	570-02-49	570-02-50	570-02-51
FEED H2:CO:AR	64:36: 0	64:36: 0	64:36: 0	64:36: 0	64:36: 0
HRS ON STREAM	1329.75	1353.25	1400.25	1424.25	1447.75
PRESSURE, PSIG	500.00	500.00	500.00	500.00	500.00
TEMP. C	240.00	221.00	222.00	221.00	221.00
FEED CC/MIN	833.00	400.00	400.00	400.00	400.00
HOURS FEEDING	26.00	23.50	47.00	24.00	23.50
EFFLNT GAS LITER	798.90	371.70	775.20	397.10	391.00
GM AQUEOUS LAYER	65.80	29.48	53.33	25.68	25.89
GM OIL	49.57	23.16	45.29	23.66	22.28
MATERIAL BALANCE					
GM ATOM CARBON %	99.90	96.83	99.20	98.95	97.44
GM ATOM HYDROGEN %	80.13	90.76	91.85	92.18	92.50
GM ATOM OXYGEN %	95.98	92.15	93.65	92.02	92.29
RATIO CHX/(H2O+CO2)	1.1754	1.2027	1.2592	1.3402	1.2463
RATIO X IN CHX	2.2973	2.2615	2.2699	2.2628	2.2757
USAGE H2/CO PRODT	1.9831	1.9570	1.9224	1.8732	1.9340
FEED H2/CO FRM EFFLNT	1.4259	1.6663	1.6460	1.6561	1.6878
RESIDUAL H2/CO RATIO	1.2254	1.5490	1.5426	1.5731	1.5975
RATIO CO2/(H2O+CO2)	0.0064	0.0021	0.0029	0.0020	0.0025
K SHIFT IN EFFLNT	0.0079	0.0033	0.0045	0.0032	0.0040
SPECIFIC ACTIVITY SA	0.9557	1.1104	1.0020	1.0565	0.9785
CONVERSION					
ON CO %	26.46	28.76	27.23	27.65	26.80
ON H2 %	36.79	33.77	31.80	31.28	30.72
ON CO+H2 %	32.53	31.89	30.08	29.91	29.26
PRDT SELECTIVITY, WT %					
CH4	8.99	7.33	7.86	7.40	8.12
C2 HC'S	0.82	0.70	0.76	0.68	0.48
C3H8	2.00	1.71	1.70	1.68	1.73
C3H6=	1.97	2.68	2.64	2.68	0.60
C4H10	2.07	1.84	1.86	1.84	1.90
C4H8=	2.01	2.59	2.52	2.52	2.40
C5H12	2.32	2.02	1.85	1.90	1.97
C5H10=	1.27	1.53	1.45	1.53	1.50
C6H14	3.26	2.65	2.34	2.50	2.67
C6H12= & CYCLO'S	0.80	1.03	0.97	0.96	1.01
C7+ IN GAS	6.10	6.13	5.73	5.32	6.08
LIQ HC'S	68.38	69.78	70.33	71.01	71.53
TOTAL	100.00	100.00	100.00	100.00	100.00
SUB-GROUPING					
C1 -C4	17.87	16.85	17.33	16.78	15.23
C5 -420 F		23.90			
420-700 F		24.98			
700-END FT		34.26			

Table B12 (continued)

FILE: 1257002J 5Q4

A1

C5+-END PT	82.13	83.15	82.67	83.22	84.77
ISO/NORMAL MOLE RATIO					
C4	0.0000	0.0000	0.0000	0.0000	0.0000
C5	0.0000	0.0390	0.0000	0.0000	0.0000
C6	0.1227	0.1424	0.1318	0.1391	0.1223
C4=	0.0000	0.0000	0.0000	0.0000	0.0000
PARAFFIN/OLEFIN RATIO					
C3	0.9678	0.6082	0.6127	0.5976	2.7430
C4	0.9913	0.6861	0.7110	0.7053	0.7633
C5	1.7770	1.2777	1.2406	1.2104	1.2729
SCHULZ-FLORY DISTRIBUTION					
ALPHA (EXP(SLOPE))	0.7893	0.8897	0.7120	0.7239	0.8917
RATIO CH4/(1-A)**2	2.0250	6.0321	0.9470	0.9704	6.9173
ALPHA FRM CORRELATION		0.7918			
ALPHA (EXPTL/CORR)		1.1237			
WYCH4 FRM CORRELATION		23.5523			
WYCH4 (EXPTL/CORR)		0.3113			
LIQ HC COLLECTION					
PHYS. APPEARANCE	OIL WAX	OIL WAX	OIL WAX	OIL WAX	OIL WAX
DENSITY					
N. REFRACTIVE INDEX					
SIMULT'D DISTILLATE					
10 WT % @ DEG F		375.00			
16		439.00			
50		688.00			
84		982.00			
90		0.00			
RANGE(16-84 %)		543.00			
WT % @ 420 F		15.20			
WT % @ 700 F		50.90			

Table B13

FILE: 1257002K 5Q4

A1

RESULT OF SYNGAS OPERATION

RUN NO. 12570-02
 CATALYST CO/X11-TC123 80 CC 37.4 C AFTER USE: 56.0 G (+18.6 G)
 FEED H2:CO OF 64:36 400 CC/MIN OR 300 GHSV (CAT#12524-18)

RUN & SAMPLE NO.	12570-02-52	570-02-53	570-02-54
FEED H2:CO:AR	64:36: 0	64:36: 0	64:36: 0
HRS ON STREAM	1472.25	1496.25	1568.25
PRESSURE, PSIG	500.00	300.00	300.00
TEMP. C	221.00	238.00	238.00
FEED CC/MIN	400.00	400.00	400.00
HOURS FEEDING	24.50	20.00	72.00
EFFLNT GAS LITER	400.00	252.90	976.00
GM AQUEOUS LAYER	26.80	41.52	141.56
GM OIL	22.66	26.62	80.83
MATERIAL BALANCE			
GM ATOM CARBON %	95.40	96.11	95.55
GM ATOM HYDROGEN %	91.25	91.97	92.09
GM ATOM OXYGEN %	90.27	91.68	94.09
RATIO CH ₄ /(H ₂ O+CO ₂)	1.2474	1.1237	1.0427
RATIO X IN CH ₄	2.2743	2.3930	2.4189
USAGE H ₂ /C ₂ PRODT	1.9327	2.0417	2.1162
FEED H ₂ /CO FRM EFFLNT	1.7005	1.7012	1.7133
RESIDUAL H ₂ /CO RATIO	1.6139	1.4500	1.4661
RATIO CO ₂ /(H ₂ O+CO ₂)	0.0026	0.0165	0.0175
K SHIFT IN EFFLNT	0.0042	0.0243	0.0261
SPECIFIC ACTIVITY SA	0.9795	1.3082	1.1038
CONVERSION			
ON CO %	27.15	42.45	38.03
ON H ₂ %	30.86	50.95	46.98
ON CO-H ₂ %	29.49	47.81	43.68
PRDT SELECTIVITY, WT %			
CH ₄	8.10	13.43	14.68
C ₂ HC'S	0.60	1.63	1.60
C ₃ H ₈	1.71	2.53	2.83
C ₃ H ₆ =	2.56	1.00	1.24
C ₄ H ₁₀	1.87	2.57	2.85
C ₄ H ₈ =	2.50	1.30	0.85
C ₅ H ₁₂	1.85	2.95	3.38
C ₅ H ₁₀ =	1.42	0.75	0.50
C ₆ H ₁₄	2.56	3.97	4.61
C ₆ H ₁₂ = & CYCLO'S	0.99	0.50	0.32
C ₇ + IN GAS	5.48	4.83	5.99
LIQ HC'S	70.36	64.55	61.14
TOTAL	100.00	100.00	100.00
SUB-GROUPING			
C ₁ -C ₄	17.33	22.46	24.05
C ₅ -420 F	24.34	31.38	32.35
420-700 F	26.67	26.79	26.41
700-END PT	31.66	19.36	17.18

