Co-Optimization of Fuels & Engines

Properties of Co-Optima Core Research Gasolines

August 2018

NATIONAL RENEWABLE ENERGY LABORATORY

About the Co-Optimization of Fuels and Engines Initiative

This is one of a series of reports produced as a result of the Co-Optimization of Fuels & Engines (Co-Optima) initiative, a Department of Energy (DOE)–sponsored effort initiated to simultaneously investigate advanced engine designs and the enabling fuel properties. This first-of-its-kind effort is designed to provide American industry with the scientific underpinnings needed to maximize vehicle performance and efficiency, leverage domestic fuel resources, boost U.S. jobs, and enhance energy security.

Co-Optima brings together DOE's Office of Energy Efficiency & Renewable Energy (EERE), 9 national laboratories, 13 universities, and numerous industry and government stakeholders in a collaboration exploring solutions with potential for near-term improvements to the types of fuels and engines found in most vehicles currently on the road, as well as to the development of revolutionary engine technologies for a longer-term, higher-impact series of solutions.

In addition to the EERE Vehicle Technologies and Bioenergy Technologies Offices, the Co-Optima team includes representatives from the National Renewable Energy Laboratory and Argonne, Idaho, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, Pacific Northwest, and Sandia National Laboratories. More details on the project—as well as the full series of reports—can be found at www.energy.gov/fuel-engine-co-optimization.

Availability

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Citation

Please cite this report as follows.

Fouts, Lisa, Gina M. Fioroni, Earl Christensen, Matthew Ratcliff, Robert L. McCormick, Bradley T. Zigler, Scott Sluder, James P. Szybist, John E. Dec, Paul C. Miles, Steve Ciatti, J. Timothy Bays, William Pitz, and Marco Mehl. 2018. *Properties of Co-Optima Core Research Gasolines.* Technical Report NREL/TP-5400-71341. Golden, CO: National Renewable Energy Laboratory.

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This work was authored in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Vehicle Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

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Acknowledgments

This research was conducted as part of the Co-Optimization of Fuels & Engines (Co-Optima) project sponsored by the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE), Bioenergy Technologies and Vehicle Technologies Offices. Co-Optima is a collaborative project of multiple national laboratories and universities initiated to simultaneously accelerate the introduction of affordable, scalable, and sustainable biofuels and high-efficiency, low-emission vehicle engines.

The following U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) officials and managers played important roles in establishing the project concept, advancing implementation, and providing ongoing guidance:

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List of Acronyms and Abbreviations

ASTM	ASTM International
Co-Optima	Co-Optimization of Fuels & Engines
^{13}C	carbon-13
DHA	detailed hydrocarbon analysis
^{1}H	proton
HOV	heat of vaporization
MON	motor octane number
NMR	nuclear magnetic resonance
PMI	particulate matter index
ppm	parts per million
RON	research octane number
wt%	percent by weight

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Introduction

The U.S. Department of Energy's Co-Optimization of Fuels & Engines (Co-Optima) initiative is conducting research to accelerate the introduction of affordable, scalable, and sustainable fuels and high-efficiency, low-emission engines. The Co-Optima initiative is focused on identifying the fuel properties and engine design characteristics needed to maximize performance and affordability while cutting pollutant emissions. The outcome of this effort will be new tools, data, and knowledge to pave the way for future generations of fuel and vehicle innovations.

In the area of spark-ignition engines and fuels, Co-Optima researchers have focused on identifying fuel properties that can enable market introduction of aggressively downsized and turbocharged engines in the 2025 timeframe. Researchers are mapping the relationships between production pathways, molecular structure, fuel chemical/physical properties, and engine performance. Because the Co-Optima initiative is being conducted across nine national laboratories (the National Renewable Energy Laboratory, Argonne, Idaho, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, Pacific Northwest, and Sandia National Laboratories) researchers required a set of common spark-ignition engine fuels having similar properties but produced from a wide range of fuel chemistries. These fuels are known as the Co-Optima Core Research Gasolines. They include alkylate, aromatic, olefin, and naphthene hydrocarbon chemistries as well as ethanol. This brief report provides an easily available tabulation of the properties of these fuels and may be updated with additional fuel property data as it becomes available.

Co-Optima researchers have already begun to utilize the Core Research Gasolines, with results published in several studies [1-7].

Methods

The Core Research Gasolines were custom blended by Gage Products to have a nominal research octane number (RON) of 98 and a motor octane number (MON) of 88, yielding an octane sensitivity (the difference between RON and MON) of 10. For the alkylate gasoline, having a high octane sensitivity is precluded by fuel chemistry and the target value was zero. Each sample was prepared to meet the targeted composition, such as high aromatic, high alkylate, high olefinic, high cycloalkane, and E30.

ASTM International (ASTM) methods were performed as written, unless otherwise noted. Detailed hydrocarbon analysis (DHA) was conducted by ASTM D6729. Compound identifications were verified with mass spectrometry using the same gas chromatography parameters in the ASTM DHA method. Oxygenate (ethanol) content was measured using ASTM D5599. Based on the DHA, the particulate matter index (PMI), originally introduced by researchers at Honda [8], was implemented using the approach described by Ratcliff et al. [9] The heat of vaporization (HOV) was measured by differential scanning calorimetry/ thermogravimetric analysis and calculated from the DHA using methods described in Chupka et al. [10] True vapor pressure was measured on an Eralytics Eravap using the automated triple expansion method of ASTM D6378, extending the temperature range to -20°C to 120°C.

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Index of refraction measurements were conducted at room temperature using a digital refractometer (VEE GEE MDX-101) at Sandia National Laboratories [4]. Nuclear magnetic resonance (NMR) spectra were recorded at Pacific Northwest National Laboratory on Agilent 500 MHz instruments using sample volumes of approximately 1 mL. $^{13}C\{^{1}H\}$ NMR spectra were recorded using chromium (III) acetylacetonate as a relaxation agent, which can result in slight NMR chemical shift differences from those reported in some databases. Details for sample preparation and data acquisition can be found in Appendix A.

Results

Basic Fuel Properties

Commonly measured fuel properties are shown in Table 1, including octane numbers, heating value, HOV, and PMI. Yield sooting index was supplied by Yale University [11]. Table 2 lists the composition of the Core Research Gasolines, derived from compound class measurements, elemental composition, and oxygenate (ethanol) content.

Table 1. Fuel Properties of Co-Optima Core Research Gasolines

		Olefinic	E30	Aromatic	Alkylate	High cycloalkane
Specific gravity	D4052	0.7231	0.7529	0.7575	0.6969	0.7557
Density @ 15°C (g/mL)	D4052	0.7229	0.7527	0.7572	0.6968	0.7555
Index of refraction @ 20°C [4]		1.409	1.401	1.431	1.391	1.426
RON (R)	D2699	98.2	97.4	98.1	98.0	98.0
MON (M)	D2700	88.0	86.6	87.8	96.6	87.1
Octane rating	R+M/2	93.1	92.0	93.0	97.3	92.6
Octane sensitivity	R-M	10.2	10.8	10.3	1.4	10.9
Reid vapor pressure (psi)	D5191	6.10	7.66	7.17	4.15	8.00
Gross heating value (MJ/kg)	D4809	47.148	41.096	45.735	47.877	46.018
Net heating value (MJ/kg)	D4809	44.071	38.170	42.952	44.524	43.208
HOV (measured) (kJ/kg)		337	565	412	309	393
HOV (calc. from DHA) (kJ/kg)		330	532	361	308	370
PMI		1.004	1.275	1.803	0.221	1.491
Yield sooting index [11]		80.95	47.86	114.9	60.91	97.92

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Table 2. Composition Information on Co-Optima Core Research Gasolines

			Olefinic	E30	Aromatic	Alkylate	High cyclo-alkane
Aromatic content	D1319	vol%	10.6	8.1	30.8	0	28.2
Olefin content	D1319	vol%	31.3	5	4.2	0	1.5
Saturate content	D1319	vol%	58.1	57.1	65	100	70.3
Aromatic content	D5580	vol%			35.8		
Sulfur	D2622	mass %	<0.001	<0.001	<0.001	<0.001	<0.001
Carbon	D5291	mass%	85.40	74.78	87.22	83.75	87.08
Hydrogen	D5291	mass%	14.50	13.79	13.12	15.80	13.24
Oxygenates							
Ethanol	D5599	vol%	<0.1	30.59	<0.1	<0.1	<0.1
Total oxygen	D5599	vol%	<0.1	11.19	<0.1	<0.1	<0.1

Nuclear Magnetic Resonance Functional Group Analysis

NMR functional group analyses were performed using ^{1}H and $^{13}C\{^{1}H\}$ NMR spectroscopy. Summaries of chemical functional groups, including carbon types and chemical substructures, are presented in Tables 3 through 5. Table 3 provides a higher-level grouping of carbon types while Tables 4 and 5 provide more detailed hydrogen and carbon type descriptions, respectively. ^{1}H and $^{13}C\{^{1}H\}$ spectra for each fuel are shown in Appendix A.

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Table 3. Summary of Selected Chemical Structure Characteristics from $^{13}C\{^{1}H\}$ NMR, Normalized by Total Carbon Content (Mole % Carbon)

	Mole % Carbon				
Structure Groupings	**Olefinic**	**E30**	**Aromatic**	**Alkylate**	**High Cyclo-alkane**
General Carbon Types					
Aromatic/Olefinic Carbon	18.4	13.6	33.3	0.3	29.5
Aliphatic Carbon	81.6	86.3	66.4	99.5	70.4
CH Carbon (60 – 40 ppm)	7.8	14.1	3.5	11.5	2.2
CH_2 Carbon (40 – 22 ppm)	56.3	40.0	40.3	78.4	50.0
CH_3 Carbon (22 – 5 ppm)	17.5	32.2	22.6	9.6	18.2
Aromatic/Olefinic Carbon Breakdown					
Phenolic Carbon	0.1	0	0	0.1	0.2
CH_2/CH Substituted Aromatic Carbon	5.0	2.4	5.8	0	4.5
Naphthene Substituted Aromatic Carbon	0.4	0.5	1.2	0	0.6
CH_3 Substituted Aromatic Carbon	1.1	0.7	1.4	0	0.9
Internal (Bridgehead) Aromatic Carbon	0.3	0.3	0.7	0	0.3
Peripheral Unsubstituted Aromatic Carbon	8.4	8.9	23.3	0.1	22.2
Other or Heteroaromatic Carbon	3.1	0.8	0.9	0.1	0.8
Total Aromatic/Olefinic Carbons	18.4	13.6	33.3	0.3	29.5

ppm: parts per million

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Table 4. Summary of Chemical Structure Characteristics from 1H NMR, Normalized by Total Hydrogen Content (Mole % Hydrogen)

		Mole % Hydrogen				
Chemical Shift Range (ppm)	Chemical Meaning	Olefinic	E30	Aromatic	Alkylate	High Cyclo-alkane
10.7 - 9.00	Polyaromatics, Aldehydes	0	0	0	0	0
9.000 - 8.200	Tri-ring aromatics	0	0	0.06	0	0.05
8.200 - 7.551	Di-ring aromatics	0.16	0.23	0.28	0	0.26
7.551 - 7.182	Di-ring aromatics	2.89	2.98	0.04	0.06	6.39
7.182 - 7.130	Mono-ring aromatics	3.44	2.09	9.19	0.07	8.87
7.130 - 6.972	Mono-ring aromatics	1.54	2.00	6.63	0.06	2.63
6.972 - 6.785	Substituted mono-ring aromatics	0.57	0.87	2.34	0.02	1.07
6.785 - 6.425	Highly substituted mono-ring aromatics	0.01	0.02	0.01	0	0.04
6.425 - 5.1	Olefinic CH, aromatic alcohols	1.37	0.70	0.83	0.01	0.13
5.1 - 4.8	Olefinic CH_2, aromatic alcohols	4.01	1.46	1.56	0.01	0.23
4.8 - 4.184	Olefinic CH_2	2.87	0	0.01	0	0
4.184 - 3.306	Bridged CH_2 groups in fluorene types, ethers, alcohols, including diols	0	9.35	0.04	0	0.01
3.306 - 2.883	aromatic α-CH	0.05	0.19	0.23	0	0.12
2.883 - 2.641	aromatic α-CH_2	0.14	0.19	0.40	0	0.23
2.641 - 2.292	aromatic α-CH_2 + α-CH_3	2.43	2.22	7.57	0.06	5.31
2.292 - 2.040	aromatic α-CH_3	1.03	1.67	3.36	0.03	1.51
2.040 - 1.963	Allylic groups	0.64	0.57	0.58	0.01	0.14
1.963 - 1.570	CH and CH_2 groups of naphthenes	16.40	11.05	3.15	8.29	2.74
1.570 - 1.391	CH groups of iso-paraffins	4.55	6.71	18.52	2.85	38.22
1.39 - 1.11	CH_2 groups of paraffins (n- and iso-)	13.24	31.50	13.85	12.75	10.38
1.115 - 0.941	CH_2 groups of paraffins (n- and iso-)	7.23	3.33	2.56	5.28	1.91
0.941 - 0.254	CH_3 groups of paraffins (n- and iso-)	37.43	22.87	28.79	70.50	19.76

