California Environmental Protection Agency

Air Resources Board

PROCEDURE FOR THE DETAILED HYDROCARBON ANALYSIS OF GASOLINES BY SINGLE COLUMN HIGH EFFICIENCY (CAPILLARY) COLUMN GAS CHROMATOGRAPHY

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1 Introduction

1.1 This method provides for the determination of the majority of individual hydrocarbon components of gasolines with boiling ranges up to 250 C. Individual components or groups of co-eluting components are determined from 0.001 to 100 mass percent. Mixtures with C4-C8 olefins at concentrations of up to thirty mass percent can be analyzed. This method is also applicable to mixtures containing alcohols or ethers.

1.2 A typical composition of an actual petroleum distillate/product material to serve as a guide for the identification of gasoline components is shown in the appendix.

1.3 This method is based upon a proposed ASTM & ISO method, committee ASTM D.02.

2 Summary of Method

2.1 Gasoline samples are collected in brown bottles or metal cans and delivered to the laboratory.

2.2 A small volume of the petroleum liquid is introduced with a special syringe into a gas chromatograph equipped with an open tubular (capillary)column coated with a methyl silicone liquid phase. Helium carrier gas transports the vaporized sample through the column in which it is partitioned into individual components. The eluting components are sensed with a flame ionization detector.

2.3 The detector signal is presented on an integrating computer. Each eluting component is identified by comparing its retention time to those established by analyzing reference standards or samples under identical conditions. Peak area data is acquired by the data system and further processed to provide individual component identification and concentrations in mass and volume percent.

3 Interferences and Limitations

3.1 Although a majority of the individual hydrocarbons present in gasolines are determined, some co-elution of compounds is encountered. Other compounds containing oxygen, sulfur, nitrogen, etc. may also be present, and may co-elute with the hydrocarbons. When known co-elution exists, these are noted in the data base file table (see appendix) with an asterisk.

3.2 The column temperature program profile is selected to afford the maximum resolution of possible co-eluting components, especially where these are of two different compound types (e.g. a paraffin and a naphthene).

4 Instrumentation and Apparatus

4.1 Gas chromatograph (GC) - A Varian 3600 CX GC equipped with a flame ionization detector (FID), a split/splitless capillary injector, a 100 meters long x 0.20 mm ID Petrocol DH-100 (SUPELCO) or equivalent capillary column and a pre-column of 2-3 meters long of DB5 analytical column.

4.2 Varian 8200 CX liquid autosampler equipped with a 1.0 microliter microsyringe.

4.3 Microsyringe, 2.0 microliter for manual injection, capable of precise injection of 0.2 uL sample volumes.

4.4 Varian GC Star Workstation - a software package interfaced with the GC/autosampler which allows complete control of the instruments, to provide capability to collect and process chromatographic data and to run samples automatically.

4.5 Data system - PC 486/66 MHz.

4.6 DHAX (Detailed Hydrocarbon Analysis) specialized application software (Neil Johansen, Inc.). The programs process peak retention time and area data acquired by the Varian Star system which provide these data in an ASCII (text) file format. Components are identified by a specialized multiple reference peak (retention index) system, quantitated using area counts and detector response factors, and the corrected peak areas are normalized to 100%. Individual component concentrations are provided in mass, volume, and mole percent. The individual component data are further processed to provide reports of sample composition summarized by carbon number and compound group types. The hydrocarbon group types are paraffins (P), isoparaffins (I), naphthenes (N), olefins (O), aromatics (A), the alcohols and ethers as oxygenates (X), and multisubstituted aromatics (M).

5 Reagents and Materials

5.1 Oxidant - Air, 99.999% pure or "Zero" grade. (**WARNING** - Compressed gas under high pressure).

5.2 Make-up Gas - Nitrogen, 99.998% pure.

5.3 Liquid Nitrogen - low pressure.

5.4 Fuel Gas - Hydrogen, 99.999% pure. (**WARNING** - Extremely flammable gas under high pressure).

5.5 Carrier Gas - Helium, 99.9995% pure. (**WARNING** - Compressed gas under high pressure).

5.6 Reference gasoline standard, PONA-V mixture or equivalent - a mixture of naphtha, FCC gasoline, reformate heavy-ends and oxygenates of known qualitative and quantitative average analysis. The analysis of this standard will establish the retention indices of all the known components of gasoline in the data base file for each individual column.

5.7 Quality control gasoline standard - a motor gasoline, the composition determined by quantitative average analysis of two laboratories. This is analyzed regularly to establish quality control charts.

5.8 Set-up blend standard mixture (Transition Labs or AC Analytical Controls) – a quantitatively prepared mixture of twenty-nine (29) individual hydrocarbons and oxygenates of interest which is used for system and column evaluation. This is analyzed to adjust column temperature programming profile for each individual column to establish a satisfactory separation for each set of components listed in Section 6.1.2.

6 Procedure

6.1 PREPARATION OF APPARATUS

6.1.1 Adjust the instrument (GC/FID) operating conditions to the values specified in Table 1 below:

Table 1: GC OPERATING CONDITIONS

Column Temperature Program:

Initial Temperature	5 ^{o} C
Initial Time	10 min.
First Program Rate	5 /min.
First Hold Temperature	50 ^{o} C
First Hold Time	48 min.
Second Program Rate	1.5 /min.
Final Temperature	195 ^{o} C
Final Hold Time	1 min.

Injector

Temperature	250° C
Split Ratio	160:1 at 5 ^{o} C
Sample Size	2 uL

Detector

Type	Flame Ionization
Temperature	250 ^{o} C
Fuel Gas	Hydrogen @ 30 mL/min
Oxidant	Air @ 300 mL/min
Make-up Gas	Nitrogen @ 20 mL/min.

Carrier Gas

Type	Helium
Pressure	40-50 psig
Ave. Linear Velocity	24-30.5 cm/s @ 5 ^{o} C

6.1.2 The column temperature programming profile is dependent upon the individual column characteristics. Table I lists the programming profile determined for a 100m methyl silicone column, modified to meet the method column specifications.

The profile is determined by establishing satisfactory separations for the sets of sample components listed below by analyzing the set-up blend standard mixture.

i-butane/methanol
ethanol/3-methyl-butene-1
i-propanol/2-methyl-butene-1
t-butanol/2-methyl-butene-2
2,3-dimethylbutane/methyl-t-butylether
1-methylcyclopentene/benzene
2,3,3-trimethylcyclopentane/methylbenzene
1,4-dimethylbenzene/2,3-dimethylheptane
I17(unknown)/1-methyl-2-ethylbenzene
1-methylnaphthalene/n-tridecane

6.l.3 After the instrument initial setup, confirm and/or adjust the column carrier gas flowrate rate by making injections of methane or natural gas. The methane retention time should be 6.53 + 0.05 minutes at 5 C which results in an average linear velocity of 29.7 cm/second. Flow rate adjustment is made by raising or lowering the carrier gas pressure (head pressure) to the injector. Repeat this procedure when a new column is installed or when there is a gross shift in the retention times that a large number of components are misidentified by the DHA software.

6.1.4 After final adjustment of the carrier gas flow rate, note the carrier gas pressure and adjust the injector split flow rate to give the specified or desired split ratio. Adjust split flow daily, if necessary.