Table B13 (continued)
 FILE: 1257002K 5Q4 A1

C5--END PT	82.67	77.54	75.95
ISO/NORMAL MOLE RATIO			
C4	0.0000	0.0297	0.0000
C5	0.0000	0.0457	0.0000
C6	0.1292	0.1705	0.0966
C4=	0.0000	0.0998	0.0000
PARAFFIN/OLEFIN RATIO			
C3	0.6388	2.4101	2.1804
C4	0.7212	1.9040	3.2292
C5	1.2628	3.8368	6.5546
SCHULZ-FLORY DISTRBTN			
ALPHA (EXP(SLOPE))	0.8873	0.8697	0.8654
RATIO CH4/(1-A)**2	6.3806	7.9088	8.1030
ALPHA FRM CORRELATION	0.7898	0.7940	0.7934
ALPHA (EXPTL/CORR)	1.1235	1.0954	1.0907
WYCH4 FRM CORRELATION	24.1734	26.9069	27.0730
WYCH4 (EXPTL/CORR)	0.3350	0.4991	0.5421
LIQ HC COLLECTION			
PHYS. APPEARANCE	OIL WAX	OIL WAX	OIL WAX
DENSITY			
N, REFRACTIVE INDEX			
SIMULT'D DISTILATN			
10 WT % @ DEG F	375.00	323.00	332.00
16	414.00	345.00	360.00
50	661.00	551.00	543.00
84	965.00	842.00	818.00
90	0.00	929.00	901.00
RANGE(16-84 %)	551.00	497.00	458.00
WT % @ 420 F	17.10	28.40	28.70
WT % @ 700 F	55.00	70.00	71.90

IV. Run 46 (12561-02) with Catalyst 46 (Co/X₁₁/TC-133)

The purpose of this run was to evaluate TC-123, the second of two newly developed Molecular Sieves, in comparison with TC-103. Preparation of the catalyst, and its theoretical content of Co and X₁₁ (8.2 and 1.6 percent respectively), were the same as for Catalyst 45.

Conversion, product selectivity, isomerization of the pentane, and percent olefins of the C₄'s are plotted against time on stream in Figs. B96-99. Simulated distillations of the C₅⁺ product are plotted in Figs. B100-109. Carbon number product distributions are plotted in Figs. B110-119. Chromatograms from simulated distillations are reproduced in Figs. B120-129. Detailed material balances appear in Tables B14-17.

The test was run for a total of 500 hours, during which the reactor temperature was held constant at 240C while the syngas feed ratio and pressure were varied in four stages.

In Stage A, at a feed ratio of 1:1 H₂:CO and 300 psig, the syngas conversion was a little higher than that of the TC-123 Catalyst 45 and substantially higher than that of the TC-103 Catalyst 32:

	Catalyst 46 TC-133	Catalyst 45 TC-123	Catalyst 32 TC-103
Conversion, pct	49.6	48.0	42.8
C ₁ , pct	5.4	3.6	5.3
C ₂ -C ₄ , pct	8.5	4.7	9.7
C ₅ ⁺ , pct	86.2	91.7	85.0
C ₄ olefin/paraffin	2.0	2.7	2.1

The stability during this stage was excellent, the syngas conversion varying less than one percentage point above and below 50 percent. The selectivity, however, was inferior to that of Catalyst 45, and more like that of Catalyst 32.

When the H₂:CO feed ratio was raised to 1.5:1 in Stage B the conversion rose sharply to about 64 percent, well above the 58 percent conversion of Catalyst 45 under similar conditions. The increase was partly offset by a corresponding increase in methane production to about 12.5 percent, as against 7 percent with Catalyst 45.

In Stage C the pressure was raised from 300 to 500 psig. As expected, the conversion was improved (by about 5 percentage points) and the methane production reduced (to less than 10 percent). But as with Catalyst 45 under similar conditions, the stability was badly impaired.

Finally, in Stage D, when the H₂:CO feed ratio was raised to 1.78:1, the stability was again excellent but the methane production rose to about 15 percent.

As compared with Catalyst 32 under similar operating conditions, this catalyst was similar in selectivity and superior in

activity. But it was significantly inferior to Catalyst 45 in overall performance--the product higher in methane and lower in both C_5^+ and olefins.

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Test conditions at each stage (Figs. 96-99)

<u>Stage</u>	<u>H₂:CO</u>	<u>psig</u>	<u>deg C</u>
A	1:1	300	240
B	1.5:1	"	"
C	1.5:1	500	"
D	1.78:1	"	"