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Table 5. Summary of Chemical Structure Characteristics from 13C{1H} NMR, Normalized by Total Carbon Content (Mole % Carbon)

		Mole % Carbon				
Chemical Shift Range (ppm)	Structure Definition	Olefinic	E30	Aromatic	Alkylate	High Cyclo-alkane
220–202	Ketone Carbonyl	0	0	0	0	0
202–195	Aldehyde Carbonyl	0	0	0	0.1	0
195–182	Quinone Carbonyl	0	0.1	0.1	0.1	0.1
182–176	Acid Carboxyl	0	0	0	0	0
176–165	Ester or Amide Carboxyl	0	0	0.2	0	0
165–143	Alkyl (other than methyl), or heteroatom (N, O, S) substituted aromatic	2.8	0.2	0.5	0.1	0.6
143–137	Tertiary carbon in alkyl substituted aromatic rings	2.2	2.1	5.2	0	4.4
137–131	Tertiary carbon in naphthalene units and methyl substituted aromatic rings	1.6	1.4	3.0	0	1.7
131–127.5	Protonated and internal aromatic carbon, substituted carbon in alkenes ($R_2C=CR_2$), ortho and meta CH in toluene	6.3	6.2	16.3	0.1	16.1
127.5–124	Protonated and internal aromatic carbon, substituted carbon in alkenes ($RHC=CR_2$), para CH in toluene	2.3	2.9	7.3	0	6.0
124–115	Protonated aromatic carbon, substituted carbon in alkenes ($RHC=CR_2$)	0.2	0	0.1	0	0
115–95	Unsubstituted carbon in alkenes ($CH_2=CR_2$)	3.0	0.8	0.9	0.1	0.7
70–60	CH_2 adjacent to oxygen and C in tertiary alcohols	0.2	0	0	0.2	0.0
60–45	CH adjacent to tertiary and isopropyl groups. CH_3 in ether linkage	5.8	12.0	2.2	9.8	1.0
45–40	CH in allylic and benzylic groups and in joining tetralin ring	1.8	2.1	1.3	1.5	1.2
40–36	CH_2 adjacent to substituted double bonds and tertiary carbon	2.0	2.8	1.8	1.2	2.7
36–33.5	CH, CH_2 β from secondary carbon and in cyclopentyl and cyclohexyl rings	3.6	4.4	2.3	1.7	2.5

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		Mole % Carbon				
Chemical Shift Range (ppm)	Structure Definition	Olefinic	E30	Aromatic	Alkylate	High Cyclo-alkane
33.5–31	CH, CH_2 γ from CH_3. CH_2 α to allylic and β to aromatic groups	7.4	6.7	4.4	2.6	3.7
31–28.5	C in open chains. CH_2 benzylic and CH_2 not adjacent to CH in alkyl group	22.7	9.0	12.5	38.9	11.2
28.5–26.5	CH, CH_2 in open chains. CH_2 in cyclohexyl groups and CH_3 in tert-butyl ether	2.5	2.4	1.5	1.6	1.6
26.5–24.5	Some naphthenic CH_2. CH_2 β in propyl, indan and cyclopentyl groups	9.9	5.7	11.8	20.1	23.4
24.5–22	CH_2 β from terminal CH_3. CH_2 β in unsubstituted tetralin	8.2	9.0	6.0	12.3	4.9
22–20	CH_3 α in hydroaromatics and alkyls not shielded by adjacent rings or groups	4.5	5.8	10.0	1.9	7.8
20–18	CH_3 α in hydroaromatics and alkyls shielded by adjacent rings or groups	3.5	13.1	3.0	2.1	2.4
18–15	CH_3 in cyclohexanes and β in ethyl aromatics and ethers	2.0	3.5	2.3	1.8	1.2
15–12.5	CH_3 γ to an aromatic ring or shielded by two adjacent rings or groups, chain α-CH_3	5.3	7.2	4.3	1.9	3.7
12.5–5	CH_3 γ to aromatic rings or ethyl substituted cyclohexanes	2.2	2.6	3.0	1.9	3.1

Detailed Hydrocarbon Analysis

DHA was performed by gas chromatograph-flame ionization detection using ASTM method D6729. The summary compound class information is shown in Table 6, and the detailed results are presented in Appendix B.

The aromatic and alkylate fuels used broad mixtures of aromatic and isoparaffinic compounds, respectively, for blending. For the high-olefin fuel, the added olefin was a mixture of two isomers of di-isobutylene (2,4,4-trimethylpent-1-ene and 2,2,4-trimethyl-3-pentene). As the DHA shows, these two molecules constitute 27 percent by weight (wt%) of the fuel. Since the total olefin content of the fuel is 32 wt%, only 5 wt% of the fuel is other olefins. Similarly, the high-cycloalkane fuel is 20 wt% cyclopentane, while the total cycloalkane content is 24 wt%, so only 4 wt% is other cycloalkanes.

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Table 6. Detailed hydrocarbon analysis by ASTM D6729, values in wt%

	Olefinic	E30	Aromatic	Alkylate	High cycloalkane
Average molecular weight, g/mole	102.9	72.9	96.0	111.0	89.0
Paraffins	9.6	11.1	6.7	2.5	6.9
Iso-paraffins	39.6	25.5	33.9	96.0	28.7
Aromatics	15.1	16.1	45.8	1.0	38.4
Cycloalkanes	2.9	7.2	7.9	0.0	24.0
Olefins	32.1	5.2	41.0	0.1	1.5
Unidentified	0.8	2.9	1.6	0.4	0.5
Oxygenates	0	32.0	0	0	0

Volatility

Distillation

The distillation curve is a critical set of properties for gasoline, related to driveability, lube oil dilution, and fine particle formation. The distillation curves for the Core Research Gasolines are reported in Figure 1 and Table 7.

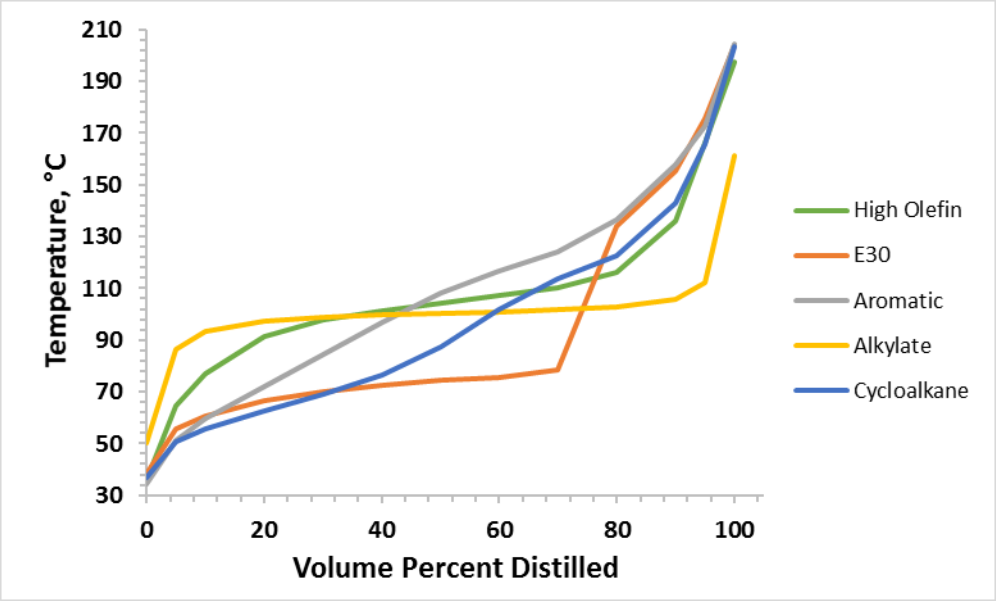

Figure 1. Distillation curves (D86) for the Co-Optima Core Research Gasolines

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Table 7. Distillation Data (D86) for the Co-Optima Core Research Gasolines

Volume Percent Distilled	Olefinic	E30	Aromatic	Alkylate	High cycloalkane
	Temperature, °C				
Initial Boiling Point	35.7	38.2	34.4	50.3	36.7
5%	64.4	55.4	51.1	86.2	50.6
10%	77.1	60.7	59.4	93.1	55.7
20%	91.1	66.6	72.2	97.4	62.4
30%	97.7	70.2	84.6	98.9	68.9
40%	101.4	72.6	96.8	99.7	76.6
50%	104.3	74.3	108.1	100.3	87.4
60%	107	75.7	116.4	100.9	101.7
70%	110.4	78.6	124	101.6	113.8
80%	116.1	134.2	136.3	102.7	122.7
90%	136.2	155.2	157.9	105.9	142.7
95%	166.1	175.9	172.8	112.3	165.8
Final Boiling Point	197.7	204.1	204.4	161.3	203.5

True Vapor Pressure

The dry vapor pressure equivalent—the modern equivalent of Reid vapor pressure—is the vapor pressure at 37.8°C. This measurement is used to control gasoline vapor pressure to limit evaporative emissions, to ensure adequate vapor pressure for cold starting and warmup in cold weather, and to avoid the potential for vapor lock and similar hot weather driveability problems [12]. Having a measurement of the actual vapor pressure at engine operating conditions should prove to be more informative in terms of revealing the fundamental physical property basis for driveability issues. Additionally, for direct injection engines, flash boiling of the spray can occur whenever the saturation pressure of the gasoline is higher than the in-cylinder temperature into which the gasoline is injected [13]. Results for true vapor pressure measurements for the Core Research Gasolines are reported in Figure 2 and Table 8.

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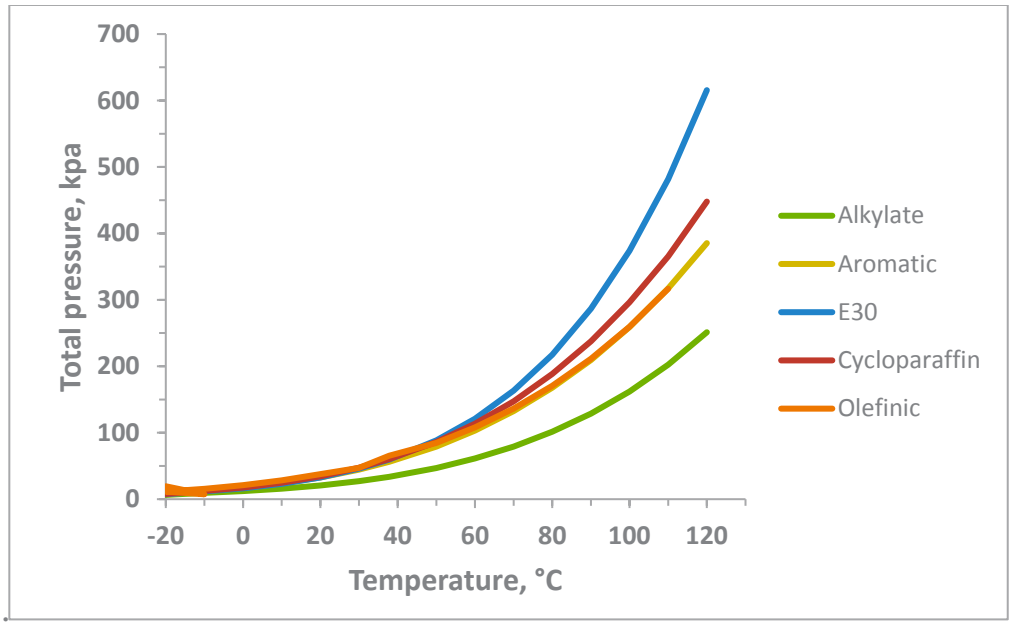