6.1.5 Make a blank analysis (no sample injection) to insure proper instrument operation and further condition of the column and instrumentation. If stray peaks or a rising baseline signal is observed. The column oven should be kept at 250 C until the baseline becomes steady and returns to that of, or at least reasonably close to, the starting temperature detector signal.

6.l.6 Set the data system for accurate presentation and calculation of the data. Optimize the integration parameters to insure that all peaks with mass percent equal to or greater than 0.001% are detected.

6.2 PREPARATION OF SAMPLES

6.2.1 Transfer each fuel sample or standard while still cold (@ 4° C) into a septum vial and seal the vial immediately. Stopper the container immediately after taking a sample.

6.2.2 Label each vial with sample ID.

6.2.3 Arrange into autosampler tray according to sample list.

6.3 ANALYSIS

6.3.1 Inject 0.20 microliter aliquot of each fuel or control/reference standard via autosampler into the GC and start the analysis.

6.3.2 Obtain a chromatogram and integrated data report.

6.4 STORAGE OF SAMPLE

6.4.l Preserve all reference standards and fuel samples by cooling at 4 C.

6.5 SAFETY PRECAUTIONS

6.5.1 Prepare gasoline samples and standards for analysis in a fume hood.

6.5.2 Wear disposable gloves when handling gasoline materials.

6.5.3 Petroleum hydrocarbon mixtures may be harmful or fatal if ingested or inhaled. Oxygenated hydrocarbons, such as alcohols and ethers, may be harmful or toxic.

6.5.4 Petroleum hydrocarbons and oxygenated hydrocarbons should be treated as extremely flammable and explosive.

7 Calculation of Results

7.1 Edit each peak baseline, modify integration parameters if necessary, and recalculate the peak area.

7.2 With the use of the DHA specialized application software, identify each peak by matching retention times with a known reference standard or sample components data base file.

7.2.l Identification of components uses the Kovats retention indices system to numerically express the relative location of components among themselves and to surrounding normal paraffins.

The formula for the calculation of Kovats retention indices is:

$$RI_i = 100 \times (n + (\log(t_i) - \log(t_n)) / (\log(t_{n+1}) - \log(t_n)))$$

where:

Ri_i = Retention Index
n = carbon number of n-paraffin
t_i = retention time of component, minutes
t_n = retention time of preceeding n-paraffin, minutes
t_{n+l} = retention time of next n-paraffln, minutes

7.2.2 The chromatographic data will be searched for the presence of the reference n-hydrocarbons (primary reference peaks) as indicated in the data base file selected. If a color monitor is being used, the display is color-coded:

RED - reference n-hydrocarbon peak was not found in sample and the retention time (RT) entered in the reference

WHITE - reference n-hydrocarbon peak was found and its retention time will be used in the RI calculations.

BLUE - reference n-hydrocarbon peak was not found. But the retention index is calculated based upon the secondary reference peak that was found.

The list of secondary compounds used as secondary reference are listed below on the data base file table (Appendix).

7.3 Check the report for the proper identification of all the n-paraffins (C3-C13). If not identified, make adjustments on the retention times of the primary or secondary index reference data in the DHA data base file. Repeat Section 7.2.

7.4 Examine the report to ensure peaks are properly identified by comparison with a known reference standard which contains most of the known components of gasoline.

7.4.1 Check for variance in reported RI values or missed identifications. Make RI data adjustments as required. To serve as a guide in making these adjustments, the following table (Table 3) has the retention index windows used in DHA for component identification.

Table 3: Retention Index (RI) Windows

RIs	Window%
>100	15.0
>300	2.6
>400	1.5
>500	0.6
>885	0.5
>900	0.6

7.5 The DHA software applies the theoretical response factors to each peak area to provide the corrected peak area.

7.5.1 The theoretical response factors (Table 2) are utilized for correction of the detector response of hydrocarbons determined by this method. The response of a FID to hydrocarbons is determined by the ratio of the molecular weight of the carbon in the analyte to the total molecular weight of the analyte. The response factors, as listed in Table 2, are relative to that calculated for heptane. Calculations are based on the following equation:

$$Fi = [([(C_{aw} \times C_n) + (H_{aw} \times H_n)] / C_n) \times 0.83905]/C_{aw}$$

where:

Fi = relative factor for a hydrocarbon type group of a particular carbon number

C_{aw} = atomic weight of carbon, 12.011

C_n = number of carbon molecules in the group

H_{aw} = atomic weight of hydrogen, 1.008

H_n = number of hydrocarbon molecules in the group
0.83905 is the correction factor with heptane as unity (1.0000)

Table 2: Theoretical FID Relative Response Factors

Carbon Number	Saturated Paraffin	Unsaturated Paraffin	Saturated Naphthenes	Unsaturated Naphthenes	Aromatics
1	1.1207	-	-	-	-
2	1.0503	-	-	-	-
3	1.0268	0.9799	-	-	-
4	1.0151	0.9799	-	-	-
5	1.0080	0.9799	0.9799	0.9517	-
6	1.0034	0.9799	0.9799	0.9564	0.9095
7	1.0000	0.9799	0.9799	0.9598	0.9195
8	0.9975	0.9799	0.9799	0.9623	0.9271
9	0.9955	0.9799	0.9799	0.9642	0.9329
10	0.9940	0.9799	0.9799	0.9658	0.9376

7.6 The corrected peak areas are normalized to 100%.

$$\text{Mass \% component} = \frac{\text{corr. peak area} \times 100}{\text{total corr. peak area}}$$

7.7 The DHA also calculates and reports the data in volume percent.

$$\text{Volume \% component} = \frac{\text{norm factor} \times (\text{mass\%/density comp})}{\text{sum of components/densities}}$$

7.8 Report the concentration of each component as mass percent (% m/m), to the nearest 0.001% or in volume percent equivalent.

8 Quality Control/Assurance

8.1 Multipoint calibration and linearity calculation is not applicable to this method. Theoretical response factors are used to calculate corrected peak areas.

8.2 Set the appropriate integration parameters to obtain the minimum measurement for this analysis to 0.001 mass percent.

8.3 Analyze the background daily to check the analytical system for cross contamination. All hydrocarbons concentration present in the background must be below the LOD before

proceeding with the analysis. To remove any contaminant, increase the column temperature to 250 C and let run until the baseline is back to normal.

8.4 Check if satisfactory separations for the sets of sample components listed in Section 6.1.2 is obtained. Complete separation of these sets is not expected, so the optimum for a particular column may contain some compromises. If necessary, adjustments in the column temperature programming profile maybe made by analyzing the set-up blend standard mixture.

8.5 Analyze a control standard one for every ten samples.

8.6 Maintain a quality control chart for each of the seven hydrocarbon group types, namely: n-paraffins (P), iso-paraffins (I), aromatics (A), naphthenes (N), olefins (O), oxygenates (X) and multi-substituted aromatics (M). The control chart establishes that the method is in "statistical control". At least five out of the seven group types must be in control for the sample results to be considered acceptable. A control sample measurement is "out-of-control" when one measured value exceeds the 3s limit, or when two (2) successive measurements of the same group type exceed the 2s limit. Out-of-control determinations will be caused by either poor component identification or inaccurate integration of the raw data. Integration problems can be instigated by noisy detector signals or erratic baseline. Integration of each chromatogram must be monitored carefully.