RUN 12561-02

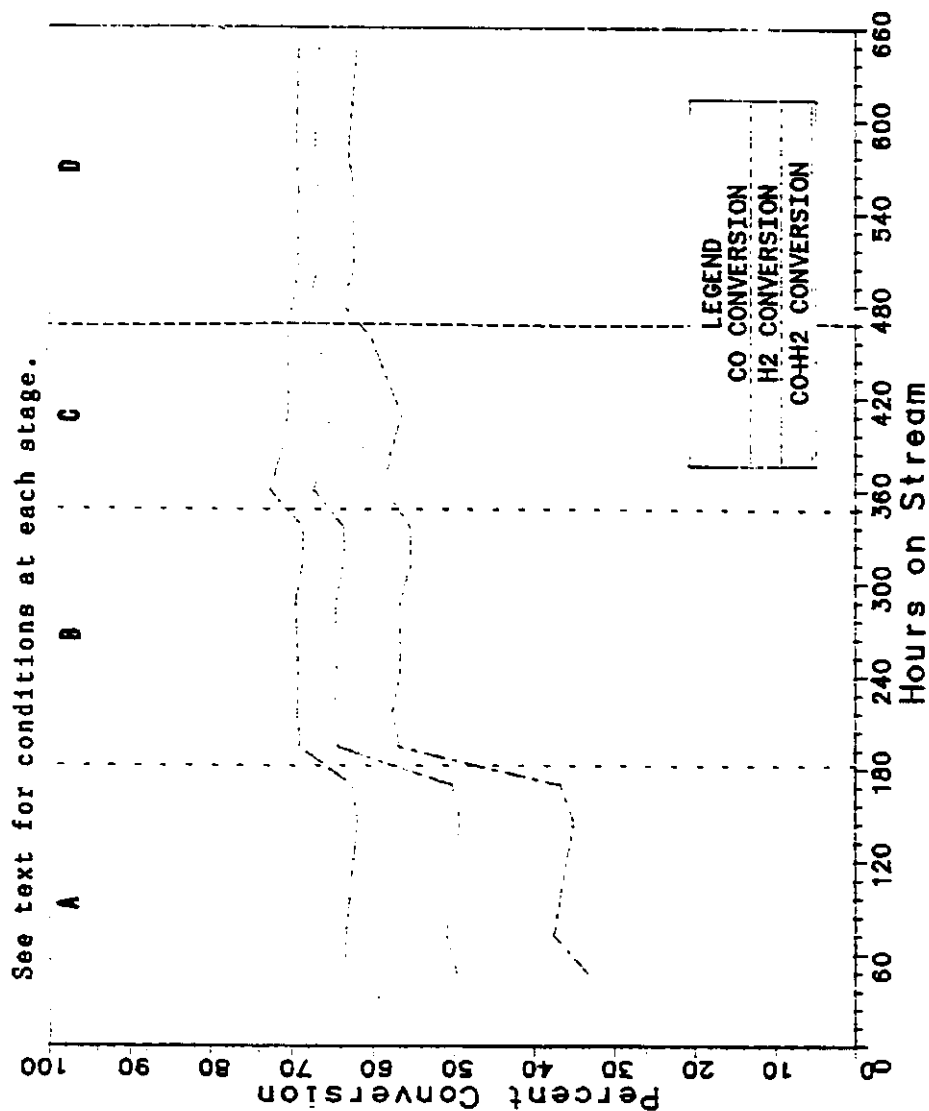


Fig. B96

RUN 12561-02

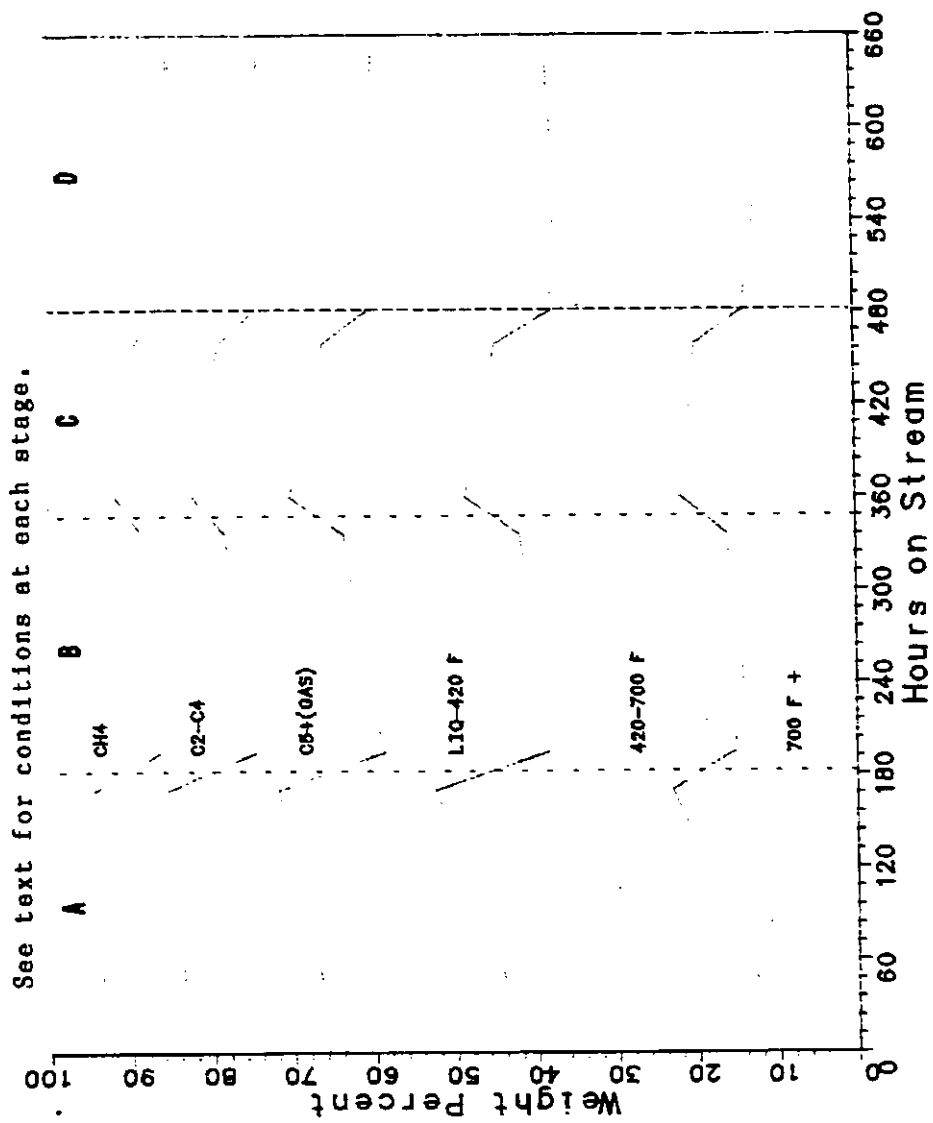


Fig. B97

RUN 12561-02

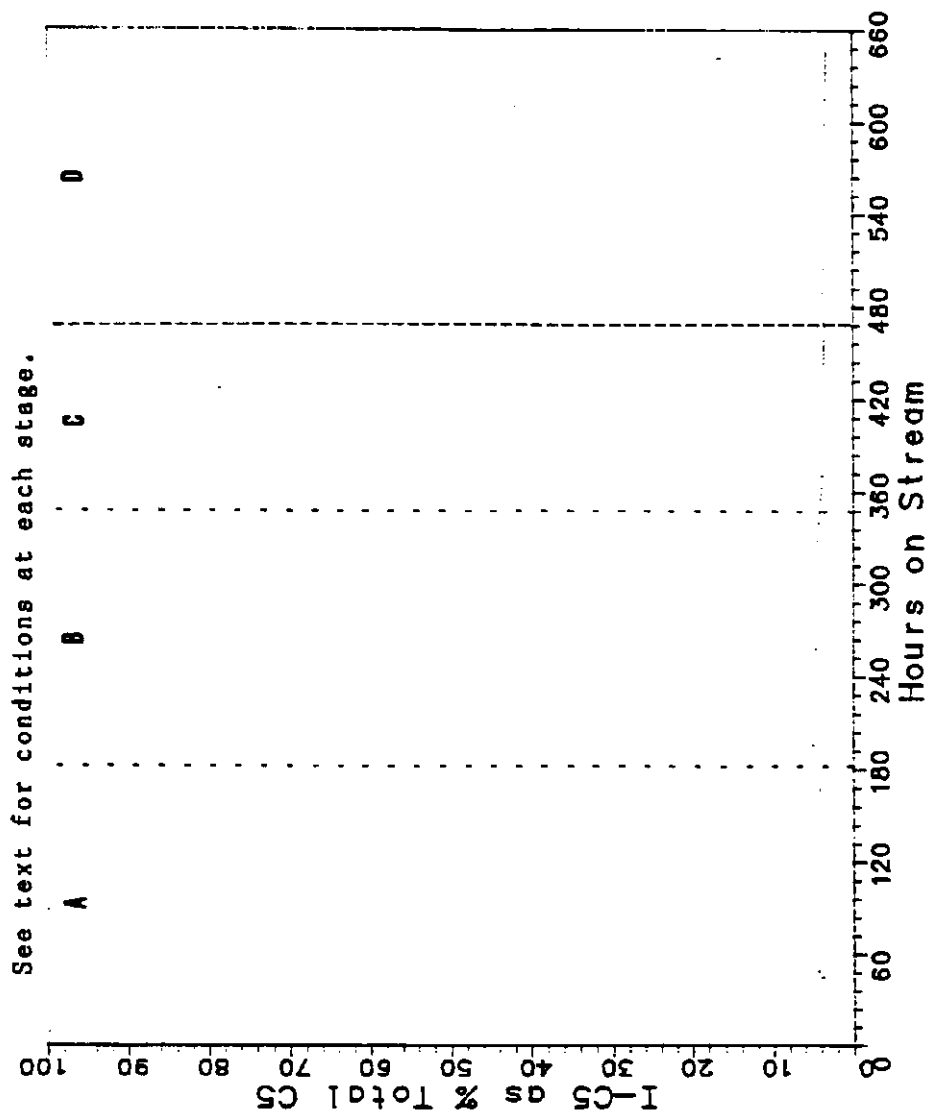


Fig. B98

RUN 12561-02

See text for conditions at each stage.