Figure 2. True vapor pressure as a function of temperature for the Co-Optima Core gasolines

Table 8. True Vapor Pressure at Different Temperatures for the Co-Optima Core Gasolines

	Vapor Pressure, psi					Vapor Pressure, kPa				
Temp, °C	Olefinic	E30	Aromatic	Alkylate	High Cyclo-alkane	Olefinic	E30	Aromatic	Alkylate	High Cyclo-alkane
-20	1.07	1.09	1.1	0.94	1.14	7.4	7.5	7.6	6.5	7.9
-10	1.68	1.71	1.78	1.38	1.82	11.6	11.8	12.3	9.5	12.5
0	2.27	2.38	2.48	1.77	2.54	15.7	16.4	17.1	12.2	17.5
10	3.06	3.35	3.44	2.28	3.57	21.1	23.1	23.7	15.7	24.6
20	4.1	4.73	4.74	2.98	4.97	28.3	32.6	32.7	20.5	34.3
30	5.48	6.65	6.46	3.93	6.86	37.8	45.9	44.5	27.1	47.3
37.8	6.83	8.64	8.15	4.88	8.74	47.1	59.6	56.2	33.6	60.3
50	9.5	12.83	11.48	6.81	12.5	65.5	88.5	79.2	47.0	86.2
60	12.28	17.55	14.97	8.89	16.48	84.7	121.0	103.2	61.3	113.6
70	15.68	23.69	19.23	11.49	21.37	108.1	163.3	132.6	79.2	147.3
80	19.8	31.53	24.32	14.71	27.32	136.5	217.4	167.7	101.4	188.4
90	24.75	41.6	30.39	18.67	34.46	170.6	286.8	209.5	128.7	237.6
100	30.65	54.21	37.58	23.51	42.99	211.3	373.8	259.1	162.1	296.4
110	37.62	69.88	46.01	29.35	53.02	259.4	481.8	317.2	202.4	365.6
120	45.93	89.28	55.89	36.44	64.96	316.7	615.6	385.4	251.2	447.9

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Summary

Extensive data on the Co-Optima Core Research Gasolines have been developed and are reported here. These include basic fuel properties as well as results of DHA and NMR. This report may be updated in the future as additional property measurements or simulations become available.

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Appendix A. NMR Spectroscopy

All ^{1}H NMR and $^{13}C\{^{1}H\}$ NMR spectra were acquired at 499.67 and 125.65 MHz, respectively, on an Agilent Inova or VNMRS System at 21° – 25°C in 5-mm o.d. NMR tubes, spinning at 20 Hz.

Quantitative $^{13}C\{^{1}H\}$ spectra were acquired using a 45° observe pulse; acquisition and relaxation delay times of 3 and 5 seconds, respectively, with ^{1}H Waltz decoupling during the acquisition delay period for nuclear Overhauser enhancement suppression; and 0.05 M $Cr(acac)_3$ for T_1 reduction and quenching of any residual nuclear Overhauser enhancement, where $Cr(acac)_3$ is chromium (III) acetylacetonate. These conditions lead to an average integral uncertainty of about ±2 percent (in carbon aromaticity). Chemical shifts were referenced to $CDCl_3$ (77.16 ppm) [14]. A total of 1,500 to 6,000 scans were collected. Samples consisted of 0.20 mL of fuel diluted to 1.00 mL in $CDCl_3$ (99.9% D, Cambridge Isotope Laboratories) with 0.05 M $Cr(acac)_3$ (Aldrich). Line broadening of 2.5 Hz was used for processing spectra to improve the signal-to-noise ratio.

Quantitative ^{1}H spectra were acquired using a 30° observe pulse with acquisition and relaxation delays of 3 and 8 seconds, respectively, for an 11-second recycle time. Samples consisted of 50.0 µL of fuel in 0.75 mL of 99.96% D $CDCl_3$ with 0.03% (v/v) tetramethylsilane (TMS) purchased from Cambridge Isotope Laboratories, Inc. Chemical shifts were referenced to TMS or to residual $CHCl_3$ in solvent $CDCl_3$ (7.26 ppm) [14]. Spectra resulted from 128 scans. Line broadening was not used.

NMR spectra were processed using analysis tools from Agilent VNMRJ Version 4.2 software or MestReNova Version 8.1.0-11315 software. Spectral range assignments and interpretation of NMR results are based on ranges and methods presented by Altgelt and Boduszynski [15]. Proton and ^{13}C NMR spectra for each of the gasolines are shown below, chemical shift ranges for specific organic functional groups are specified in Tables 3 and 4 in the main body of this report.

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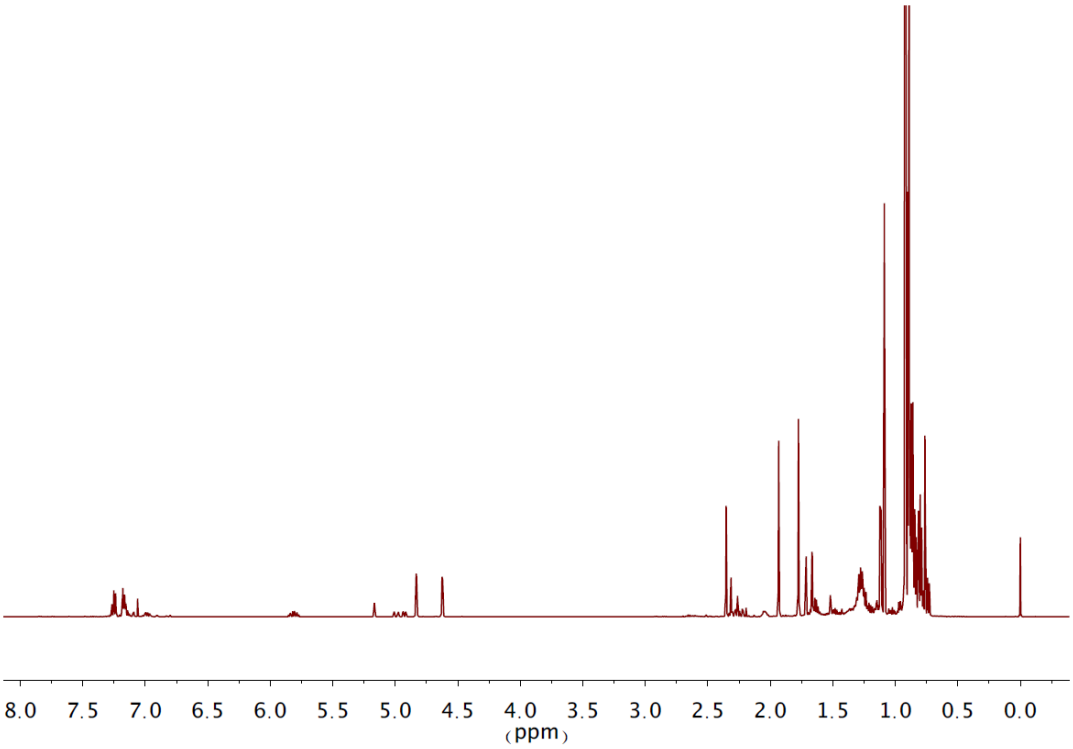
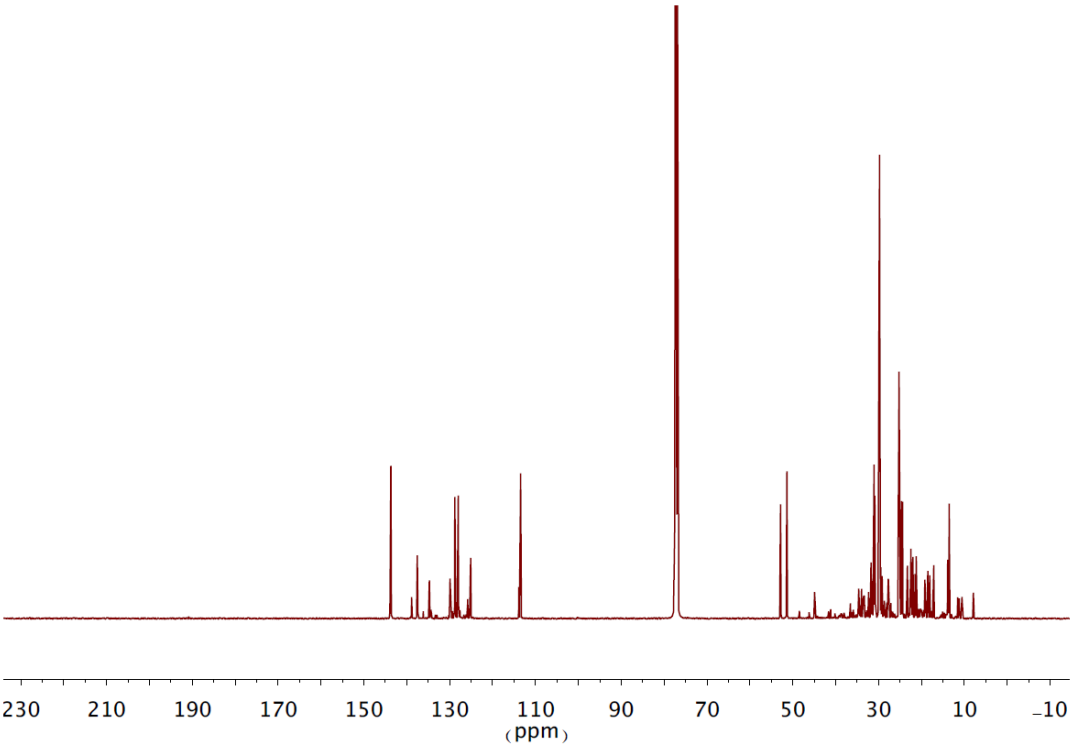