8.6.1 Create a control chart for each group type by obtaining at least ten control standard results measured on different days.

8.6.2 Calculate the average standard concentration and standard deviations.

8.6.3 Construct a control chart for each of the group type by plotting the total weight percent (y-axis) versus the date of analysis (x-axis). Draw the lower and upper warning limits at two standard deviations (+ 2s). Draw the lower and upper control limits at three standard deviations (+ 3s).

8.7 A duplicate analysis of one sample is performed for every ten samples.

8.7.1 Maintain a quality control chart of duplicates. A set of components to represent 'critical' criteria are listed below. Select at least three compounds from the list with a high, medium, and low mass % value.

n-pentane	2,3-dimethylheptane
l-methyl-tertiary-butyl-ether	1,2-methylethylbenzene
benzene	naphthalene
toluene	2-methylnaphthalene

8.7.2 Calculate the relative percent difference (RPD) for each of the selected hydrocarbons in each duplicate run.

$$\text{RPD (\%)} = \frac{\text{difference between two measurements x 100}}{\text{average of two measurements}}$$

8.7.3 The requirement for duplicate measurements is:

RPD = 100% for 1-10 times LOD
= 30% for 10-20 times LOD
= 20% for 20-50 times LOD
= 15% for >50 times LOD

The LOD is calculated to be 0.003 mass % (see Section 8.7.4), based on the compound butene-l.

Therefore,

RPD = 100% for 0.003 to 0.03 mass%
= 30% for >0.03 to 0.06 mass%
= 20% for >0.06 to 0.15 mass%
= 15% for >0.15 mass%

8.7.4 The limit of detection (LOD) is determined for the lowest concentration compound in the control standard which is 3-4 times greater than the instrument's minimum measurement reading (see Section 8.2) using the following formula:

$$LOD = ts$$

where:

t = t-value for the number of repeat measurements (8 or more)
s = standard deviation in mass%

The LOD is determined when the instrument is set up or when a new capillary column is installed.

9 Data Management

9.1 Archive the raw data, final report and all file information of each sample and reference/control standard on optical disk/tape for future reference.

9.2 Keep a hard copy of final report for quick reference.

1O References

10.1 Johansen, Neil G., "Procedure for the Detailed Hydrocarbon Analysis of Gasolines by Single Column High Efficiency (Capillary) Column Chromatograhy", 4th edition @ 1994 Neil Johansen, Inc.

10.2 Johansen, Neil G., DHA Detailed Hydrocarbon Analysis software, @ 1993, Neil G. Johansen, Inc.

APPENDIX

Detailed Hydrocarbon Analysis (DHAX)
Southern Laboratory Branch
sample: PONA-Va Reference Standard

Primary Index Reference Data

Component	RT, min.	Win%
C1	6.52	0.90
C2	6.76	0.55
C3	7.3	0.60
n-C4	9.28	0.65
n-C5	14.61	0.60
n-C6	22.26	0.45
n-C7	32.75	0.40
n-C8	52.3	0.45
n-C9	84.05	0.36
n-C10	103.56	0.16
n-C11	117.87	0.13
n-C12	129.76	0.09
n-C13	140.25	0.10
n-C14	149.69	0.09

Secondary Index Reference Data

Component/RI Ref	Rtime	Win%	RRT
n-C4/C3	9.28	1.00	0.7871
n-C5/n-C4	14.61	0.80	0.6348
1,2-dimethbenz/n-C9	77.6	0.35	1.0800
1,2,4-rimethbenz/n-C10	99.98	0.27	1.0352
1,2,3,5-tetramethbenz/n-C11	118.86	0.16	0.9917
Naphthalene/n-C12	125.8	0.15	1.0312
2-methylnaphthalene/n-C13	138.29	0.12	1.0135

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, °C
methane	00074-82-8	P1	100	1.121	16.043	0.2600	-161.50
ethylene		O2	178.1	1.050	28.054	0.3000	-103.68
ethane	00074-84-0	P2	200	1.051	30.070	0.3399	-88.60
propylene	00115-07-1	O3	283	1.030	42.081	0.5053	-47.72
propane	00074-98-6	P3	300	1.027	44.097	0.5005	-42.04
i-butane	00075-28-5	I4	366	1.015	58.124	0.5572	-11.72
methanol	00067-56-1	X1	380	2.970	32.040	0.7914	64.96
butene-1	00106-98-9	O4	389.2	0.980	56.108	0.5951	-6.25
isobtylene	00563-46-2	O4	392	0.980	56.108	0.5951	-6.25
1,3-butadiene	00106-99-0	O4	393	0.980	54.092	0.6211	-4.41
n-butane	00106-97-8	P4	400	1.015	58.124	0.5788	-0.50
vinyl acetylene	00689-97-4	O4	407.15	1.100	54.090	0.6500	0.00
t-butene-2	00624-64-6	O4	412.3	0.980	56.108	0.6042	0.88
2,2-dimethylpropane	00463-82-1	I5	415.3	1.008	72.151	0.5910	9.50
c-butene-2	00590-18-1	O4	428.2	0.980	56.108	0.6213	3.72
1,2-butadiene	00590-19-2	O4	450	0.945	54.092	0.6520	10.85
ethanol	00064-17-5	X2	456.5	2.050	46.070	0.7890	78.50
3-methylbutene-1	00563-45-1	O5	461.2	0.980	70.135	0.6272	20.05
O1		O5	468.9	0.980	70.135	0.6300	0.00
O2		O5	474	0.980	70.135	0.6300	0.00
i-pentane	00078-78-4	I5	477.5	1.008	72.151	0.6196	27.84
*acetone	00067-64-1	X3	477.55	1.850	58.080	0.7899	56.20
1,4-petadiene	00591-93-5	O5	480.5	0.952	68.119	0.6607	25.96
butyne-2	00503-17-3	O4	488	0.945	54.092	0.6910	26.98
pentene-1	00109-67-1	O5	491	0.980	70.135	0.6405	29.96
i-propanol	00067-63-0	X3	494	1.400	60.110	0.8000	26.00
2-methylbutene-1	00563-46-2	O5	496.8	0.980	70.135	0.6504	31.15
n-pentane	00109-66-0	P5	500	1.008	72.151	0.6262	36.06
isoprene	00078-79-5	O5	506	0.952	68.119	0.6809	34.06
t-pentene-2	00646-04-8	O5	510.8	0.980	70.135	0.6482	36.34
3,3-dimethylbutene-1	00558-37-2	O5	517	1.050	70.135	0.6500	41.24
c-pentene-2	00627-20-3	O5	519.6	0.980	70.135	0.6556	36.93
t-butanol	00075-65-0	X4	523.5	1.283	74.120	0.7887	82.20
2-methylbutene-2	00513-35-9	O5	525	0.980	70.135	0.6623	38.56
1t,3-pentadiene	02004-70-8	O5	528	0.952	68.119	0.6760	42.02
3-methylbutadiene-1,2	00598-25-4	O5	535.5	0.952	68.120	0.6500	0.00
cyclopentadiene	00542-92-7	O5	538.1	0.938	67.100	0.6500	0.00
2,2-dimethylbutane	00075-83-2	I6	540.25	1.004	86.178	0.6491	49.73
1c,3-pentadiene	01574-41-0	O5	541.2	0.952	68.119	0.6910	44.06
O5		O5	547.5	1.020	70.135	0.6500	0.00
O6		O5	549	1.020	70.135	0.6500	0.00
cyclopentene	00142-29-0	O5	557	0.952	68.119	0.7720	44.23
n-propanol	00071-23-8	X3	561	1.400	60.110	0.8035	97.40
4-methylpentene-1	00691-37-2	O6	561.7	0.980	84.162	0.6673	53.86
3-methylpentene-1	00760-20-3	O6	562.7	0.980	84.162	0.6637	54.17
cyclopentane	00287-92-3	N5	566.5	0.980	70.135	0.7454	49.25
2,3-dimethylbutane	00079-29-8	I6	569	1.004	86.178	0.6616	57.98
methyl-t-butylether	01634-04-4	X5	570.12	1.439	88.150	0.7405	55.20