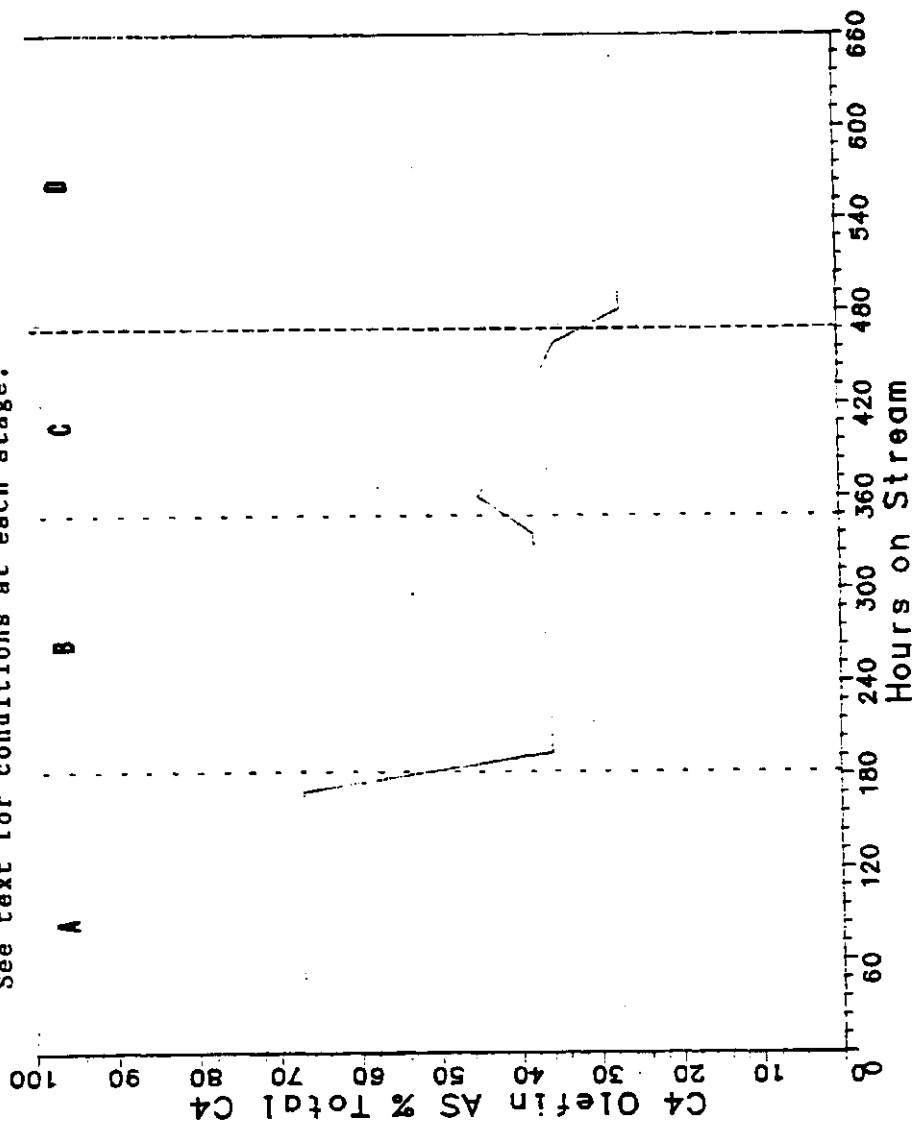


Fig. B99

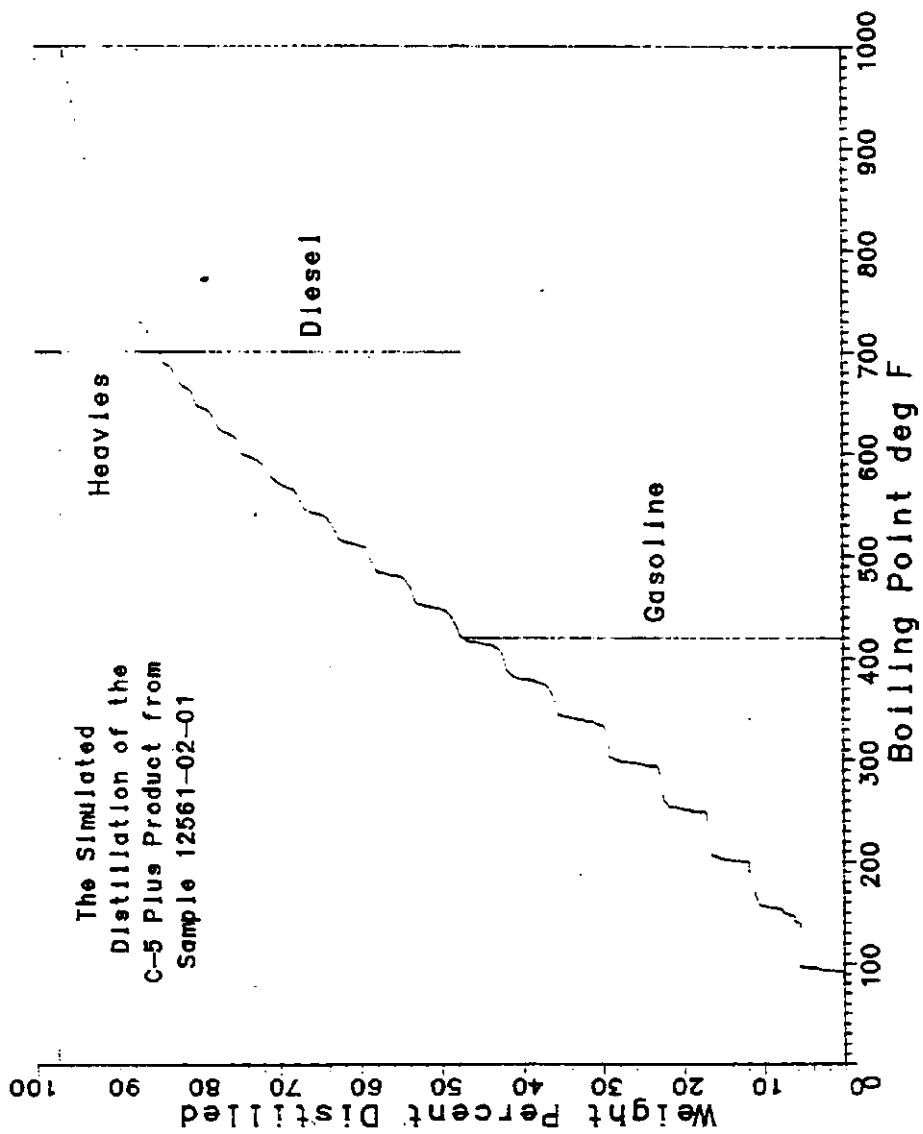


Fig. B100

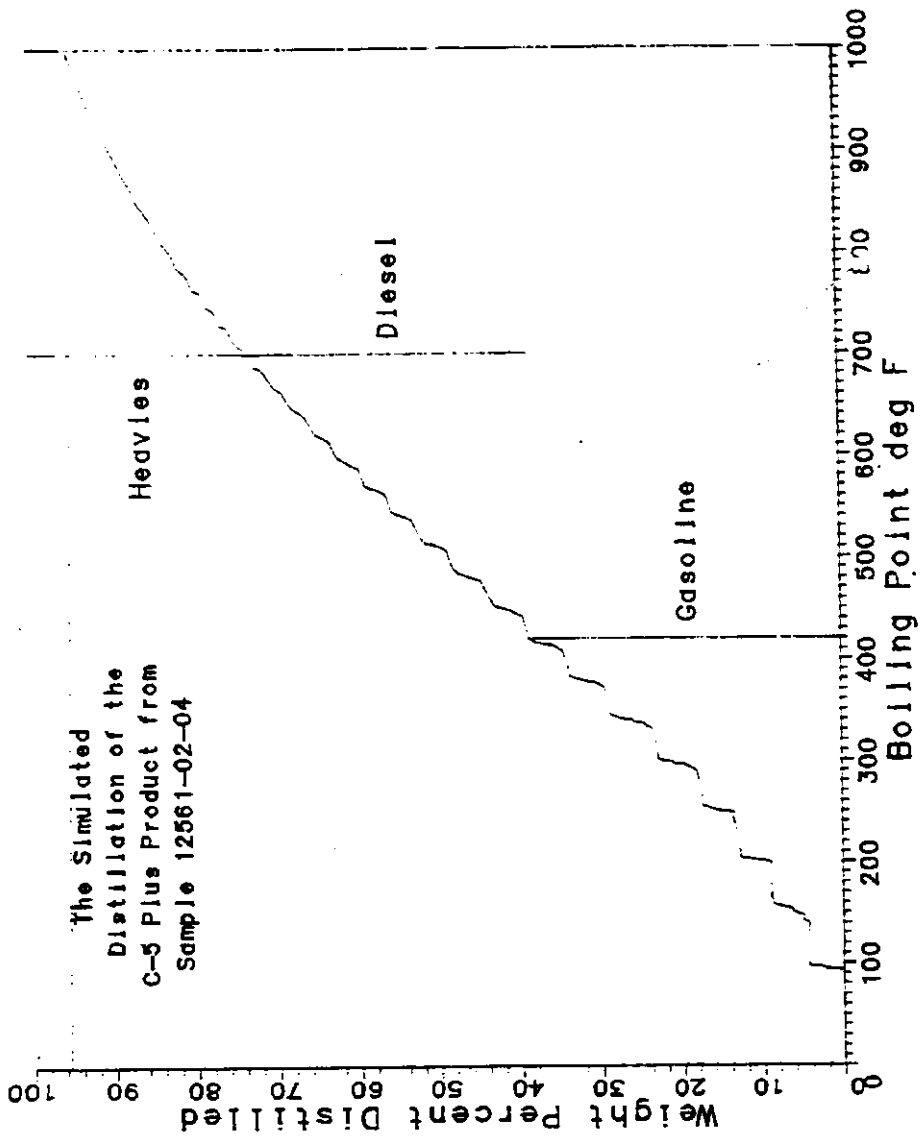