^{1}H NMR Spectrum of the Olefinic Co-Optima Core Research Gasoline



^{13}C{^{1}H} NMR spectrum of the Olefinic Co-Optima Core Research Gasoline

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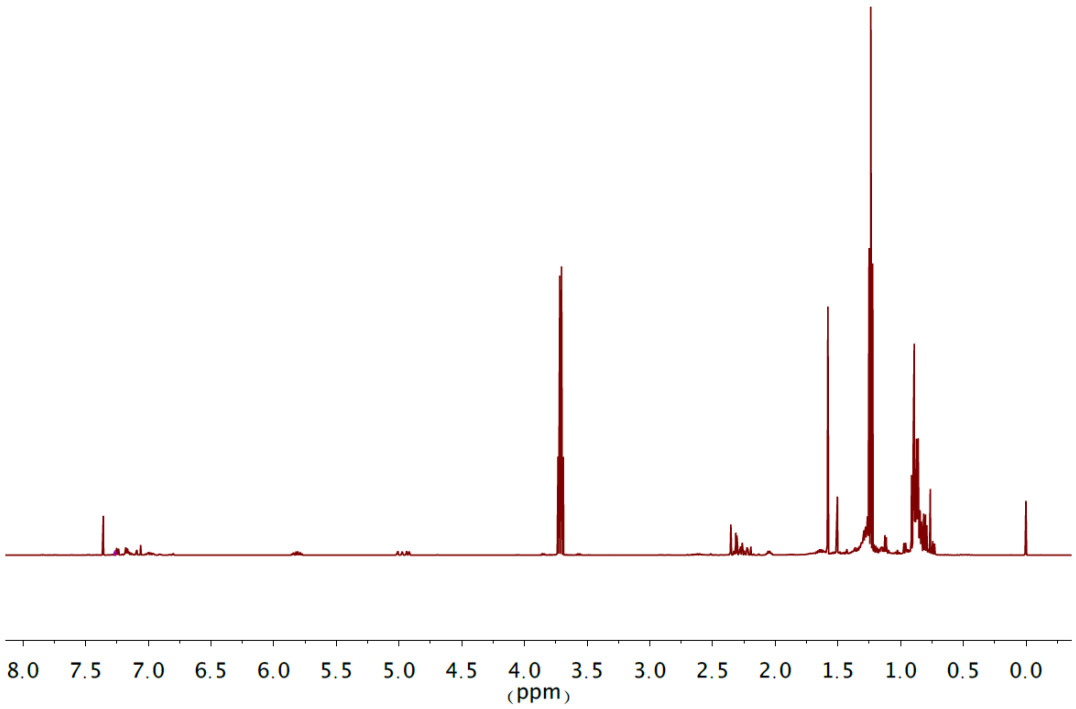
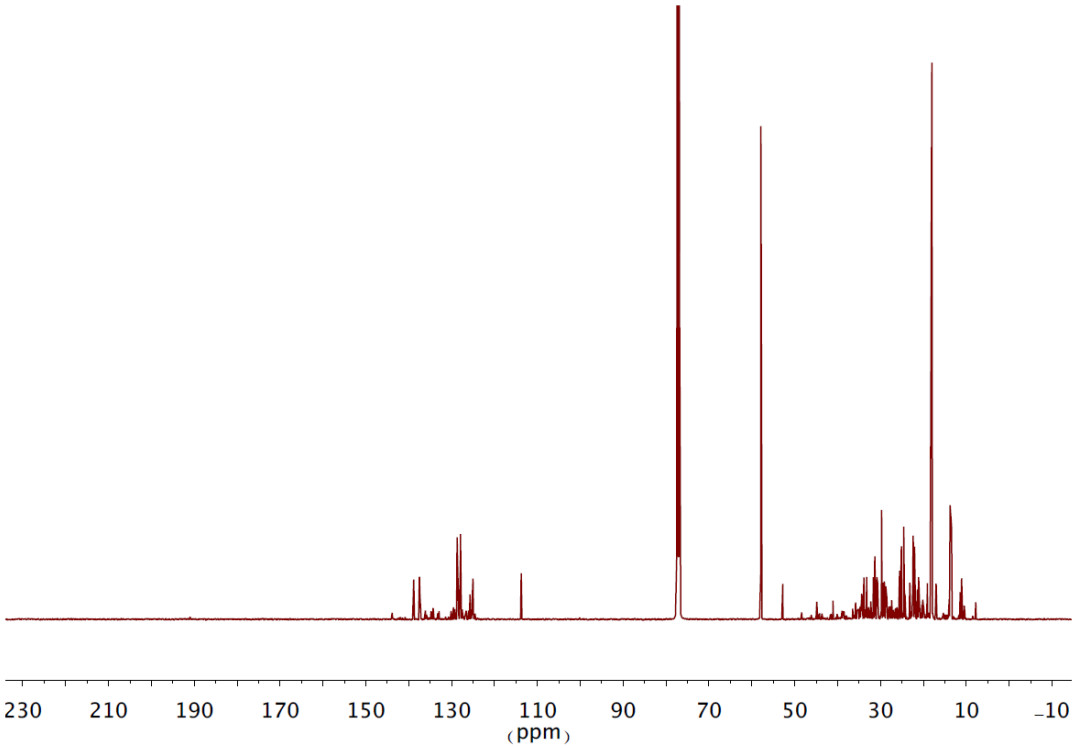


^{1}H NMR spectrum of the E30 Co-Optima Core Research Gasoline



^{13}C{^{1}H} NMR spectrum of the E30 Co-Optima Core Research Gasoline

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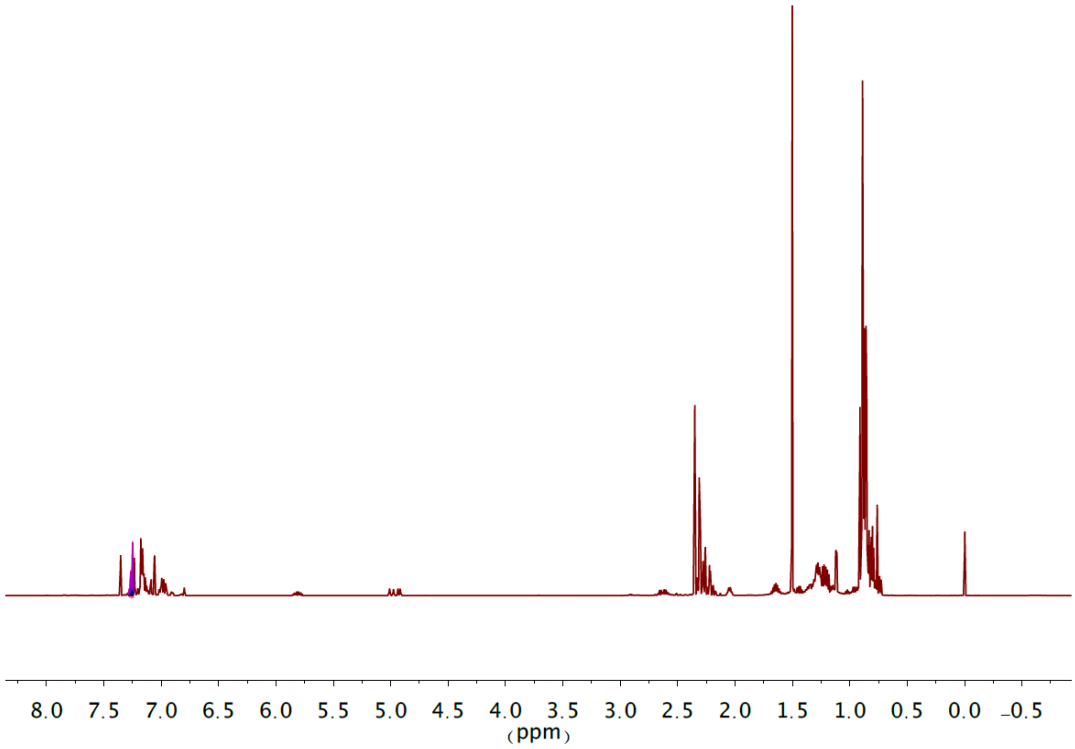
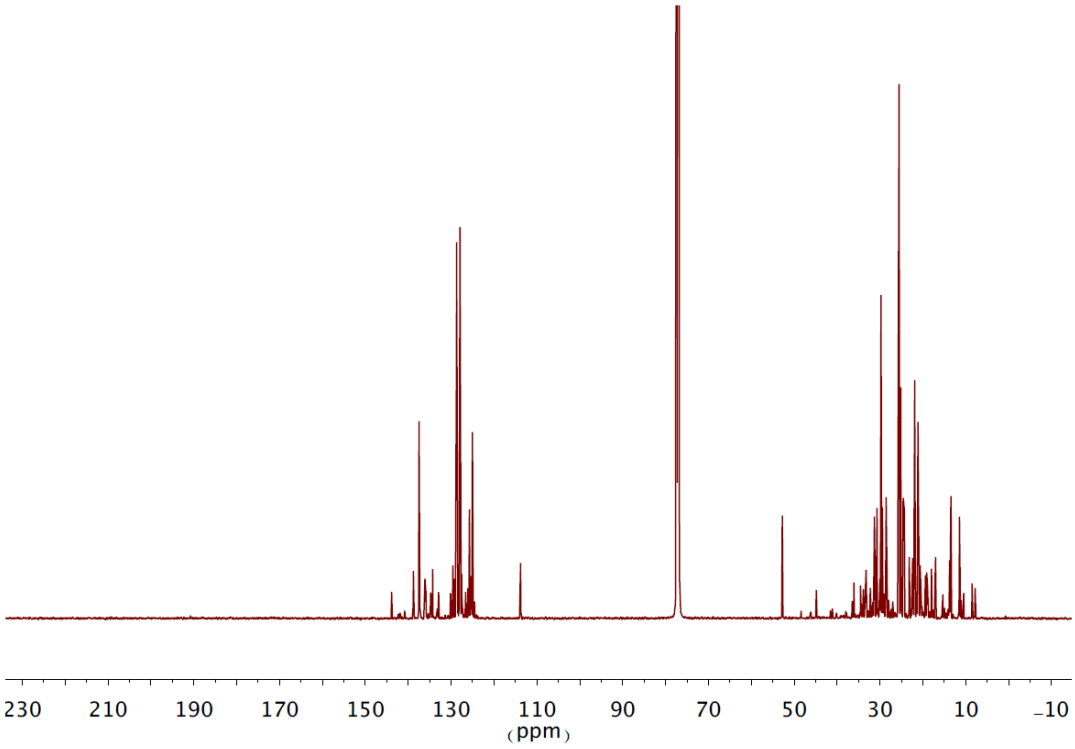


^{1}H NMR spectrum of the Aromatic Co-Optima Core Research Gasoline



^{13}C{^{1}H} NMR spectrum of the Aromatic Co-Optima Core Research Gasoline

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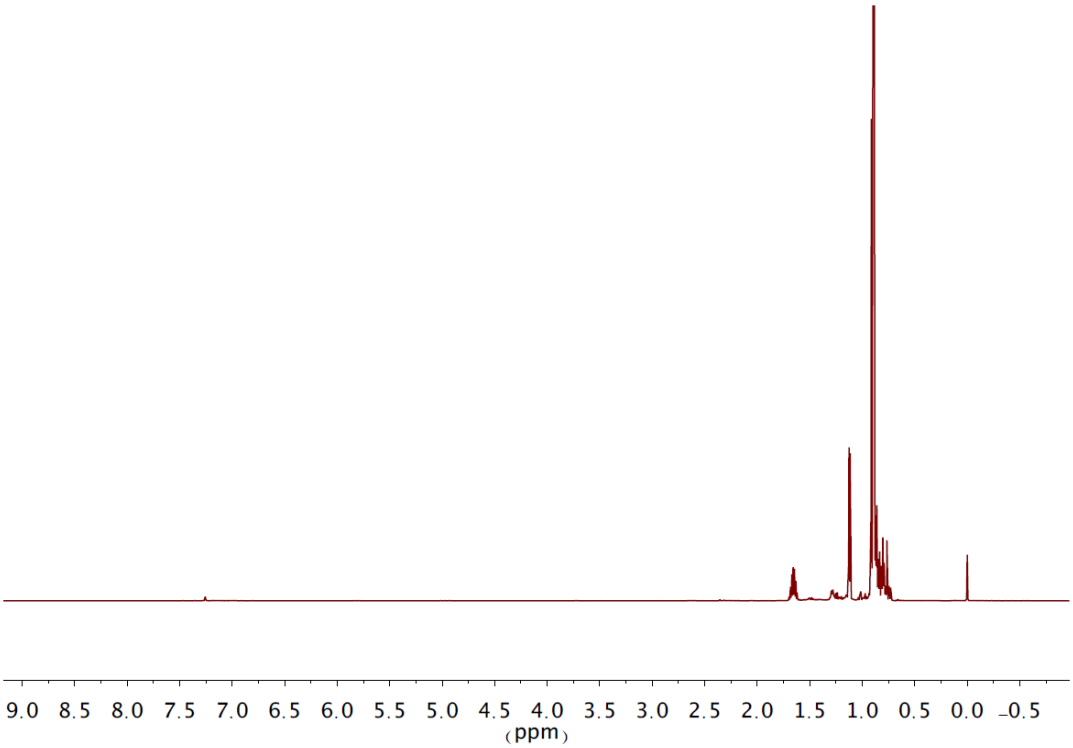
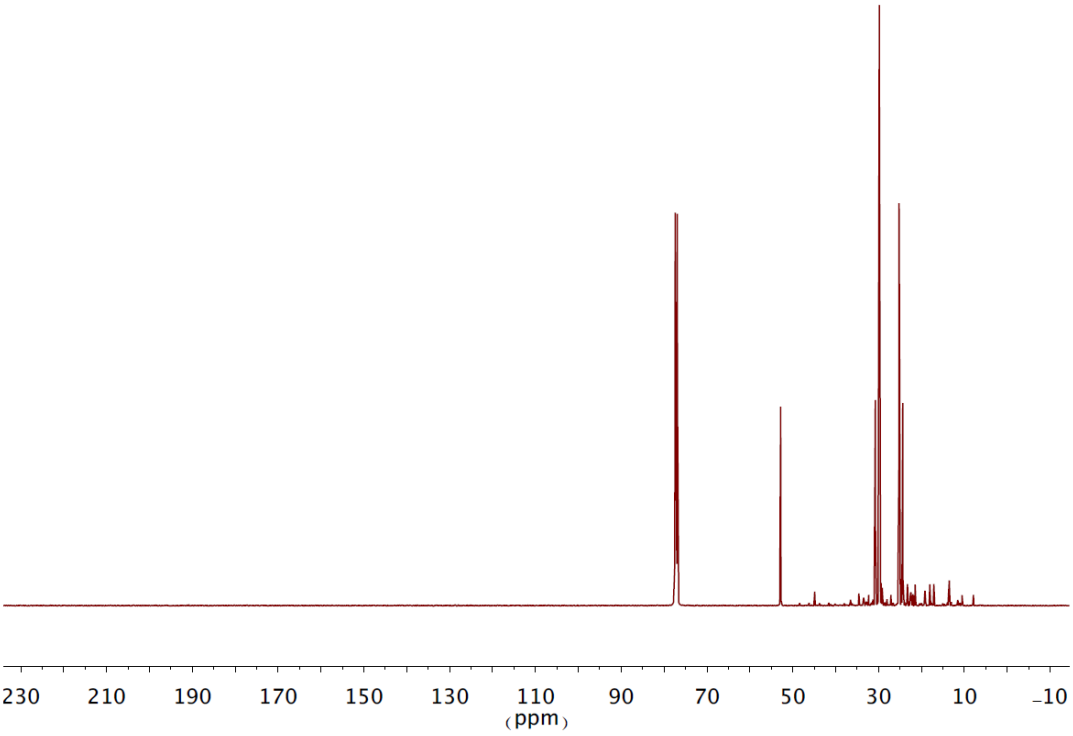