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, ^{o}C
4-methyl-c-pentene-2	00691-38-3	O6	571.2	0.980	84.162	0.6741	56.38
2,3-dimethylbutene-1	00563-78-0	O6	572.5	0.980	84.162	0.6830	55.61
2-methylpentane	00107-83-5	I6	573.5	1.004	86.178	0.6531	60.26
4-methyl-t-pentene-2	00674-76-0	O6	575.5	0.980	84.162	0.6736	58.60
O8		O6	576.5	0.980	84.162	0.6736	0.00
2-methyl-1,4-pentadiene	00763-30-4	O6	578	0.980	82.146	0.6940	56.00
1,5-hexadiene	00592-42-7	O6	581.6	0.980	82.146	0.6923	59.45
3-methylpentane	00096-14-0	I6	585.5	1.004	86.178	0.6643	63.27
2-methylpentene-1	00763-29-1	O6	590.2	0.980	84.162	0.6848	62.10
hexene-1	00592-41-6	O6	591.2	0.980	84.162	0.6780	63.47
O11		O6	592	0.980	84.162	0.6780	0.00
i-butanol		X4	594.6	1.283	74.120	0.8030	
1c/t,4-hexadiene	00592-45-0	O6	597.2	0.980	84.146	0.7000	65.00
2-ethylbutene-1	00760-21-4	O6	598.8	0.980	84.162	0.6944	64.67
n-hexane	00110-54-3	P6	600	1.004	86.178	0.6594	68.73
diisopropylether		X6	602	1.100	102.180	0.7241	68.00
t-hexene-3	13269-52-8	O6	603	0.980	84.162	0.6821	67.08
c-hexene-3	07642-09-3	O6	603.75	0.980	84.162	0.6847	66.44
t-hexene-2	04050-45-7	O6	605.5	0.980	84.162	0.6827	67.88
2-hethylpentene-2	00625-27-4	O6	608	0.980	84.162	0.6912	67.30
3-methyl-c-pentene-2	00992-62-3	O6	610.54	0.980	84.162	0.6980	67.69
3-methylcyclopentene	01120-62-3	O6	611.4	0.980	82.146	0.7622	64.90
O13		O6	613	0.980	84.162	0.6920	0.00
c-hexene-2	07688-21-3	O6	614.75	0.980	84.162	0.6920	68.88
O14		O6	616.9	0.980	84.162	0.6920	0.00
ethyl-t-butylether	00637-92-3	X6	620	1.379	102.180	0.7519	73.10
3,3-dimethylpentene-1	n/a	O7	621	0.980	98.189	0.7019	77.47
3-methyl-t-pentene-2	00616-12-6	O6	622.2	0.980	84.162	0.7023	70.43
2-butanol		X4	622.4	0.980	74.120	0.8080	99.50
4,4-dimethyl-t-pentene-2	n/a	O7	623.1	0.980	98.189	0.6936	76.73
2,2-dimethylpentane	00590-35-2	I7	624.25	1.000	100.205	0.6738	79.19
methylcyclopentane	00096-37-7	N6	625.6	0.980	84.162	0.7486	71.80
cyclic diolefin or triolefin		O7	627	0.957	82.140	0.7092	0.00
2,4-dimethylpentane	00108-08-7	I7	630.6	1.000	100.205	0.6727	80.49
2,3,3-trimethy-1-butene	00594-56-9	O7	631.65	0.980	98.189	0.7092	77.89
cyclic diolefin or triolefin		O7	632.9	0.957	82.140	0.7092	0.00
2,3,3-trimethy-1-butene	00464-06-2	I7	634.81	1.000	100.205	0.6901	80.88
cyclic diolefin or triolefin		O7	638.25	0.957	82.140	0.7092	0.00
O17		O7	641.9	0.980	84.160	0.7039	0.00
4,4-dimethyl-c-pentene-2	07385-78-6	O7	642.8	0.980	98.189	0.7022	80.79
2,4-dimethylpentene-1	n/a	O7	646.6	0.980	98.189	0.7039	80.42
diolefin		O6	647.52	0.957	82.140	0.6988	0.00
1-methylcyclopentene	00693-89-0	O6	648.6	0.957	82.146	0.7795	75.48
benzene	00071-43-2	A6	649.7	0.910	78.114	0.8789	80.09
3-ethylpentene-1	04038-04-4	O7	650	0.980	98.189	0.7005	84.11
*n-butanol	00071-36-3	X4	650.05	1.295	74.120	0.8000	117.25
3-methylhexene-1	03404-61-3	O7	651	0.980	98.189	0.6959	83.90
2-methyl-c-hexene-3	n/a	O7	652.6	0.980	98.189	0.6980	86.00
3,3-dimethylpentane	00562-49-2	I7	654.25	1.000	100.205	0.6932	86.06
5-methylhexene-1	03524-73-0	O7	655.5	0.980	98.189	0.6965	85.31