Fig. B101

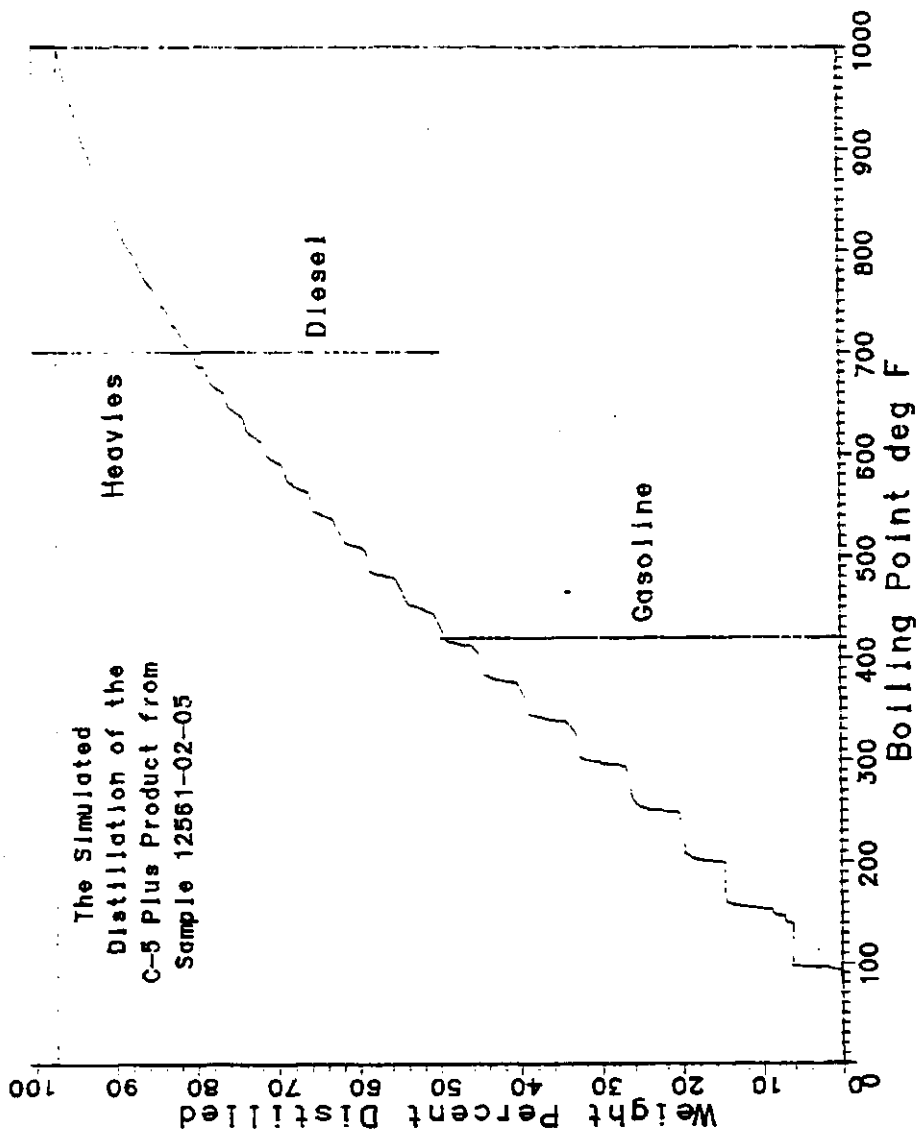


Fig. B102

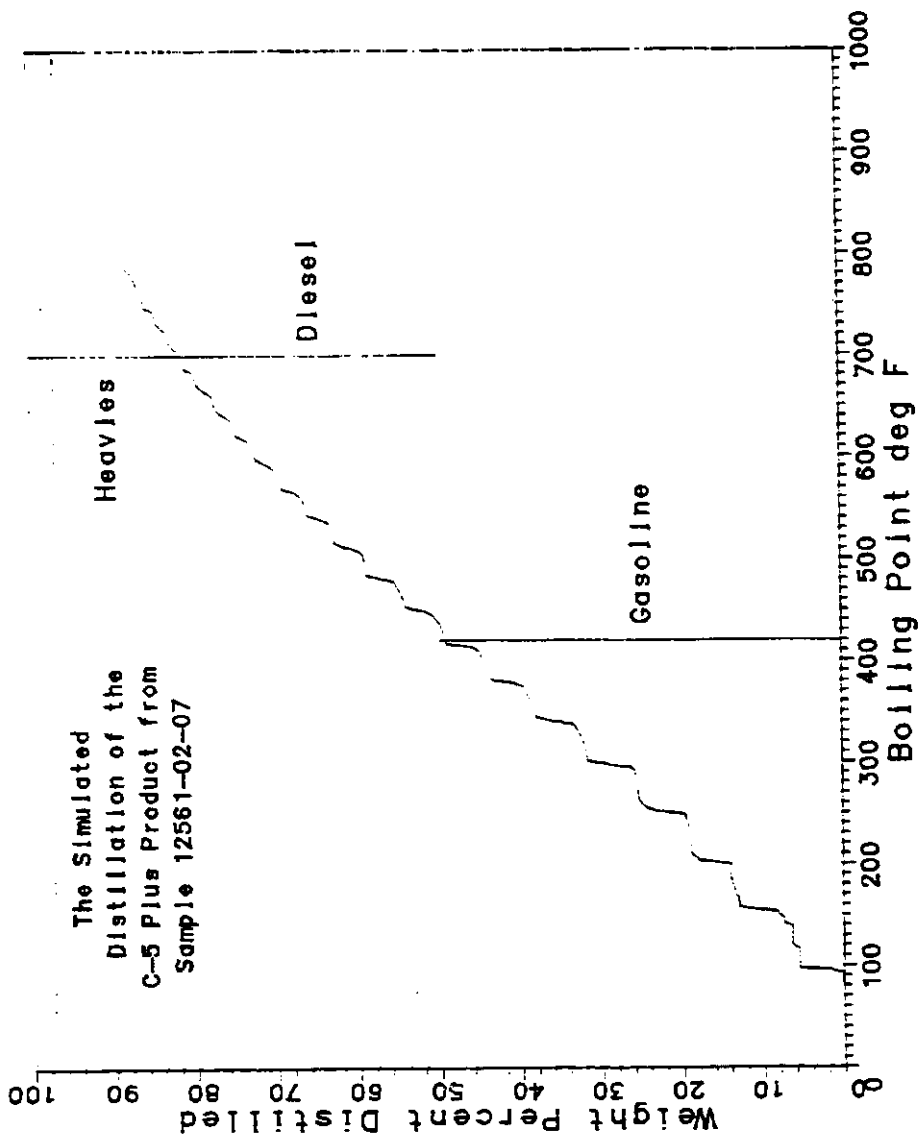


Fig. B103