^{1}H NMR spectrum of the Alkylate Co-Optima Core Research Gasoline



^{13}C{^{1}H} NMR spectrum of the Alkylate Co-Optima Core Research Gasoline

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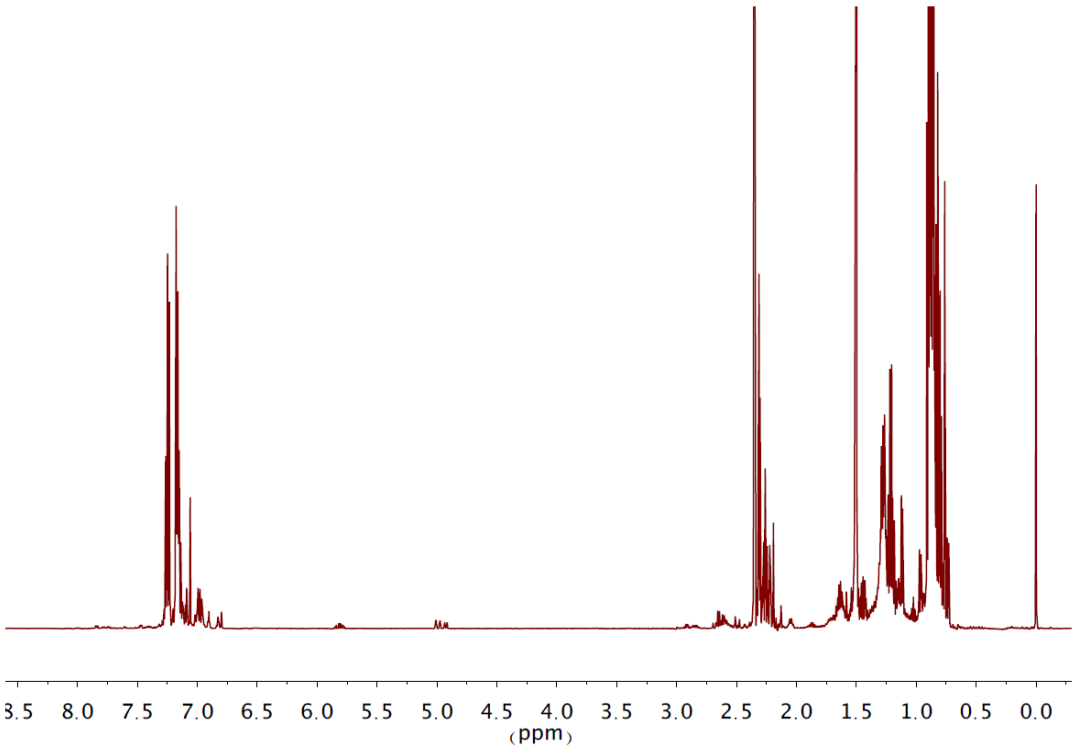
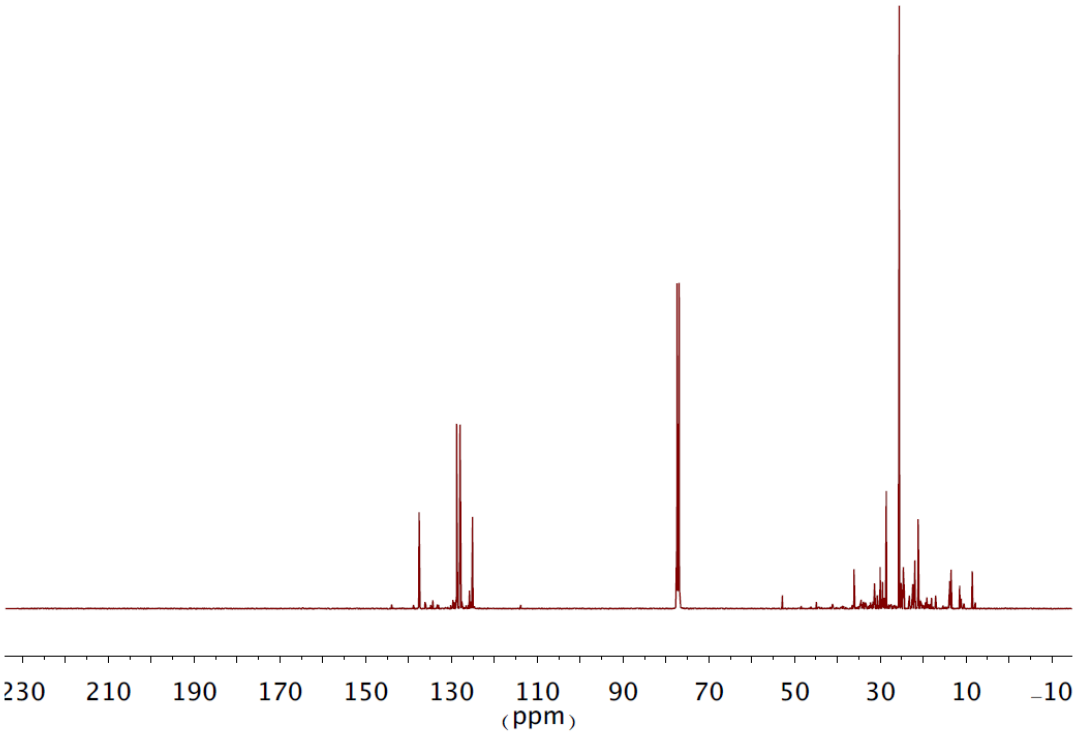


^{1}H NMR spectrum of the High Cycloalkane Co-Optima Core Research Gasoline



^{13}C{^{1}H} NMR spectrum of the High Cycloalkane Co-Optima Core Research Gasoline

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Appendix B. Detailed Hydrocarbon Analysis

Alkylate

Group	CASNO	Component	%Wgt	%Vol	%Mol
Paraffin	106-97-8	n-Butane	2.417	2.892	4.610
	109-66-0	n-Pentane	0.004	0.005	0.006
	110-54-3	n-Hexane	0.003	0.003	0.004
	111-84-2	n-Nonane	0.073	0.070	0.063
	124-18-5	n-Decane	0.023	0.021	0.018
	1120-21-4	n-Undecane	0.019	0.017	0.013
	112-40-3	n-Dodecane	0.003	0.003	0.002
	629-50-5	n-Tridecane	0.001	0.001	0.001
	629-59-4	n-Tetradecane	0.002	0.002	0.001
I-Paraffins	463-82-1	2,2-Dimethylpropane	0.005	0.006	0.008
	78-78-4	i-Pentane	1.204	1.345	1.849
	79-29-8	2,3-Dimethylbutane	1.019	1.067	1.311
	107-83-5	2-Methylpentane	0.295	0.313	0.380
	96-14-0	3-Methylpentane	0.152	0.159	0.196
	108-08-7	2,4-Dimethylpentane	0.876	0.902	0.969
	464-06-2	2,2,3-Trimethylbutane	0.064	0.064	0.071
	591-76-4	2-Methylhexane	0.597	0.610	0.661
	589-34-4	3-Methylhexane	0.063	0.064	0.070
	540-84-1	2,2,4-Trimethylpentane	75.561	75.632	73.330
	590-73-8	2,2-Dimethylhexane	0.954	0.950	0.926
	564-02-3	2,2,3-Trimethylpentane	1.258	1.217	1.221
	592-13-2	2,5-Dimethylhexane	1.080	1.078	1.048
	589-43-5	2,4-Dimethylhexane	0.944	0.934	0.916
	563-16-6	3,3-Dimethylhexane	0.006	0.006	0.006
	565-75-3	2,3,4-Trimethylpentane	3.970	3.824	3.853
	560-21-4	2,3,3-Trimethylpentane	4.016	3.830	3.897
	584-94-1	2,3-Dimethylhexane	0.809	0.787	0.785
	592-27-8	2-Methylheptane	0.031	0.031	0.030
	589-53-7	4-Methylheptane	0.080	0.078	0.077
	583-48-2	3,4-Dimethylhexane	0.080	0.077	0.078
	589-81-1	3-Methylheptane	0.024	0.024	0.023
	3522-94-9	2,2,5-Trimethylhexane	1.249	1.223	1.080
		C9-Isoparaffin-x	0.031	0.029	0.027
	1069-53-0	2,3,5-Trimethylhexane	0.178	0.171	0.154
	1071-26-7	2,4-Dimethylheptane	0.021	0.021	0.018
	1072-05-5	2,6-Dimethylheptane	0.033	0.032	0.028
		2,5-Dimethylheptane	0.079	0.076	0.068
	3221-61-2	2-Methyloctane	0.002	0.002	0.001
		C10 - IsoParaffin - 1	0.167	0.159	0.130
	14720-74-2	2,2,4-trimethylheptane	0.113	0.108	0.088
		C10-isoparaffin-x	0.000	0.000	0.000
		2,3-Dimethyloctane	0.047	0.045	0.037
	15869-87-1	2,2-Dimethyloctane	0.012	0.011	0.009
	15869-89-3	2,5-Dimethyloctane	0.008	0.008	0.006
	2040-95-1	2,7-Dimethyloctane	0.003	0.003	0.003
	2051-30-1	2,4-Dimethyloctane	0.021	0.020	0.016

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Alkylate (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
I-Paraffins		2,6-Dimethyloctane	0.007	0.007	0.006
		2,2,6-Trimethyloctane	0.263	0.251	0.205
		C11-Isoparaffin-1	0.019	0.017	0.013
		C10 - IsoParaffin - 5	0.037	0.035	0.028
	62016-30-4	2,3,3-trimethyloctane	0.039	0.036	0.027
		C11-Isoparaffin-3	0.013	0.012	0.009
		C11 Isoparaffin-4	0.005	0.005	0.003
		2,5,6-Trimethyloctane	0.233	0.217	0.165
		C11-Isoparaffin-7	0.079	0.073	0.056
		C11-Isoparaffin-9	0.024	0.022	0.017
		C11- Isoparaffin-10	0.027	0.025	0.019
		C11- Isoparaffin-11	0.129	0.120	0.091
		C11- Isoparaffin - 12	0.061	0.057	0.043
		C12 - IsoParaffin - 1	0.010	0.009	0.007
		C12 - IsoParaffin - 2	0.007	0.007	0.005
		C12 - IsoParaffin - 4	0.006	0.006	0.004
Aromatics					
Mono-Aromatics	108-38-3	m-Xylene	0.004	0.003	0.004
	106-42-3	p-Xylene	0.024	0.019	0.025
	95-47-6	o-Xylene	0.014	0.011	0.015
	103-65-1	n-Propylbenzene	0.004	0.003	0.003
	620-14-4	1-Methyl-3-ethylbenzene	0.003	0.002	0.003
	95-63-6	1,2,4-Trimethylbenzene	0.023	0.018	0.021
	538-93-2	i-Butylbenzene	0.014	0.011	0.011
	526-73-8	1,2,3-Trimethylbenzene	0.002	0.002	0.002
	535-77-3	1-Methyl-3-i-propylbenzene	0.002	0.002	0.002
	99-87-6	1-Methyl-4-i-propylbenzene	0.033	0.027	0.027
	1074-43-7	1-Methyl-3-n-propylbenzene	0.187	0.151	0.155
	135-01-3	1,2-Diethylbenzene	0.019	0.015	0.016
	1074-17-5	1-Methyl-2-n-propylbenzene	0.028	0.022	0.023
	874-41-9	1,3-Dimethyl-4-ethylbenzene	0.157	0.124	0.130
	934-80-5	1,2-Dimethyl-4-ethylbenzene	0.018	0.014	0.015
	2870-04-4	1,3-Dimethyl-2-ethylbenzene	0.175	0.136	0.145
		1-Ethyl-3-i-propylbenzene	0.036	0.028	0.027
	4218-48-8	1-Ethyl-4-i-propylbenzene	0.026	0.020	0.019
		1,2,4,5-Tetramethylbenzene	0.009	0.007	0.007
	527-53-7	1,2,3,5-Tetramethylbenzene	0.004	0.003	0.003
		C11 - Aromatic - 2	0.004	0.003	0.003
		C11 - Aromatic - 3	0.028	0.022	0.021
		1,2-Di-i-propylbenzene	0.003	0.002	0.002
	1595-16-0	1-methyl-4-(1-methylpropyl)be	0.003	0.002	0.002
	5161-04-6	Benzene, 1-methyl-4-(2-methylp	0.005	0.004	0.004
	538-68-1	n-Pentylbenzene	0.001	0.001	0.001
	577-55-9	1-Methyl-2-n-butylbenzene	0.005	0.004	0.004
		C11 - Aromatic - 7	0.007	0.006	0.005
		C11 - Aromatic - 11	0.002	0.001	0.001