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, ^{o}C
cyclohexane	00110-82-7	N6	657.8	0.980	84.162	0.7785	80.72
2-methyl-t-hexene-3	n/a	O7	661	0.980	98.189	0.6941	85.90
diolefin (hexadiene)		O6	661.6	0.980	98.189	0.6941	70.00
2-ethyl-3-methylbutene-1	n/a	O7	662.7	0.980	98.189	0.7135	86.36
4-methylhexene-1	03769-23-1	O7	663.7	0.980	98.189	0.7030	86.73
4-methyl-t/c-hexene-2	03683-22-5	O7	666.2	0.980	98.189	0.7040	86.31
2-methylhexane	00591-76-4	I7	667.6	1.000	100.205	0.6786	90.05
2,3-dimethylpentane	00565-59-3	I7	668.8	1.000	100.205	0.6951	89.78
5-methyl-t-hexene-2	00994-05-8	O7	670	0.980	98.189	0.6971	88.11
1,1-dimethylcyclopentane	n/a	N7	671.1	0.980	98.189	0.7545	87.48
t-amylmethylether	00995-05-8	X6	672.5	1.338	102.180	0.7517	91.00
cyclohexene	00110-83-8	O6	673.6	0.980	82.146	0.8110	82.97
3-methylhexane	00589-34-4	I7	675.8	1.000	100.205	0.6871	91.85
1,6-heptadiene	03070-53-9	O7	677.4	0.980	98.190	0.7500	96.17
3,4-dimethyl-c-pentene-2	n/a	O7	679.4	0.980	98.189	0.7180	89.25
5-methyl-c-hexene-2	03404-62-4	O7	680	0.980	98.189	0.7060	89.50
1c,3-dimethylcyclopentane	02532-58-3	N7	681.5	0.980	98.189	0.7448	90.77
1t,3-dimethylcyclopentane	00822-50-4	N7	684.3	0.980	98.189	0.7488	91.72
3-ethylpentane	00617-78-7	I7	685.9	1.000	100.205	0.6981	93.47
1t,2-dimethylcyclopentane	00822-50-4	N7	687	0.980	98.189	0.7514	91.87
2,2,4-trimethylpentane	00540-84-1	I8	688.44	0.998	114.232	0.6919	99.24
heptene-1	00592-76-7	O7	688.5	0.980	98.189	0.6970	93.64
2-ethylpentene-1	n/a	O7	689.6	0.980	98.189	0.6970	93.64
1,5-heptadiene	n/a	O7	691.6	0.980	93.168	0.7500	96.17
O25		O7	693	0.980	98.189	0.6900	0.00
3-methyl-c-hexene-3	n/a	O7	694.8	0.980	98.189	0.7181	95.40
t-heptene-3	14686-14-7	O7	698.4	0.980	98.189	0.7026	95.67
n-heptane	00142-82-5	P7	700	1.000	100.205	0.6837	98.42
c-heptene-3	07642-10-6	O7	700.9	0.980	98.189	0.7028	95.75
2-methyl-2-hexene	02738-19-4	O7	701.35	0.980	98.189	0.7126	95.41
3-methyl-c-hexene-2	n/a	O7	702.5	0.980	98.189	0.7126	95.41
3-methyl-t-hexene-3	03899-36-3	O7	703.2	0.980	98.189	0.6941	93.54
t-heptene-2	14686-13-6	O7	704.6	0.980	98.189	0.7057	97.95
3-ethylpentene-2	00816-79-5	O7	706	0.980	98.189	0.7249	96.01
c-heptene-2	06443-92-1	O7	708.8	0.980	98.189	0.7116	98.41
3-methyl-t-hexene-2	n/a	O7	709.5	0.980	98.189	0.7188	95.18
O28		O7	710.53	0.980	98.189	0.7188	0.00
2,3-dimethylpentene-2	10574-37-5	O7	712	0.980	98.189	0.7322	97.40
3-ethylcyclopentene	n/a	O7	713	0.980	96.173	0.7830	97.77
O29		O7	715.5	0.980	98.189	0.7190	0.00
1c,2-dimethylcyclopentane	n/a	N7	716.7	0.980	98.189	0.7322	99.53
methylcyclohexane	00108-87-2	N7	717.7	0.980	98.189	0.7694	100.93
O30		O7	719	0.980	98.189	0.7322	0.00
2,2-dimethylhexane	00590-73-8	I8	720.4	0.998	114.232	0.6953	106.84
*1,1,3-trimethylcyclopentane	n/a	N8	720.42	0.980	112.216	0.7482	104.89
O32		O7	721	0.980	98.189	0.7322	0.00
O33		O7	722	0.980	112.216	0.7322	0.00
O34		O7	723	0.980	112.216	0.7322	0.00
O35		O7	724.3	0.980	98.189	0.7322	0.00
O36		O7	726.2	0.980	98.189	0.7322	0.00

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, ^{o}C
ethylcyclopentane	01640-89-7	N7	728.7	0.980	98.189	0.7664	103.47
2,5-dimethylhexane	00592-13-2	I8	730	0.998	114.232	0.6935	109.11
2,2,3-trimethylpentane	n/a	I8	730.8	0.998	114.232	0.7160	109.85
2,4-dimethylhexane	00589-43-5	I8	731.8	0.998	114.232	0.7003	109.43
O37		O7	735	0.980	98.189	0.7322	0.00
1c-2t,4-trimethylcyclopentane	n/a	N8	737	0.980	112.216	0.7634	116.74
3,3-dimethylhexane	00563-16-6	I8	738.3	0.998	114.232	0.7100	111.97
O38		O7	740.3	0.980	98.189	0.7322	0.00
1t,2c,3-trimethylcyclopentane	n/a	N8	744	0.980	112.216	0.7704	110.41
O39		O7	745	0.980	98.189	0.7322	0.00
2,3,4-trimethylpentane	00565-75-3	I8	746.7	0.998	114.232	0.7190	113.47
I1		I8	747.8	0.998	114.232	0.7190	113.47
O40		O7	749.2	0.980	98.189	0.7322	0.00
2,3,3-triimethylpentane	00560-21-4	I8	720.6	0.998	114.232	0.7262	114.77
toluene	00108-88-3	A7	752	0.920	92.143	0.8670	110.63
O41		O8	752.3	0.980	112.220	0.7322	0.00
O42		O8	753.6	0.980	112.220	0.7322	0.00
O43		O8	755.5	0.980	112.220	0.7322	0.00
2,3-dimethylhexane	00584-94-1	I8	757.9	0.998	114.232	0.7121	115.61
2-methyl-3-ethylpentane	n/a	I8	759	0.980	114.232	0.7121	115.61
1,1,2-trimethylcyclopentane	n/a	N8	760.3	0.980	112.216	0.7725	113.73
O44		O8	761.6	0.980	112.220	0.7322	0.00
O45		O8	762.85	0.980	112.220	0.7322	0.00
O46		O7	763.1	0.980	112.220	0.7322	0.00
2-methylheptane	00592-27-8	I8	764.1	0.998	114.232	0.6979	117.65
*2-ethylhexene-1	01632-16-2	O8	764.12	0.980	112.220	0.7650	124.00
4-methylheptane	00589-53-7	I8	765.6	0.998	114.232	0.7046	117.71
3-methyl-3-ethylpentane	n/a	I8	766.5	0.980	114.232	0.7121	115.61
3,4-dimethylhexane	n/a	I8	767.2	0.998	114.232	0.7192	117.73
1c,2c,4-trimethcyclopentane	n/a	N8	738.75	0.980	112.216	0.7620	116.73
1c,3-dimethylcyclohexane	00638-04-0	N8	769.8	0.980	112.216	0.7625	119.36
3-methylheptane	00589-81-1	I8	771.7	0.998	114.232	0.7058	118.93
1c,2y,3-trimethylcyclopentane	15890-40-1	N8	772.7	0.980	112.216	0.7704	117.50
3-ethylhexane	00619-99-8	I8	773.4	0.998	114.232	0.7136	118.54
1t,4-dimethylcyclohexane	02207-04-7	N8	774.5	0.980	112.216	0.7625	119.36
1,3-octadiene	n/a	O8	777.1	0.980	110.200	0.7650	124.00
O48		O8	778.5	0.980	112.220	0.7322	0.00
1,1-dimethylcyclohexane	00590-66-9	N8	780.3	0.980	112.216	0.7809	119.55
2,2,5-trimethylhexane	03522-94-9	I9	782.9	0.996	128.259	0.7072	125.09
3c-ethylmethylcyclopentane	n/a	N8	784.25	0.980	112.216	0.7670	121.10
2,6-dimethylheptene-1	n/a	O9	785.2	0.980	126.240	0.7196	0.00
3t-ethylmethylcyclopentane	n/a	N8	786.5	0.980	112.216	0.7670	121.10
2t-ethylmethylcyclopentane	02613-65-2	N8	787.7	0.980	112.216	0.7690	121.20
*octene-1	00111-66-0	O8	787.72	0.980	112.220	0.7650	124.50
1,1-methylethylcyclopentane	n/a	N8	788.8	0.980	112.216	0.7809	121.53
2,2,4-trimethylhexane	16747-26-5	I9	790.8	0.996	128.259	0.7392	0.00
1t,2-dimethylcyclohexane	n/a	N8	792.7	0.980	112.216	0.7760	123.43
t-octene-4	14850-23-8	O8	794.25	0.980	112.216	0.7185	122.26
3,5,5-trimethylhexane-1	n/a	O8	795	0.980	126.240	0.7196	0.00
t-octene-3	14919-01-8	O8	796.35	0.980	112.216	0.7196	123.30