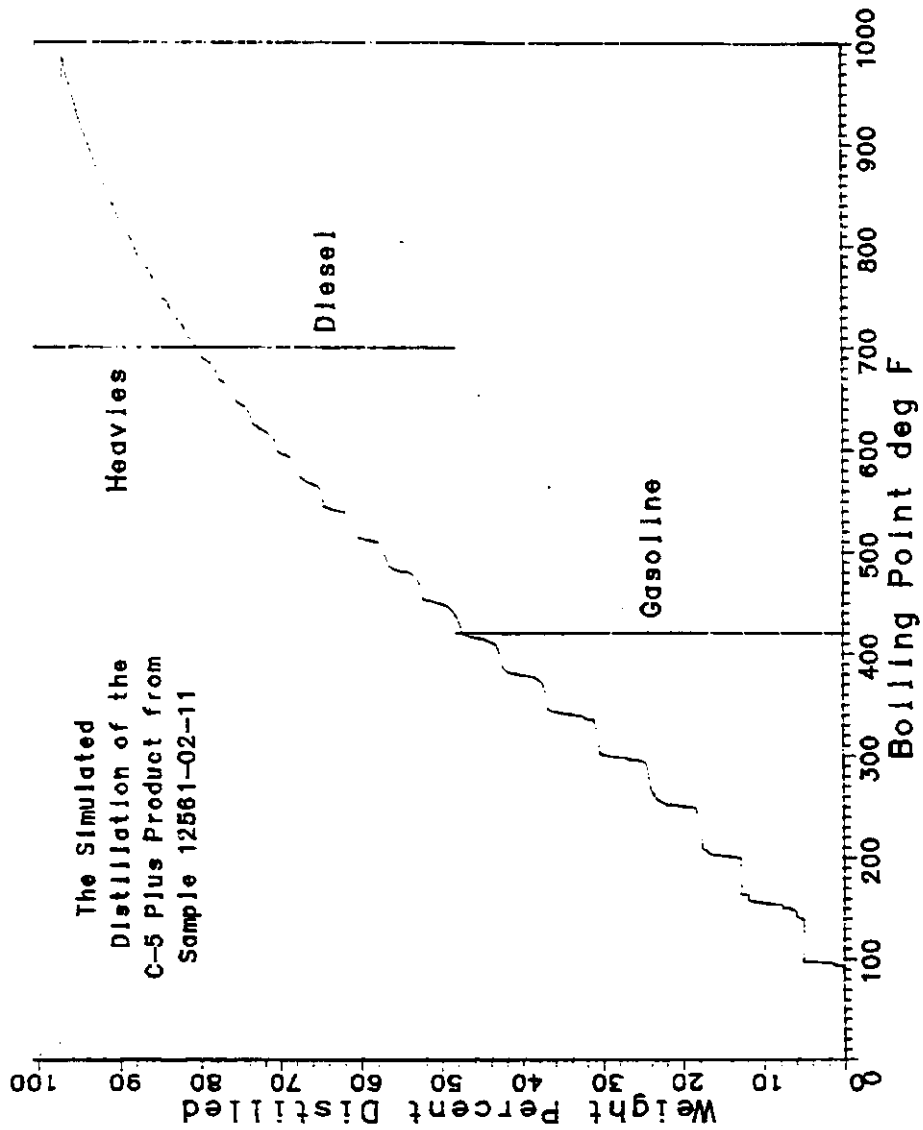


Fig. B104

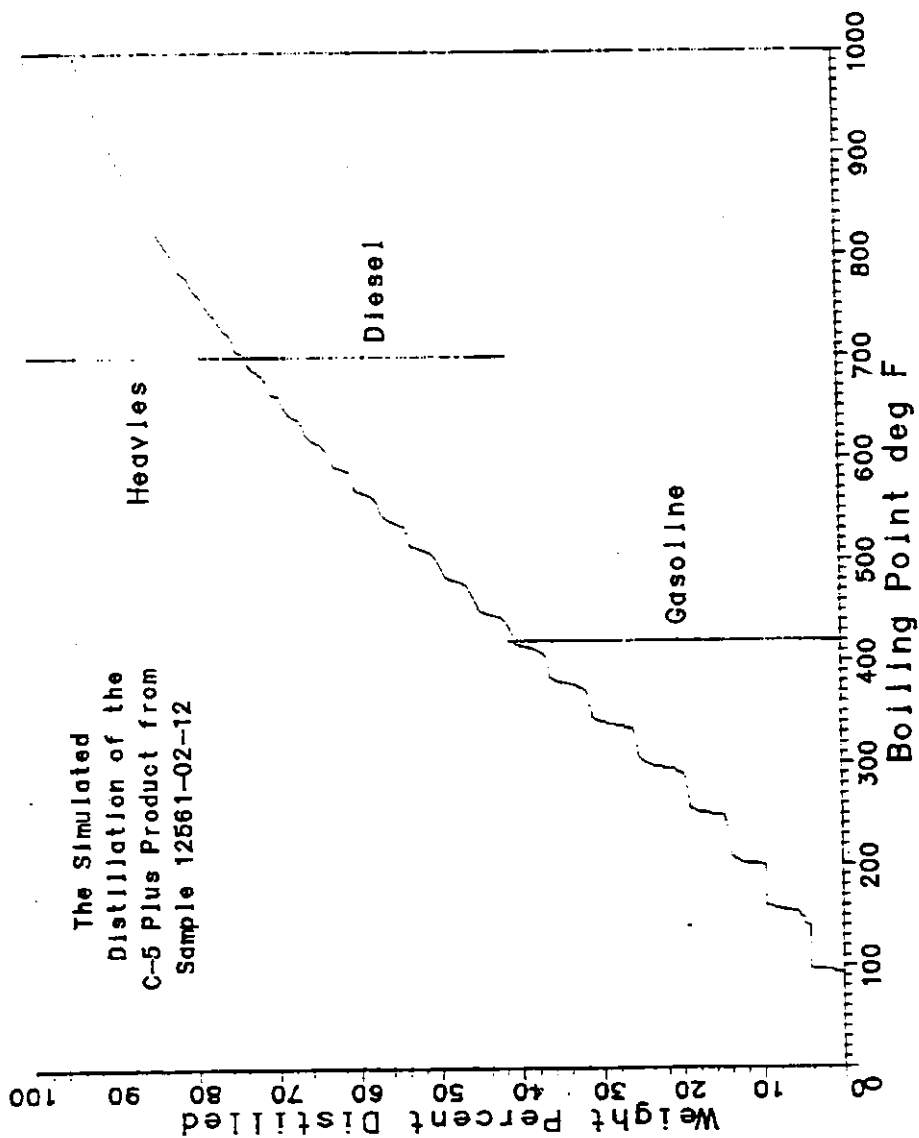


Fig. B105

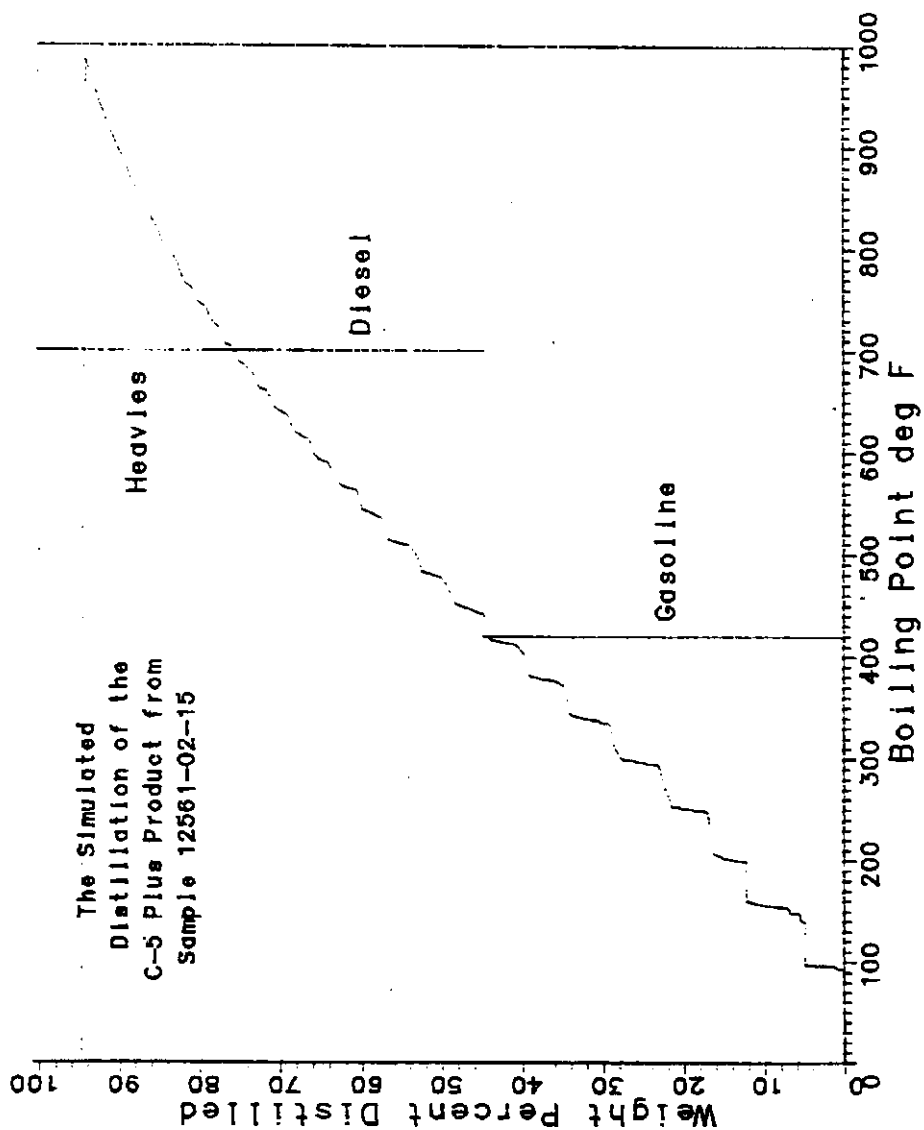