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Alkylate (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Aromatics		C12 - Aromatic - 1	0.004	0.003	0.003
		C12 - Aromatic - 10	0.004	0.003	0.003
	877-44-1	1,2,4-Triethylbenzene	0.009	0.007	0.006
		C12 - Aromatic - 11(1)	0.002	0.001	0.001
		1-Methyl-3-Hexylbenzene	0.013	0.010	0.008
Naphthalenes	91-20-3	Naphthalene	0.020	0.014	0.017
	3877-19-8	Naphthalene, 1,2,3,4-tetrahydr	0.003	0.002	0.002
	91-57-6	2-Methylnaphthalene	0.004	0.003	0.003
	90-12-0	1-Methylnaphthalene	0.001	0.000	0.000
Naphtheno/Olefin		Indan	0.006	0.005	0.006
		2-Methylindan	0.023	0.017	0.020
	874-35-1	5-Methylindan	0.003	0.002	0.002
	824-22-6	4-Methylindan	0.002	0.002	0.002
	824-63-5	2-Methylindan(1)	0.003	0.002	0.003
		4,7-Dimethyl Indane	0.006	0.004	0.004
		1,1-Dimethyl Indane	0.001	0.001	0.001
		Dimethyl Indane - 1	0.004	0.003	0.003
		Dimethyl Indane - 4	0.003	0.002	0.002
		Trimethyl Indane - 4	0.003	0.002	0.002
Indenes					
Naphthenes					
Mono-Naphthene	7667-60-9	1c,2t,4t-Trimethylcyclohexane	0.009	0.008	0.008
	4926-90-3	1,1-Methylethylcyclohexane	0.002	0.002	0.002
	696-29-7	1-Methyl-2-propyl-cyclopentan	0.001	0.001	0.001
		C10 - MonoNaph - 2	0.004	0.003	0.003
Di/Bicyclo-Napht					
Olefins					
n-Olefins	693-61-8	2-Undecene, (E)-	0.018	0.017	0.014
		5-Undecene	0.036	0.034	0.029
Iso-Olefins		C8 - IsoOlefin - 7	0.012	0.010	0.011
	19549-87-2	2,4-Dimethylheptene-1	0.004	0.004	0.003
		C9-IsoOlefin-3	0.004	0.004	0.004
		C10-IsoOlefin-4	0.001	0.001	0.001
Naphtheno-Olefin		C9 Naph-Olefin -1	0.014	0.013	0.013
Di-Olefins					
Oxygenates					
Unidentified		Unidentified	0.000	0.000	0.000
		Unidentified	0.031	0.039	0.060
		Unidentified	0.053	0.042	0.056
		Unidentified	0.004	0.003	0.003

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Alkylate (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Unidentified		Unidentified	0.006	0.005	0.006
		Unidentified	0.046	0.043	0.033
		Unidentified	0.013	0.010	0.012
		Unidentified	0.019	0.018	0.015
		Unidentified	0.001	0.001	0.001
		Unidentified	0.004	0.003	0.004
		Unidentified	0.048	0.039	0.040
		Unidentified	0.020	0.019	0.014
		Unidentified	0.008	0.007	0.006
		Unidentified	0.018	0.014	0.014
		Unidentified	0.003	0.002	0.002
		Unidentified	0.008	0.006	0.007
		Unidentified	0.013	0.012	0.008
		Unidentified	0.010	0.008	0.007
		Unidentified	0.030	0.028	0.020
		Unidentified	0.005	0.003	0.004
		Unidentified	0.001	0.000	0.000
		Unidentified	0.003	0.002	0.002
		Unidentified	0.004	0.003	0.003
		Unidentified	0.002	0.002	0.001
		Unidentified	0.008	0.007	0.004
		Unidentified	0.003	0.002	0.002
		Unidentified	0.008	0.007	0.004
		Unidentified	0.003	0.002	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.004	0.003	0.002
		Unidentified	0.006	0.004	0.004
		Unidentified	0.001	0.001	0.001

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Aromatics

Group	CASNO	Component	%Wgt	%Vol	%Mol
Paraffin	106-97-8	n-Butane	3.178	4.156	5.229
	109-66-0	n-Pentane	1.697	2.051	2.249
	110-54-3	n-Hexane	0.827	0.950	0.918
	142-82-5	n-Heptane	0.008	0.009	0.008
	111-65-9	n-Octane	0.226	0.243	0.189
	111-84-2	n-Nonane	0.281	0.297	0.210
	124-18-5	n-Decane	0.174	0.180	0.117
	1120-21-4	n-Undecane	0.215	0.219	0.132
	112-40-3	n-Dodecane	0.040	0.040	0.022
	629-62-9	n-Pentadecane	0.014	0.014	0.006
I-Paraffins	463-82-1	2,2-Dimethylpropane	0.008	0.010	0.011
	78-78-4	i-Pentane	6.615	8.081	8.770
	75-83-2	2,2-Dimethylbutane	2.806	3.272	3.115
	79-29-8	2,3-Dimethylbutane	0.876	1.003	0.973
	107-83-5	2-Methylpentane	0.692	0.801	0.768
	96-14-0	3-Methylpentane	0.539	0.614	0.599
	108-08-7	2,4-Dimethylpentane	0.748	0.842	0.714
	464-06-2	2,2,3-Trimethylbutane	0.055	0.060	0.052
	562-49-2	3,3-Dimethylpentane	0.033	0.036	0.032
	591-76-4	2-Methylhexane	0.685	0.764	0.654
	589-34-4	3-Methylhexane	0.184	0.203	0.175
	540-84-1	2,2,4-Trimethylpentane	11.429	12.502	9.570
	590-73-8	2,2-Dimethylhexane	0.071	0.077	0.059
	564-02-3	2,2,3-Trimethylpentane	0.501	0.529	0.419
	592-13-2	2,5-Dimethylhexane	0.884	0.965	0.740
	589-43-5	2,4-Dimethylhexane	0.759	0.820	0.635
	565-75-3	2,3,4-Trimethylpentane	2.626	2.765	2.199
	584-94-1	2,3-Dimethylhexane	0.674	0.717	0.565
	592-27-8	2-Methylheptane	0.067	0.073	0.056
	589-53-7	4-Methylheptane	0.081	0.087	0.067
	583-48-2	3,4-Dimethylhexane	0.066	0.070	0.056
	589-81-1	3-Methylheptane	0.054	0.058	0.045
	619-99-8	3-Ethylhexane	0.048	0.051	0.040
	3522-94-9	2,2,5-Trimethylhexane	1.033	1.106	0.770
		C9-Isoparaffin-x	0.035	0.036	0.026
	1069-53-0	2,3,5-Trimethylhexane	0.154	0.162	0.115
	1071-26-7	2,4-Dimethylheptane	0.035	0.037	0.026
	1072-05-5	2,6-Dimethylheptane	0.073	0.078	0.055
		2,5-Dimethylheptane	0.101	0.107	0.076
		3,5-Dimethylheptane	0.009	0.010	0.007
	2216-34-4	4-Methyloctane	0.055	0.058	0.041
	3221-61-2	2-Methyloctane	0.069	0.073	0.051
	15869-80-4	Heptane, 3-ethyl-	0.015	0.016	0.011
	2216-33-3	3-Methyloctane	0.138	0.145	0.103
		C10 - IsoParaffin - 1	0.165	0.172	0.111
	14720-74-2	2,2,4-trimethylheptane	0.133	0.138	0.089

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Aromatics (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
I-Paraffins		C10-isoparaffin-x	0.000	0.000	0.000
		2,3-Dimethyloctane	0.051	0.053	0.034
	15869-87-1	2,2-Dimethyloctane	0.018	0.018	0.012
	15869-89-3	2,5-Dimethyloctane	0.023	0.024	0.016
	2040-95-1	2,7-Dimethyloctane	0.012	0.013	0.008
	2051-30-1	2,4-Dimethyloctane	0.028	0.030	0.019
		2,6-Dimethyloctane	0.042	0.043	0.028
		3-Methyl-5-ethylheptane	0.019	0.020	0.013
	15869-85-9	5-Methylnonane	0.019	0.020	0.013
	17301-94-8	4-Methylnonane	0.043	0.044	0.029
		2,2,6-Trimethyloctane	0.245	0.256	0.165
	5881-17-4	3-Ethyloctane	0.009	0.009	0.006
	5911-04-6	3-Methylnonane	0.039	0.041	0.026
	61868-42-6	Heptane, 2,2,3,5-tetramethyl-	0.021	0.016	0.013
		C11-Isoparaffin-1	0.045	0.046	0.027
		C11-Isoparaffin-2	0.024	0.024	0.015
		C10 - IsoParaffin - 5	0.026	0.026	0.017
	62016-30-4	2,3,3-trimethyloctane	0.033	0.033	0.020
		C11-Isoparaffin-3	0.010	0.010	0.006
		C11 Isoparaffin-4	0.010	0.011	0.006
		C11-Isoparaffin-5	0.033	0.034	0.020
		2,5,6-Trimethyloctane	0.204	0.208	0.125
		C11-Isoparaffin-7	0.079	0.081	0.048
		C11-Isoparaffin-8	0.008	0.008	0.005
		C11-Isoparaffin-9	0.029	0.030	0.018
		C11- Isoparaffin-10	0.023	0.024	0.014
		C11- Isoparaffin-11	0.122	0.124	0.075
		C11- Isoparaffin - 12	0.052	0.053	0.032
		C11- IsoParaffin - 13	0.017	0.017	0.010
		C12 - Isoparaffin - 1	0.039	0.039	0.022
		C12 - Isoparaffin - 2	0.050	0.051	0.028
		C12 - Isoparaffin - 3	0.015	0.015	0.008
		C12 - Isoparaffin - 4	0.028	0.028	0.015
		C14 - Isoparaffin-1	0.006	0.006	0.003
Aromatics					
Mono-Aromatics	71-42-3	Benzene	0.708	0.610	0.867
	108-88-3	Toluene	19.341	16.884	20.076
	100-41-4	Ethylbenzene	2.081	1.817	1.875
	108-38-3	m-Xylene	5.462	4.784	4.921
	106-42-3	p-Xylene	2.350	2.066	2.117
	95-47-6	o-Xylene	1.973	1.697	1.778
	98-82-8	i-Propylbenzene	0.043	0.038	0.034
	103-65-1	n-Propylbenzene	0.499	0.438	0.397
	620-14-4	1-Methyl-3-ethylbenzene	1.921	1.681	1.528
	622-96-8	1-Methyl-4-ethylbenzene	0.885	0.778	0.704
	108-67-8	1,3,5-Trimethylbenzene	1.059	0.927	0.843