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, °C
1c,2c,3-trimethylcyclopentan	n/a	N8	797.2	0.980	112.216	0.7792	123.00
1t,3-dimethylcyclohexane	02207-03-6	N8	798.7	0.980	112.216	0.7760	123.43
n-octane	00111-65-9	P8	800	0.998	114.232	0.7025	125.68
1c,4-dimethylcyclohexane	00624-29-3	N8	801.2	0.980	112.216	0.7828	124.33
3,3-dimethylheptene-1	n/a	O9	802.5	0.980	126.240	0.7196	0
octene-2	13389-42-9	O8	804.4	0.980	112.216	0.1796	0
O50		O8	805.7	0.980	112.216	0.1796	0
I2		I9	806.5	0.996	128.259	0.7300	0
I-propylcyclopentane	n/a	N8	808.2	0.980	112.216	0.7765	126.43
2,4,4-trimethylhexane	n/a	I9	809	0.996	128.259	0.7392	0
O52		O9	810.8	0.980	126.240	0.7196	0
O53		O8	813.8	0.980	126.240	0.7196	0
N1		N8	815.2	0.980	112.216	0.7800	0
2,2,3,4-tetramethylpentane	n/a	I9	816.6	0.996	128.259	0.7389	133.03
2,3,4-trimethylhexane	n/a	I9	818.4	0.996	128.259	0.7392	139.06
N2		N8	820.1	0.980	112.216	0.7800	0
N3		N8	822.55	0.980	112.216	0.7800	0
2,3,3-trimethylhexaane-1	n/a	O9	825	0.980	126.240	0.6826	0
1c,2-dimethylcyclohexane	02207-01-4	N8	826.6	0.980	112.216	0.7962	129.74
2,3,5-trimethylhexane	01069-53-0	I9	827.7	0.996	128.259	0.7219	131.35
2,2-dimethylheptane	n/a	I9	829.9	0.996	128.259	0.7105	132.70
1,1,4-trimethylcyclohexane	n/a	N9	833	0.980	126.243	0.7722	135.00
N4		N8	834.2	0.980	112.216	0.7800	0
2,2,3-trimethylhexane	n/a	I9	835.5	0.996	128.259	0.7153	132.90
2,4-dimethylheptane	02213-23-2	I9	837	0.996	128.259	0.7153	132.90
4,4-dimethylheptane	01069-19-5	I9	839	0.996	128.259	0.7153	132.90
ethylcycloheptane	01678-91-7	N8	840	0.980	112.216	0.7839	131.79
n-propylcyclopentane	02040-96-2	N8	841.73	0.980	112.216	0.7763	130.96
*1c,3c,5-trimethcyclohexane	n/a	N9	841.75	0.996	126.243	0.7697	138.43
2,5-dimethylheptane	n/a	I9	843.3	0.996	128.259	0.7167	136.00
3,3-dimethylheptane	n/a	I9	844.6	0.996	128.259	0.7256	137.02
3,5-dimethylheptane	00926-82-9	I9	845.6	0.996	128.259	0.7225	136.00
2,6-dimethylheptane	01072-05-5	I9	847	0.996	128.259	0.7089	135.22
1,1,3-trimethylcyclohexane	n/a	N9	849	0.980	126.243	0.7870	146.59
2,4-dimethylheptene-1	n/a	O9	850	0.980	126.240	0.6826	0
N7		N8	852	0.980	112.216	0.7800	0
N8		N8	853.5	0.980	112.216	0.7800	0
N10		N9	854.2	0.980	126.240	0.7800	0
ethylbenzene	00100-41-4	A8	855.6	0.927	106.168	0.8670	136.20
N11		N9	856	0.980	126.240	0.7800	0
1c,2t,4t-trimethylcyclohexane	n/a	N9	857.5	0.980	126.243	0.7800	0
I3		I9	859	0.996	128.259	0.7300	0
2-methyloctene-1	n/a	O9	860	0.980	126.240	0.6826	0
I4		I9	861.5	0.996	128.259	0.7300	0
2-methyloctine-2	n/a	O9	863	0.980	126.240	0.6826	0
N12		N9	863.8	0.980	126.243	0.7800	0
N13		N9	863.85	0.980	126.243	0.7800	0
1,3-dimethylbenzene	00108-38-3	A8	865.05	0.927	106.168	0.8642	139.12