Fig. B106

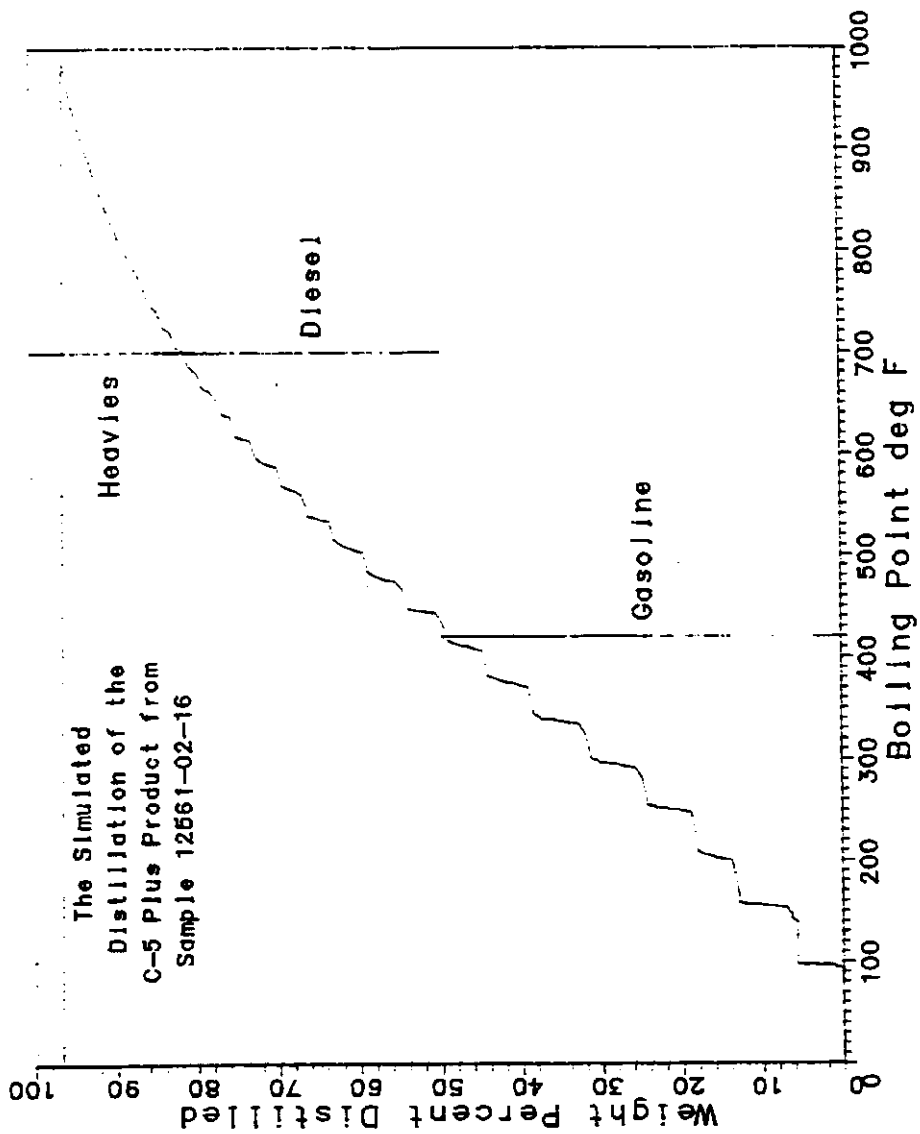


Fig. B107

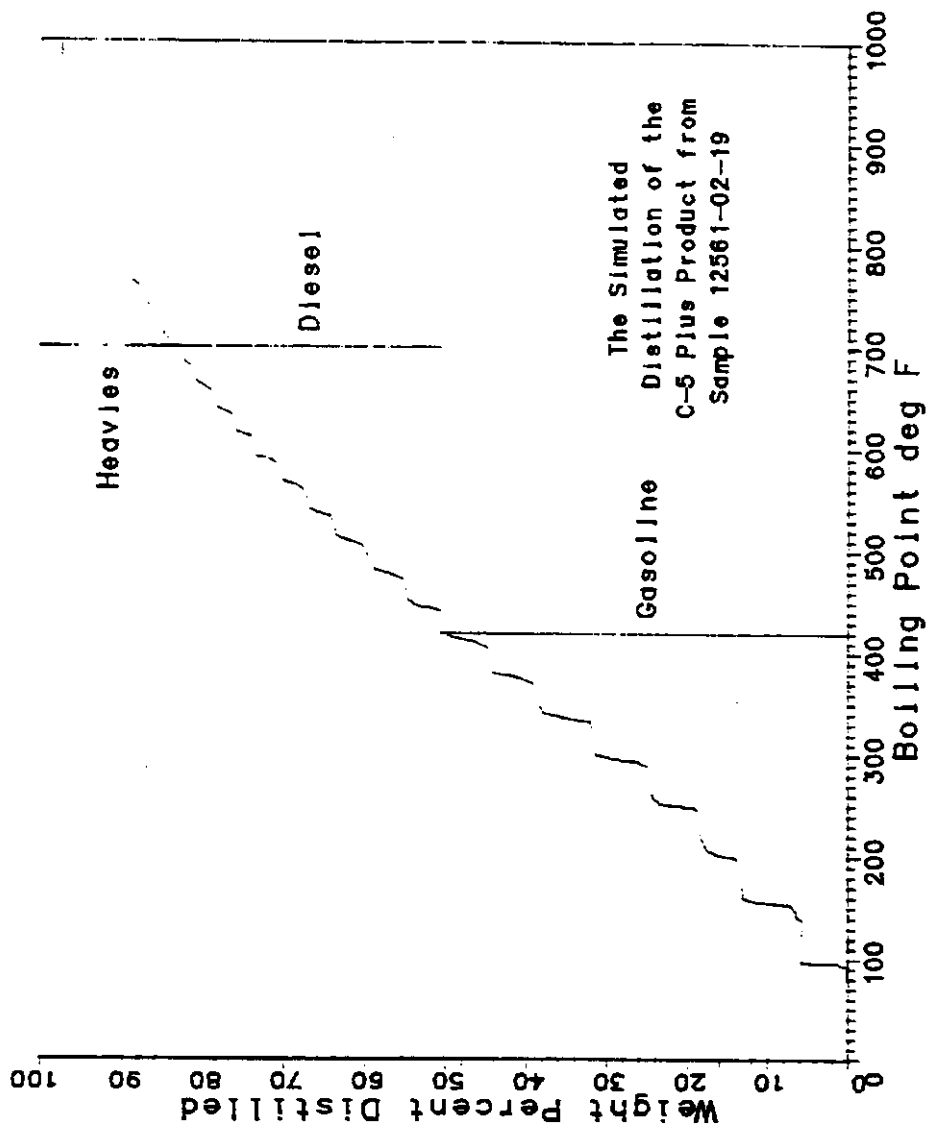


Fig. B108