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Aromatics (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Aromatics	611-14-3	1-Methyl-2-ethylbenzene	0.625	0.537	0.497
	95-63-6	1,2,4-Trimethylbenzene	3.114	2.691	2.478
	538-93-2	i-Butylbenzene	0.075	0.067	0.053
	526-73-8	1,2,3-Trimethylbenzene	0.560	0.474	0.445
	535-77-3	1-Methyl-3-i-propylbenzene	0.019	0.016	0.013
	99-87-6	1-Methyl-4-i-propylbenzene	0.028	0.025	0.020
	141-93-5	1,3-Diethylbenzene	0.099	0.086	0.070
	1074-43-7	1-Methyl-3-n-propylbenzene	0.408	0.359	0.291
	105-05-5	1,4-Diethylbenzene	0.215	0.189	0.153
	934-74-7	1,3-Dimethyl-5-ethylbenzene	0.234	0.201	0.167
	135-01-3	1,2-Diethylbenzene	0.038	0.033	0.027
	1074-17-5	1-Methyl-2-n-propylbenzene	0.073	0.063	0.052
	1758-88-9	1,4,Dimethyl-2-ethylbenzene	0.133	0.114	0.094
	874-41-9	1,3-Dimethyl-4-ethylbenzene	0.144	0.124	0.102
	934-80-5	1,2-Dimethyl-4-ethylbenzene	0.340	0.295	0.243
	2870-04-4	1,3-Dimethyl-2-ethylbenzene	0.192	0.163	0.137
		1-Methyl-4-t-butylbenzene	0.043	0.038	0.028
	933-98-2	1,2-Dimethyl-3-ethylbenzene	0.151	0.128	0.107
	4218-48-8	1-Ethyl-4-i-propylbenzene	0.085	0.072	0.055
		1,2,4,5-Tetramethylbenzene	0.290	0.248	0.207
	527-53-7	1,2,3,5-Tetramethylbenzene	0.379	0.322	0.270
		C11 - Aromatic - 2	0.010	0.008	0.006
		C11 - Aromatic - 3	0.081	0.069	0.052
		1,2-Di-i-propylbenzene	0.052	0.045	0.031
	1595-16-0	1-methyl-4-(1-methylpropyl)be	0.098	0.084	0.063
		C11 - Aromatic - 4	0.068	0.058	0.044
	538-68-1	n-Pentylbenzene	0.023	0.019	0.015
		tert-Pentylbenzene	0.084	0.072	0.054
	577-55-9	1-Methyl-2-n-butylbenzene	0.028	0.024	0.018
		C11 - Aromatic - 7	0.051	0.046	0.033
	100-18-5	1,4-Di-i-propylbenzene	0.053	0.045	0.031
		C12-Aromatic-1	0.010	0.009	0.006
		C11 - Aromatic - 10	0.012	0.011	0.008
		1,3-Di-n-propylbenzene	0.027	0.023	0.016
		C11 - Aromatic - 11	0.010	0.009	0.007
		C11 - Aromatic - 12	0.007	0.007	0.005
		C11 - Aromatic - 13	0.004	0.004	0.003
		C11 - Aromatic - 14	0.005	0.004	0.003
		C12 - Aromatic - 1	0.012	0.010	0.007
		C12 - Aromatic - 11	0.006	0.005	0.003
	877-44-1	1,2,4-Triethylbenzene	0.012	0.011	0.007
	700-12-9	Pentamethylbenzene	0.042	0.032	0.027
		1-Methyl-3-Hexylbenzene	0.006	0.005	0.003
		C13 - Aromatic - 2	0.006	0.005	0.003
Naphthalenes	91-20-3	Naphthalene	0.144	0.106	0.107
	91-57-6	2-Methylnaphthalene	0.273	0.202	0.182

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Aromatics (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Naphthalenes	90-12-0	1-Methylnaphthalene	0.133	0.098	0.089
		Dimethylnaphthalene-3	0.022	0.018	0.014
		Dimethylnaphthalene-4	0.022	0.017	0.014
		Dimethylnaphthalene-5	0.055	0.043	0.034
		Dimethylnaphthalene - 6	0.026	0.020	0.016
		Dimethylnaphthalene-5(1)	0.019	0.015	0.012
		Dimethylnaphthalene-6	0.013	0.010	0.008
Naphtheno/Olefin		Indan	0.211	0.166	0.171
		2-Methylindan	0.044	0.034	0.032
	874-35-1	5-Methylindan	0.146	0.124	0.105
	824-22-6	4-Methylindan	0.182	0.154	0.131
	824-63-5	2-Methylindan(1)	0.152	0.129	0.110
		1,1-Dimethyl Indane	0.010	0.008	0.007
		Dimethyl Indane - 1	0.005	0.004	0.003
		C2 Indane - 1	0.006	0.005	0.004
		4,7-DimethylIndane	0.021	0.017	0.014
		Dimethyl Indane - 3	0.014	0.011	0.009
		Dimethyl Indane - 4	0.006	0.005	0.004
		C3 Indane - 6	0.026	0.021	0.016
Indenes					
Naphthenes					
Mono-Naphthene	287-92-3	Cyclopentane	6.796	6.901	9.268
	96-37-7	Methylcyclopentane	0.361	0.365	0.410
	110-82-7	Cyclohexane	0.040	0.039	0.045
	1759-58-6	1t,3-Dimethylcyclopentane	0.009	0.009	0.009
	2532-58-3	1c,3-Dimethylcyclopentane	0.008	0.008	0.008
	822-50-4	1t,2-Dimethylcyclopentane	0.018	0.018	0.017
	108-87-2	Methylcyclohexane	0.020	0.020	0.020
	4850-28-6	1c,2t,4-Trimethylcyclopentane	0.007	0.007	0.006
	15890-40-1	1t,2c,3-Trimethylcyclopentane	0.008	0.008	0.007
		1,3-dimethyl-t-cyclohexane	0.119	0.117	0.102
		3c-Ethylmethylcyclopentane	0.029	0.029	0.025
	2207-01-4	1c,2-Dimethylcyclohexane	0.028	0.027	0.024
	1678-91-7	Ethylcyclohexane	0.153	0.148	0.131
	7094-27-1	1,1,4-Trimethylcyclohexane	0.010	0.010	0.008
	3073-66-3	1,1,3-Trimethylcyclohexane	0.018	0.017	0.014
		C9 - MonoNaph - 4	0.022	0.022	0.017
	3728-57-2	Cyclopentane, 1-methyl-2-propy	0.039	0.034	0.036
		trans-1,3-Diethylcyclopentane	0.078	0.067	0.059
	4926-90-3	1,1-Methylethylcyclohexane	0.043	0.040	0.032
		1-ethyl-4-t-methylcyclohexane	0.011	0.010	0.008
	696-29-7	1-Methyl-2-propyl-cyclopentan	0.003	0.002	0.002
		1,2,3,5-t-Tetramethylcyclohex	0.027	0.026	0.020
	1678-98-4	i-Butylcyclohexane	0.017	0.016	0.011
		n-ButylCyclohexane	0.014	0.013	0.010

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Aromatics (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Naphthene					
Di/Bicyclo-Napht					
Olefins					
n-Olefins	592-41-6	Hexene-1	3.572	3.988	4.059
	4050-45-7	t-Hexene-2	0.008	0.009	0.009
		C9-isoolefin	0.059	0.066	0.045
	20063-92-7	t-Nonene-3	0.013	0.015	0.010
		C10-n-Olefin	0.009	0.009	0.006
	693-61-8	2-Undecene, (E)-	0.027	0.027	0.018
		5-Undecene	0.034	0.035	0.023
Iso-Olefins	625-27-4	2-Methylpentene-2	0.003	0.003	0.003
	922-62-3	3-Methyl-c-pentene-2	0.004	0.004	0.004
		C8 - Diolefin - 1	0.004	0.004	0.003
		C8 - IsoOlefin - 7	0.011	0.010	0.009
	4485-16-9	3-Heptene, 4-methyl-	0.067	0.066	0.057
		C8 - IsoOlefin - 10	0.004	0.004	0.003
		C9 - IsoOlefin - 1	0.004	0.003	0.003
	33933-74-4	3-Heptene, 4-ethyl-	0.005	0.005	0.004
	19549-87-2	2,4-Dimethylheptene-1	0.011	0.012	0.008
	16993-86-4	2-Methyloctene-2	0.007	0.008	0.005
	3074-64-4	2,3-Dimethylheptene-2	0.004	0.005	0.003
		C10-IsoOlefin-4	0.003	0.003	0.002
		C10 Iso-olefin - 5	0.016	0.018	0.011
		C10 Iso-olefin - 6	0.003	0.003	0.002
		C10-IsoOlefin-7	0.010	0.011	0.007
		C10-IsoOlefin-12	0.010	0.011	0.007
	69405-42-1	3-Nonene, 3-methyl-, (E)-	0.002	0.003	0.002
Naphtheno-Olefin	1068-19-5	1-Ethyl-2-Methylcyclopentene	0.077	0.080	0.067
		C9 Naph-Olefin -1	0.118	0.122	0.091
		C9 - NaphOlefin - 2	0.014	0.015	0.011
		C9-NaphthenoOlefin-6	0.000	0.000	0.000
Di-Olefins					
Oxygenates					
Unidentified		Unidentified	0.000	0.001	0.001
		Unidentified	0.030	0.041	0.050
		Unidentified	0.006	0.006	0.010
		Unidentified	0.003	0.003	0.003
		Unidentified	0.080	0.084	0.077
		Unidentified	0.018	0.018	0.015
		Unidentified	0.010	0.010	0.009
		Unidentified	0.877	0.865	0.747
		Unidentified	0.005	0.005	0.004
		Unidentified	0.009	0.009	0.007
		Unidentified	0.010	0.011	0.007

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Aromatics (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Unidentified		Unidentified	0.009	0.010	0.007
		Unidentified	0.016	0.016	0.012
		Unidentified	0.033	0.034	0.024
		Unidentified	0.008	0.008	0.005
		Unidentified	0.004	0.004	0.003
		Unidentified	0.004	0.004	0.003
		Unidentified	0.004	0.003	0.003
		Unidentified	0.003	0.003	0.002
		Unidentified	0.006	0.006	0.004
		Unidentified	0.003	0.003	0.002
		Unidentified	0.030	0.026	0.024
		Unidentified	0.130	0.112	0.093
		Unidentified	0.008	0.008	0.005
		Unidentified	0.032	0.029	0.020
		Unidentified	0.044	0.038	0.032
		Unidentified	0.019	0.016	0.012
		Unidentified	0.010	0.010	0.006
		Unidentified	0.014	0.014	0.008
		Unidentified	0.022	0.023	0.013
		Unidentified	0.004	0.004	0.002
		Unidentified	0.001	0.001	0.001
		Unidentified	0.003	0.002	0.002
		Unidentified	0.004	0.004	0.002
		Unidentified	0.003	0.002	0.002
		Unidentified	0.005	0.005	0.003
		Unidentified	0.007	0.007	0.004
		Unidentified	0.019	0.019	0.009
		Unidentified	0.002	0.002	0.001
		Unidentified	0.003	0.003	0.001
		Unidentified	0.004	0.004	0.002
		Unidentified	0.004	0.003	0.002
		Unidentified	0.013	0.014	0.007
		Unidentified	0.003	0.003	0.002
		Unidentified	0.009	0.009	0.004
		Unidentified	0.007	0.007	0.003
		Unidentified	0.004	0.004	0.002
		Unidentified	0.004	0.004	0.002
		Unidentified	0.012	0.012	0.006
		Unidentified	0.010	0.010	0.005
		Unidentified	0.002	0.002	0.001
		Unidentified	0.006	0.006	0.003
		Unidentified	0.006	0.006	0.003
		Unidentified	0.005	0.005	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.006	0.006	0.003
		Unidentified	0.005	0.005	0.002
		Unidentified	0.010	0.010	0.004
		Unidentified	0.005	0.005	0.002
		Unidentified	0.007	0.007	0.003