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, °C
1,4-dimethylbenzene	00106-42-3	A8	866	0.927	106.168	0.8610	138.36
2,3-dimethylbenzene	03074-71-3	I9	867	0.996	128.259	0.7260	140.50
3,4-dimethylbenzene	n/a	I9	868.4	0.996	128.259	0.7314	140.60
3,4-dimethylbenzene		I9	869.2	0.996	128.259	0.7314	140.60
N14		N9	870.3	0.980	126.243	0.7800	0
I5		I9	871.6	0.996	128.259	0.7300	0
4-ethylheptane	n/a	I9	873.3	0.996	128.259	0.7202	142.44
4-methyloctane	02216-34-4	I9	874.4	0.996	128.259	0.7202	142.44
2-methyloctane	03221-61-2	I9	875.4	0.996	128.259	0.7134	143.28
N15		N9	876.5	0.980	126.243	0.7800	0
1c,2t,3-trimethylcyclohexane	n/a	N9	878.35	0.980	126.243	0.7580	151.20
3-ethylheptane	02216-33-3	I9	879.7	0.996	128.259	0.7265	143.00
3-methyloctane		I9	880.6	0.996	128.259	0.7205	144.23
*3,3-diethylpentane		I9	880.62	0.996	128.259	0.7536	146.19
1c,2t,4c-trimethylcyclohexane	n/a	N9	882.8	0.980	126.243	0.7722	135.00
1,1,2-trimethylcyclohexane	n/a	N9	882.8	0.980	126.243	0.8000	145.20
1,2-dimethylbenzene	00095-47-6	A8	883.8	0.927	106.168	0.8802	144.43
I6		I9	885.65	0.996	128.259	0.7300	0
I7		I9	886.65	0.996	128.259	0.7300	0
N18		N9	887.72	0.980	126.243	0.7800	0
N19		N9	888.3	0.980	126.243	0.7800	0
nonene-1	00124-11-8	O9	889.2	0.980	126.240	0.7684	134.50
I8		I9	890.3	0.996	128.259	0.7300	0
N20		N9	890.35	0.980	126.243	0.7800	0
I9		I9	891.2	0.996	128.259	0.7300	0
i-butylcyclopentane	n/a	N9	892	0.980	126.243	0.7809	147.97
N21		N9	893	0.980	126.243	0.7800	0
t-7-methyloctene-3	n/a	O9	895.02	0.980	126.241	0.6826	0
N22		N9	896.05	0.980	126.243	0.7800	0
N23/c-nonene-2		N9	897.5	0.980	126.243	0.7800	0
t-nonene-3	10063-92-7	O9	897.9	0.980	126.241	0.6826	0
I10		I9	899.15	0.996	128.259	0.7300	0
n-nonene	0111-84-2	P9	900.2	0.996	128.259	0.7176	150.82
1,1-methylethylcyclohexane	n/a	N9	901.5	0.980	126.243	0.8062	152.18
3,7-dimethyloctene-1	04984-01-4	O10	902.9	0.980	140.270	0.7013	0
N25		N9	905.5	0.980	126.243	0.7900	0
t-2,2,5,5-tetramethylhexene-3	n/a	O10	906.7	0.980	140.270	0.7013	0
I-propylbenzene	00098-82-8	A9	912.2	0.933	120.195	0.8618	152.41
N26		N9	913.43	0.980	126.243	0.7900	0
N27		N9	914.55	0.980	126.243	0.7900	0
c-nonene-3	n/a	O9	915	0.980	126.240	0.6826	0
I11		I10	916.1	0.994	142.286	0.7300	0
i-propylcyclohexane	00696-29-7	N9	917.3	0.980	126.243	0.8022	154.79
I12		I10	921.2	0.994	142.286	0.7300	0
2,2-dimethyloctane	15869-87-1	I10	922.8	0.994	142.286	0.7245	156.90
2,4-dimethyloctane	04032-94-4	I10	924.4	0.994	142.286	0.7264	155.90
N28		N9	926.2	0.980	126.243	0.7900	0
N29		N9	927.7	0.980	126.243	0.7900	0
2,6-dimethyloctane	02051-30-1	I10	930.75	0.994	142.286	0.7276	160.41
2,5-dimethyloctane	15869-89-3	I10	932.6	0.994	142.286	0.7302	158.50

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, °C
n-butylcyclopentane	n/a	N9	935.85	0.980	126.243	0.7846	156.62
I13		I10	937.05	0.994	142.286	0.7300	0
N30		N10	938.1	0.980	140.270	0.8000	0
I14		I10	940.3	0.994	142.286	0.7300	0
3,3-dimethyloctane	n/a	I10	942.2	0.994	142.286	0.7390	161.20
N31		N10	943.4	0.980	140.270	0.8000	0
n-propylbenzene	00103-65-1	A9	946.15	0.933	120.195	0.8620	159.24
3,6-dimethyloctane	n/a	I10	948.3	0.994	142.286	0.7363	160.80
3-methyl-5-ethylheptane	n/a	I10	949.3	0.994	142.286	0.7264	158.20
N32		N10	951.25	0.980	140.270	0.8000	0
1,3-methylethylbenzene	00620-14-4	A9	954.3	0.933	120.195	0.8645	161.33
1,4-methyethylbenzene	00622-96-8	A9	956.1	0.933	120.195	0.8612	162.01
N33		N10	958.2	0.980	140.270	0.8000	0
1,3,5-trimethylbenzene	00108-67-8	A9	961.8	0.933	120.195	0.8652	164.74
2,3-dimethyloctane	n/a	I10	961.9	0.994	142.286	0.7379	164.34
I15		I10	963.6	0.994	142.286	0.7400	0
N34		N10	964.7	0.980	140.270	0.8000	0
I16		I10	966.6	0.994	142.286	0.7400	0
5-methylnonane	n/a	I10	967.8	0.994	142.286	0.7326	165.10
I17		I10	969.4	0.994	142.286	0.7400	0
1,2-methylethylbenzene	00611-14-3	A9	970.2	0.933	120.195	0.8807	165.18
2-methylnonane	00871-83-0	I10	971.7	0.994	142.286	0.7264	167.03
3-ethyloctane	n/a	I10	974.5	0.994	142.286	0.7399	166.50
N35		N10	976.2	0.980	140.270	0.8000	0
3-methylnanane	05911-04-6	I10	977.2	0.994	142.286	0.7334	167.80
N36		N10	979	0.980	140.270	0.8000	0
3-ethyl-2-methylheptene-2	n/a	O10	979.1	0.980	140.270	0.7013	0
I18		I10	980.15	0.994	142.286	0.7400	0
I19		I10	981.4	0.994	142.286	0.7400	0
1,2,4-trimethylbenzene	00095-63-6	A9	983.2	0.933	120.195	0.8758	169.38
*t-butylbenzene	n/a	A10	983.22	0.933	120.200	0.8665	169.15
I20		I10	984.1	0.994	142.286	0.7400	0
I-butylcyclohexane	n/a	N10	986.45	0.980	140.270	0.7960	171.30
I21		I10	987.1	0.994	142.286	0.7400	0
I22		I10	988.2	0.994	142.286	0.7400	0
I23		I10	989.3	0.994	142.286	0.7400	0
N37		N10	990.55	0.980	140.270	0.8000	0
1-decene	00872-05-9	O10	992.5	0.990	140.270	0.7408	170.60
t-1-met-2-n-propcyclohexane	n/a	N10	993.4	0.980	140.270	0.8000	171.00
2,3-dimethylotane-2	n/a	O10	993.42	0.990	140.270	0.7400	0
I24		I10	994.5	0.994	142.286	0.7400	0
i-butybenzene	00538-93-2	A10	995.7	0.938	134.222	0.8532	172.79
I25		I10	996.7	0.994	142.286	0.7400	0
sec-butylbenzene	00135-98-8	A10	997.9	0.938	134.222	0.8620	173.34
n-decane	00124-18-5	P10	1000.2	0.994	142.286	0.7300	174.15
I26		I11	1001.75	0.993	156.313	0.7400	0
N38		N10	1003.65	0.980	140.260	0.8000	0
1,2,3-trimrthylbenzene	00576-73-8	A9	1006.85	0.933	120.195	0.8944	176.12
1,2-methyl-i-propylbenzene	00535-77-3	A10	1009.85	0.938	134.222	0.8610	175.08
N39		N11	1011.1	0.980	154.290	0.8000	0