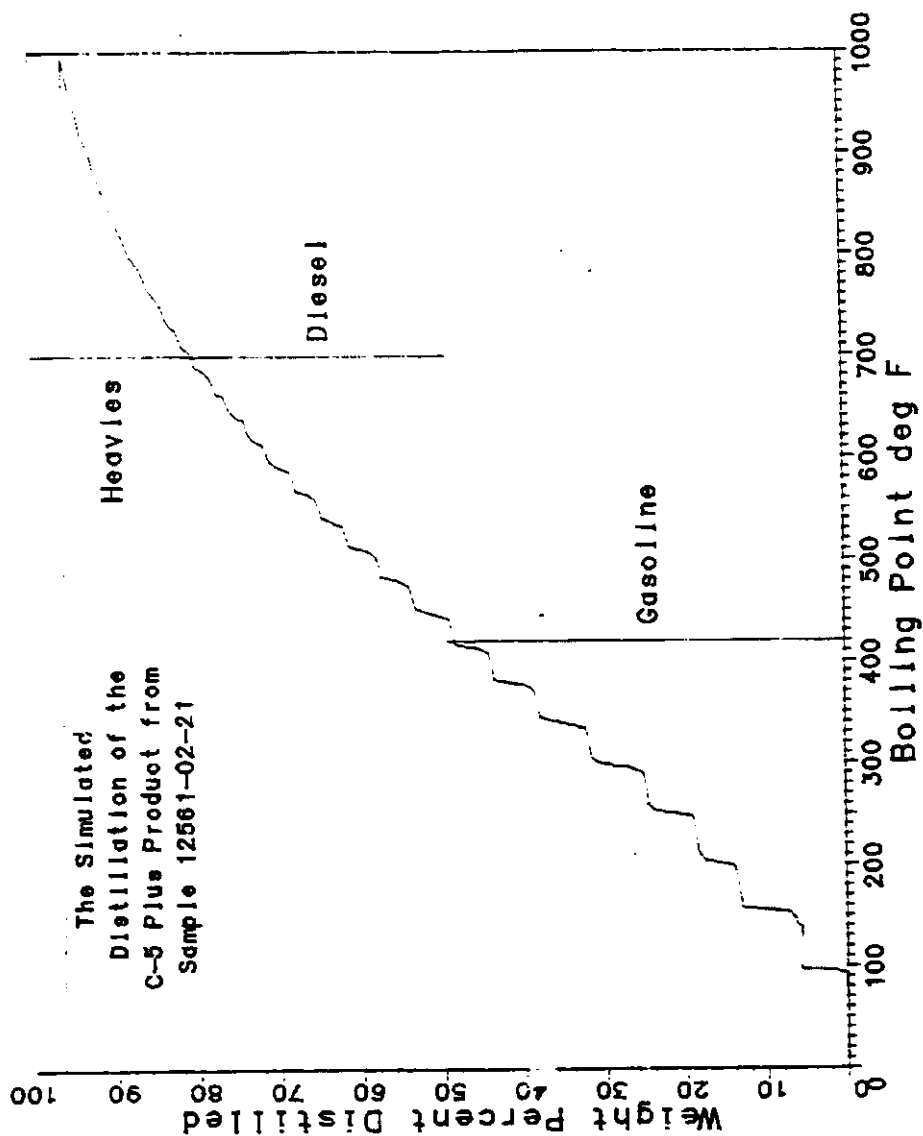


Fig. B109

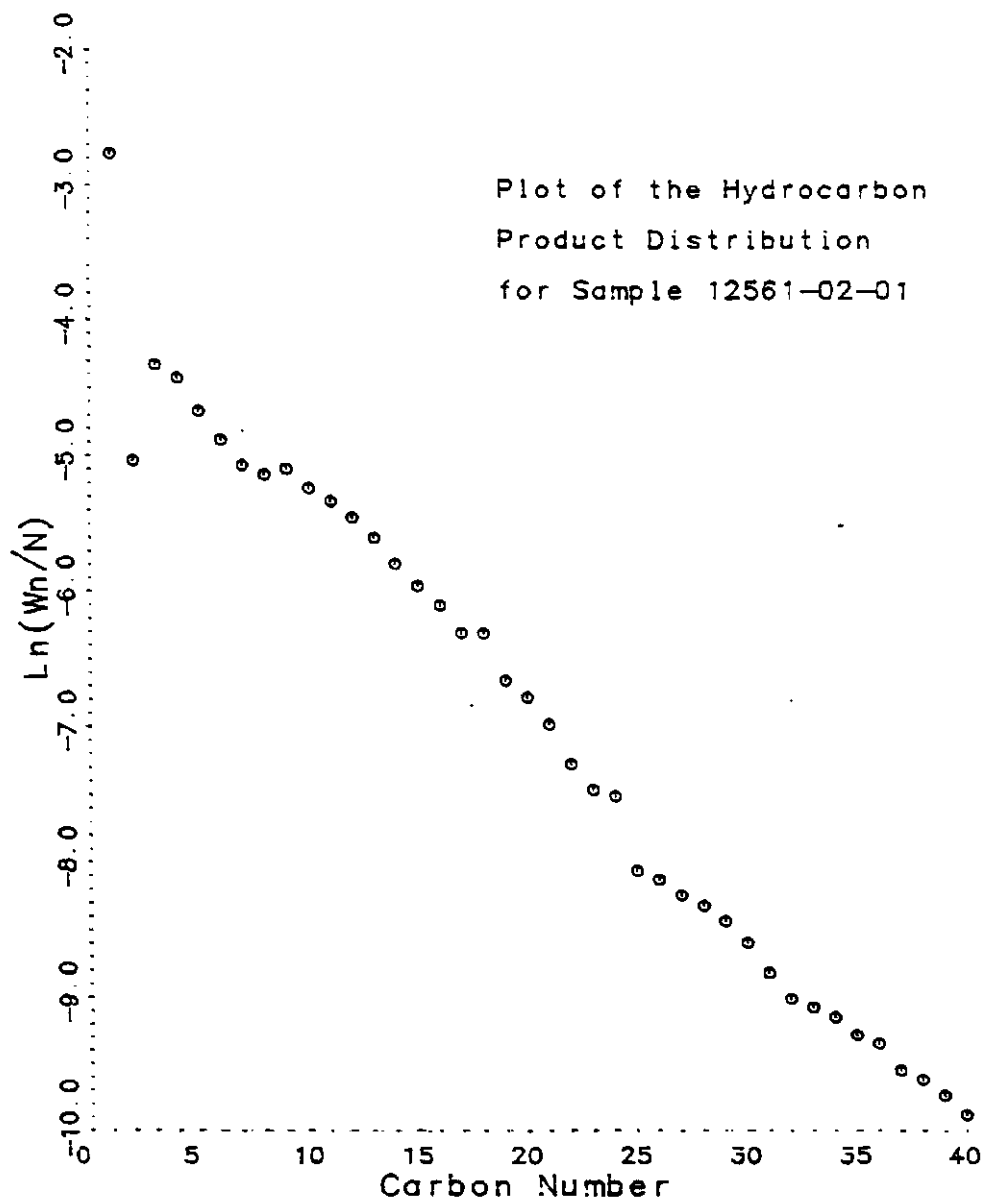


Fig. B110

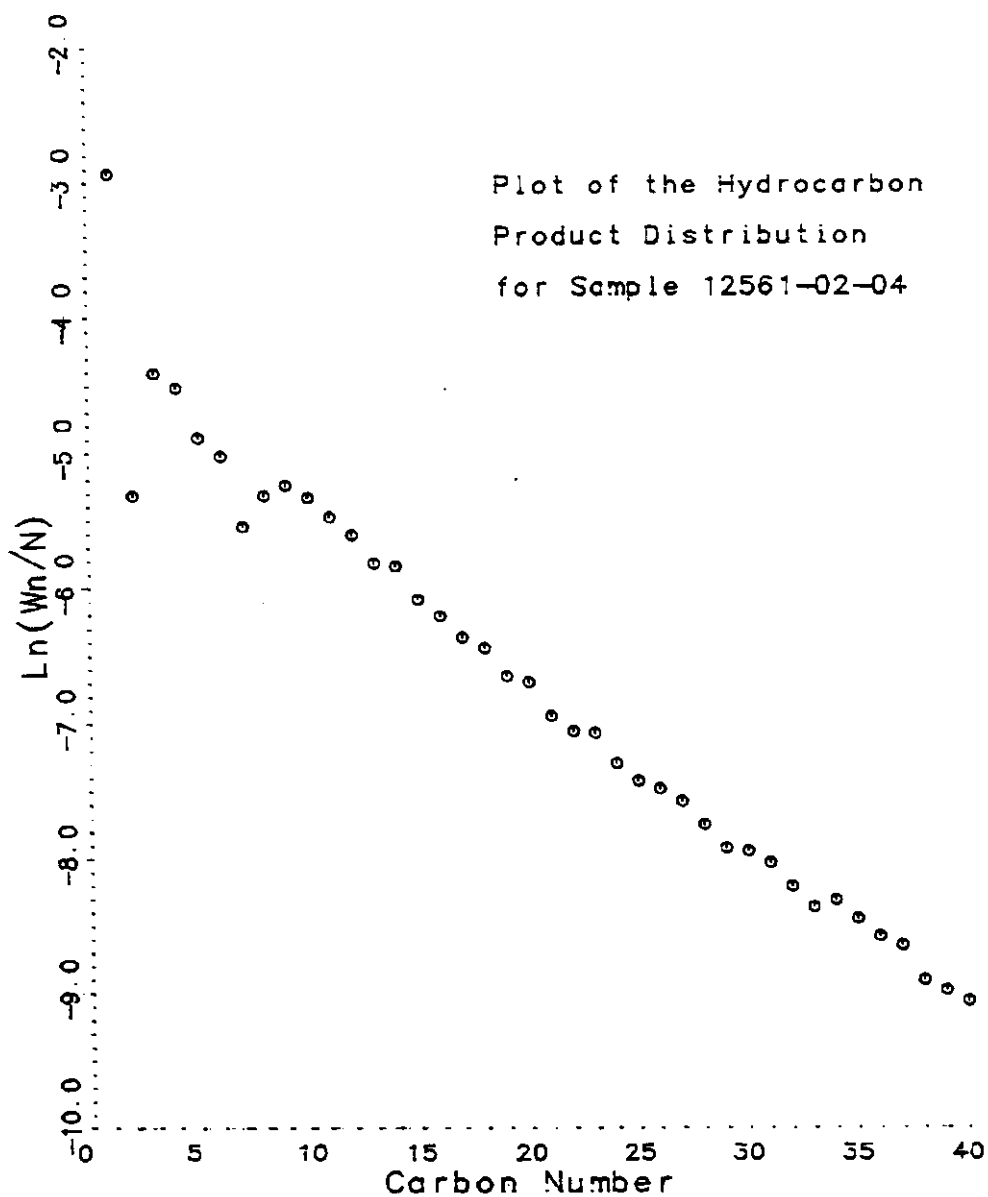


Fig. B111