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, ^{o}C
1,4-methyl-i-propylbenzene	00099-87-6	A10	1013.35	0.938	134.222	0.8573	177.13
I27		I11	1014.25	0.993	156.313	0.7400	0
I28		I11	1015.95	0.993	156.313	0.7400	0
I29		I11	1017.25	0.993	156.313	0.7400	0
2-3-dihydroindene	00496-11-7	A10	1019.45	0.918	118.179	0.9640	177.85
sec-butycyclohexane	n/a	N10	1023.35	0.980	140.270	0.8140	179.34
I30		I11	1026.45	0.993	156.313	0.7400	0
1,2-methyl-isopropylbenzene	00527-84-4	A10	1027.85	0.938	134.222	0.8766	178.18
3-ethylnonane	n/a	I11	1029.4	0.993	156.313	0.7440	0
N40		N11	1032.5	0.980	154.290	0.8000	0
I31		I11	1033.6	0.993	156.313	0.7400	0
I32		I11	1036.95	0.993	154.290	0.8000	0
1,3-diethylbenzene	00141-93-5	A10	1039.9	0.938	134.222	0.8639	181.14
1,3-methyl-n-propylbenzene	01074-43-7	A10	1042.5	0.938	134.222	0.8609	182.01
I33		I11	1044.4	0.993	156.313	0.7400	0
1,4-diethylbenzene	00105-05-5	A10	1045.25	0.938	134.222	0.8620	183.79
1,4-methyl-n-propylbenzene	01074-55-1	A10	1046.4	0.938	134.222	0.8584	183.42
n-butylbenzene	00104-51-8	A10	1047.4	0.938	134.222	0.8610	183.3
1,3-dimethyl-5-ethylbenzene	00934-74-7	A10	1049.75	0.938	134.222	0.8800	183.62
1,2-diethylbenzene	00135-01-3	A10	1051.7	0.938	134.222	0.8799	183.46
I34		I11	1051.9	0.993	156.313	0.7400	0
t-decahydronaphthalene	00493-02-7	N10	1052.85	0.980	154.290	0.8000	187.2
N41		N11	1054.6	0.980	154.290	0.8000	0
1,2-methyl-n-propylbenzene	01074-17-5	A10	1057.85	0.938	134.222	0.8736	184.97
I35		I11	1058.85	0.993	156.313	0.7400	0
I36		I11	1061.2	0.993	156.313	0.7400	0
I37		I11	1062.65	0.993	156.313	0.7400	0
I38		I11	1065.6	0.993	156.313	0.7400	0
1,4,dimethyl-2-ethylbenzene	01758-88-9	A10	1068	0.938	134.222	0.8722	186.87
A3		A10	1068.4	0.938	134.222	0.8594	0
1,3-dimethyl-4-ethylbenzene	00874-41-9	A10	1069.6	0.938	134.222	0.8594	188.24
I39		I11	1070.7	0.993	156.313	0.7400	0
I40		I11	1074.35	0.993	156.313	0.7400	0
1,2-dimethyl-4-ethylbenzene	00934-80-5	A10	1075.25	0.938	134.222	0.8745	189.52
I41		I11	1079.55	0.993	156.313	0.7400	0
1,3-dimethyl-2-ethylbenzene	02870-04-4	A10	1080.75	0.938	134.222	0.8904	190.05
I42		I11	1081.7	0.993	156.313	0.7400	0
I43		I11	1084.25	0.993	156.313	0.7400	0
undecene-1		O11	1090.5	0.980	154.300	0.7503	192.7
1,4-methyl-t-butylbenzene	00098-51-1	A11	1091.95	0.942	148.240	0.8500	0
1,2-dimethyl-3-ethylbenzene	00933-98-2	A10	1093.15	0.938	134.222	0.8921	193.95
1,2-ethyl-i-propylbenzene	n/a	A11	1097.25	0.942	148.240	0.8900	0
n-undecane	01120-21-4	P11	1100	0.993	156.313	0.7440	195.9
1,4-ethyl-i-propylbenzene	n/a	A11	1102.45	0.942	148.240	0.8900	0
1,2,4,5-tetramethylbenzene	00095-93-2	A10	1104.85	0.938	134.222	0.8875	196.84
1,2-methyl-n-butylbenzene	03968-85-2	A11	1107.3	0.942	148.240	0.8900	199
1,2,3,5-tetramethylbenzene	00527-53-7	A10	1108.8	0.938	134.222	0.8903	198.04
1,2-methyl-t-butylbenzene	27138-21-2	A11	1122.8	0.942	148.240	0.8900	0

Component	CAS#	Group Type	Reference Index(RI)	Response Factor(RF)	Molecular Weight	Specific Gravity	BP, ^{o}C
5-methylindan	n/a	A10	1127.35	0.938	132.200	0.8900	0
I43		I12	1131.1	0.992	170.340	0.7530	216.3
4-methylindan	n/a	A10	1133.65	0.938	132.200	0.8900	0
1,2-ethyl-n-propylbenzene	n/a	A11	1136.45	0.942	148.240	0.8900	0
2-methylindan	n/a	A10	1138.15	0.938	132.200	0.9034	187
1,3-methyl-n-butylbenzene	n/a	A11	1140.6	0.942	148.240	0.8900	199
1,3-di-i-propylbenzene	00099-62-7	A12	1142.75	0.945	162.272	0.8900	203.2
s-pentylbenzene	n/a	A11	1144.25	0.942	148.240	0.8900	205
n-pentylbenzene	00538-68-1	A11	1148.7	0.942	148.240	0.8900	205.4
1t-M-2-(4-MP)cyclopetane	n/a	N12	1151.8	0.980	168.320	0.8000	0
1,2,-di-i-propylbenzene	00577-55-9	A12	1153.05	0.945	162.272	0.8900	204
1,4,-di-i-propylbenzene	00100-18-5	A12	1159.5	0.945	162.272	0.8900	210.3
tetrahydronaphthalene	00119-64-2	A10	1163.35	0.924	132.206	0.9695	207.62
naphthalene	00091-20-3	A10	1168	0.896	128.174	1.0253	217.99
1-t-butyl-3,5-dimethylbenzene	00098-19-1	A12	1169.6	0.945	162.272	0.8900	0
1,4-ethyl-t-butylbenzene	00637-92-3	A12	1173.6	0.945	162.272	0.8900	0
I45		I12	1177.85	0.942	170.300	0.7530	216.3
I46		I12	1179.45	0.942	170.300	0.7530	216.3
I47		I12	1183.35	0.942	170.300	0.7530	216.3
I48		I12	1187.1	0.942	170.300	0.7530	216.3
1,3-di-n-propylbenzene	n/a	A12	1188.6	0.945	162.272	0.8900	0
A5		A12	1190.2	0.945	162.272	0.8900	0
dodecene-1		O12	1192.2	0.980	168.330	0.7584	213.4
A6		A12	1198.45	0.945	162.272	0.8900	0
n-dodecene	00112-40-3	P12	1200	0.992	170.340	0.7530	216.3
1,3,5-triethylbenzene	00102-25-0	A12	1211.55	0.945	162.272	0.8897	216
1,2,4-triethylbenzene	00887-44-1	A12	1230.9	0.945	162.272	0.8897	217.5
1,4-methyl-n-pentylbenzene	n/a	A12	1241.7	0.945	162.272	0.8897	0
n-hexylbenzene	01077-16-3	A12	1252.75	0.945	162.272	0.8897	0
I49		I13	1270.75	0.991	184.370	0.7560	235.4
1,2,3,4,5-pentamethbenzene	00700-12-9	A11	1274.15	0.942	148.240	1.0000	232
2-methylnaphthalene	00091-57-6	A11	1282.6	0.903	143.170	1.0200	241.05
tridecene-1		O13	1290	0.980	182.350	0.7658	232.8
1-methylnaphthalene	00090-12-0	A11	1297.8	0.903	143.170	1.0200	244.64
n-tridecane	00629-50-5	P13	1300	0.991	184.370	0.7564	235.4
C14+		+	1300.5	0.990	198.390	0.7628	253.7

Group Type:

P - n-paraffins
I - iso-paraffins
O – olefins
N – naphthenes
A – aromatics
X - oxygenates