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Cycloalkane

Group	CASNO	Component	%Wgt	%Vol	%Mol
Paraffin	106-97-8	n-Butane	2.638	3.437	4.060
	109-66-0	n-Pentane	0.830	0.999	1.028
	110-54-3	n-Hexane	2.066	2.363	2.145
	142-82-5	n-Heptane	0.066	0.073	0.059
	111-65-9	n-Octane	0.463	0.497	0.362
	111-84-2	n-Nonane	0.674	0.708	0.470
	124-18-5	n-Decane	0.140	0.144	0.088
	1120-21-4	n-Undecane	0.045	0.045	0.025
	112-40-3	n-Dodecane	0.003	0.003	0.001
I-Paraffins	75-28-5	i-Butane	0.023	0.032	0.036
	78-78-4	i-Pentane	4.100	4.989	5.082
	75-83-2	2,2-Dimethylbutane	8.515	9.892	8.838
	79-29-8	2,3-Dimethylbutane	0.597	0.680	0.619
	107-83-5	2-Methylpentane	0.927	1.070	0.962
	96-14-0	3-Methylpentane	0.935	1.061	0.970
	108-08-7	2,4-Dimethylpentane	0.606	0.680	0.541
	464-06-2	2,2,3-Trimethylbutane	0.045	0.049	0.040
	562-49-2	3,3-Dimethylpentane	0.072	0.078	0.064
	591-76-4	2-Methylhexane	0.936	1.040	0.835
	589-34-4	3-Methylhexane	0.430	0.472	0.384
	617-78-7	3-Ethylpentane	0.024	0.026	0.021
	540-84-1	2,2,4-Trimethylpentane	4.010	4.371	3.140
	564-02-3	2,2,3-Trimethylpentane	0.288	0.303	0.226
	592-13-2	2,5-Dimethylhexane	0.561	0.610	0.440
	589-43-5	2,4-Dimethylhexane	0.484	0.522	0.379
	563-16-6	3,3-Dimethylhexane	0.005	0.005	0.004
	565-75-3	2,3,4-Trimethylpentane	1.648	1.728	1.291
	584-94-1	2,3-Dimethylhexane	0.455	0.482	0.357
	592-27-8	2-Methylheptane	0.178	0.192	0.139
	589-53-7	4-Methylheptane	0.097	0.104	0.076
	583-48-2	3,4-Dimethylhexane	0.044	0.046	0.035
	589-81-1	3-Methylheptane	0.133	0.143	0.105
	619-99-8	3-Ethylhexane	0.152	0.160	0.119
	3522-94-9	2,2,5-Trimethylhexane	0.677	0.722	0.472
		C9-Isoparaffin-x	0.029	0.029	0.020
	1069-53-0	2,3,5-Trimethylhexane	0.116	0.121	0.081
	1071-26-7	2,4-Dimethylheptane	0.074	0.078	0.052
	1072-05-5	2,6-Dimethylheptane	0.178	0.189	0.124
		2,5-Dimethylheptane	0.170	0.179	0.118
		3,5-Dimethylheptane	0.033	0.034	0.023
	2216-32-2	4-Ethylheptane	0.051	0.053	0.035
	2216-34-4	4-Methyloctane	0.170	0.178	0.119
	3221-61-2	2-Methyloctane	0.207	0.218	0.144
	2216-33-3	3-Methyloctane	0.428	0.448	0.298
		C10 - IsoParaffin - 1	0.103	0.107	0.065
	14720-74-2	2,2,4-trimethylheptane	0.172	0.179	0.108

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Cycloalkane (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
I-Paraffins		C10-isoparaffin-x	0.000	0.000	0.000
		2,3-Dimethyloctane	0.054	0.057	0.034
	15869-87-1	2,2-Dimethyloctane	0.022	0.023	0.014
	15869-89-3	2,5-Dimethyloctane	0.029	0.030	0.018
	2040-95-1	2,7-Dimethyloctane	0.011	0.012	0.007
	2051-30-1	2,4-Dimethyloctane	0.033	0.034	0.021
		2,6-Dimethyloctane	0.040	0.041	0.025
		3-Methyl-5-ethylheptane	0.023	0.024	0.015
	15869-85-9	5-Methylnonane	0.017	0.017	0.010
	17301-94-8	4-Methylnonane	0.037	0.038	0.023
		2,2,6-Trimethyloctane	0.156	0.162	0.098
	5881-17-4	3-Ethyloctane	0.008	0.009	0.005
	5911-04-6	3-Methylnonane	0.030	0.031	0.019
		C11-Isoparaffin-1	0.051	0.051	0.029
		C11-Isoparaffin-2	0.017	0.017	0.010
		C10 - IsoParaffin - 5	0.023	0.024	0.015
	62016-30-4	2,3,3-trimethyloctane	0.026	0.026	0.015
		C11-Isoparaffin-3	0.008	0.009	0.005
		C11 Isoparaffin-4	0.009	0.009	0.005
		C11-Isoparaffin-5	0.040	0.041	0.023
		2,5,6-Trimethyloctane	0.128	0.130	0.073
		C11-Isoparaffin-7	0.055	0.056	0.032
		C11-Isoparaffin-8	0.005	0.005	0.003
		C11-Isoparaffin-9	0.018	0.018	0.010
		C11- Isoparaffin-11	0.076	0.077	0.043
		C11- Isoparaffin - 12	0.031	0.031	0.018
		C11- IsoParaffin - 13	0.007	0.007	0.004
		C12 - IsoParaffin - 1	0.008	0.008	0.004
		C12 - IsoParaffin - 2	0.023	0.024	0.012
		C12 - IsoParaffin - 4	0.007	0.007	0.003
		C14-Isoparaffin-1	0.003	0.003	0.001
Aromatics					
Mono-Aromatics	71-42-3	Benzene	0.004	0.003	0.005
	108-88-3	Toluene	24.436	21.252	23.720
	100-41-4	Ethylbenzene	1.017	0.885	0.857
	108-38-3	m-Xylene	2.545	2.221	2.144
	106-42-3	p-Xylene	1.247	1.092	1.051
	95-47-6	o-Xylene	1.078	0.923	0.908
	98-82-8	i-Propylbenzene	0.015	0.013	0.011
	103-65-1	n-Propylbenzene	0.177	0.154	0.131
	620-14-4	1-Methyl-3-ethylbenzene	0.652	0.569	0.485
	622-96-8	1-Methyl-4-ethylbenzene	0.310	0.271	0.230
	108-67-8	1,3,5-Trimethylbenzene	0.389	0.339	0.290
	611-14-3	1-Methyl-2-ethylbenzene	0.230	0.197	0.171
	95-63-6	1,2,4-Trimethylbenzene	1.134	0.976	0.844
	538-93-2	i-Butylbenzene	0.040	0.036	0.027

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Cycloalkane (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Aromatics	526-73-8	1,2,3-Trimethylbenzene	0.215	0.181	0.160
	535-77-3	1-Methyl-3-i-propylbenzene	0.005	0.005	0.003
	99-87-6	1-Methyl-4-i-propylbenzene	0.017	0.015	0.011
	141-93-5	1,3-Diethylbenzene	0.040	0.035	0.027
	1074-43-7	1-Methyl-3-n-propylbenzene	0.225	0.197	0.150
	105-05-5	1,4-Diethylbenzene	0.125	0.109	0.083
	934-74-7	1,3-Dimethyl-5-ethylbenzene	0.120	0.103	0.080
	135-01-3	1,2-Diethylbenzene	0.023	0.020	0.016
	1074-17-5	1-Methyl-2-n-propylbenzene	0.050	0.043	0.034
	1758-88-9	1,4,Dimethyl-2-ethylbenzene	0.117	0.101	0.078
	874-41-9	1,3-Dimethyl-4-ethylbenzene	0.221	0.190	0.147
	934-80-5	1,2-Dimethyl-4-ethylbenzene	0.341	0.294	0.227
	2870-04-4	1,3-Dimethyl-2-ethylbenzene	0.105	0.089	0.070
		1-Methyl-4-t-butylbenzene	0.044	0.039	0.026
	933-98-2	1,2-Dimethyl-3-ethylbenzene	0.151	0.127	0.100
	4218-48-8	1-Ethyl-4-i-propylbenzene	0.037	0.031	0.022
		C11 - Aromatic - 1	0.006	0.005	0.004
		1,2,4,5-Tetramethylbenzene	0.384	0.326	0.256
	527-53-7	1,2,3,5-Tetramethylbenzene	0.549	0.465	0.366
		C11 - Aromatic - 2	0.007	0.006	0.004
		C11 - Aromatic - 3	0.076	0.065	0.046
		1,2-Di-i-propylbenzene	0.075	0.064	0.041
	1595-16-0	1-methyl-4-(1-methylpropyl)be	0.112	0.095	0.067
		C11 - Aromatic - 4	0.055	0.047	0.033
	5161-04-6	Benzene, 1-methyl-4-(2-methylp	0.076	0.064	0.046
	538-68-1	n-Pentylbenzene	0.032	0.027	0.019
		tert-Pentylbenzene	0.114	0.096	0.069
	577-55-9	1-Methyl-2-n-butylbenzene	0.052	0.044	0.031
		C11 - Aromatic - 7	0.067	0.059	0.040
	100-18-5	1,4-Di-i-propylbenzene	0.092	0.078	0.051
		C12-Aromatic-1	0.006	0.006	0.003
		C11 - Aromatic - 10	0.012	0.010	0.007
		1,3-Di-n-propylbenzene	0.038	0.032	0.021
		C11 - Aromatic - 11	0.020	0.018	0.012
		C11 - Aromatic - 12	0.010	0.009	0.006
		C11 - Aromatic - 13	0.002	0.002	0.001
		C12 - Aromatic - 1	0.006	0.005	0.004
		C12 - Aromatic - 11	0.005	0.005	0.003
	877-44-1	1,2,4-Triethylbenzene	0.006	0.005	0.003
	700-12-9	Pentamethylbenzene	0.027	0.020	0.016
		C13 - Aromatic - 2	0.003	0.002	0.001
Naphthalenes	91-20-3	Naphthalene	0.136	0.100	0.095
	91-57-6	2-Methylnaphthalene	0.239	0.177	0.149
	90-12-0	1-Methylnaphthalene	0.110	0.081	0.069
		Dimethylnaphthalene-3	0.018	0.014	0.010
		Dimethylnaphthalene-4	0.020	0.015	0.011

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Cycloalkane (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Naphthalenes		Dimethylnaphthalene-5	0.045	0.035	0.026
		Dimethylnaphthalene - 6	0.027	0.021	0.016
		Dimethylnaphthalene-5(1)	0.020	0.016	0.012
		Dimethylnaphthalene-6	0.012	0.009	0.007
Naphtheno/Olefin		Indan	0.085	0.066	0.064
		2-Methylindan	0.026	0.020	0.018
	874-35-1	5-Methylindan	0.199	0.168	0.134
	824-22-6	4-Methylindan	0.256	0.217	0.173
	824-63-5	2-Methylindan(1)	0.175	0.148	0.118
		4,7-Dimethyl Indane	0.016	0.013	0.010
		1,1-Dimethyl Indane	0.016	0.012	0.010
		Dimethyl Indane - 1	0.007	0.005	0.004
		C2 Indane - 1	0.004	0.003	0.002
		4,7-DimethylIndane	0.014	0.011	0.009
		Dimethyl Indane - 3	0.010	0.008	0.006
		Dimethyl Indane - 4	0.008	0.006	0.005
		C3 Indane - 6	0.021	0.017	0.012
Indenes					
Naphthenes					
Mono-Naphthene	287-92-3	Cyclopentane	19.960	20.191	25.455
	96-37-7	Methylcyclopentane	0.974	0.982	1.036
	110-82-7	Cyclohexane	0.121	0.117	0.128
	1759-58-6	1t,3-Dimethylcyclopentane	0.037	0.037	0.034
	2532-58-3	1c,3-Dimethylcyclopentane	0.033	0.033	0.030
	822-50-4	1t,2-Dimethylcyclopentane	0.043	0.043	0.039
	108-87-2	Methylcyclohexane	0.154	0.151	0.140
	4516-69-2	1,1,3-Trimethylcyclopentane	0.017	0.017	0.014
	1640-89-7	Ethylcyclopentane	0.014	0.014	0.013
	4850-28-6	1c,2t,4-Trimethylcyclopentane	0.036	0.036	0.029
	15890-40-1	1t,2c,3-Trimethylcyclopentane	0.042	0.041	0.033
		1,3-dimethyl-t-cyclohexane	0.390	0.382	0.311
		3c-Ethylmethylcyclopentane	0.034	0.033	0.027
	624-29-3	1c,4-Dimethylcyclohexane	0.221	0.213	0.176
	2207-01-4	1c,2-Dimethylcyclohexane	0.092	0.087	0.073
	1678-91-7	Ethylcyclohexane	0.490	0.471	0.391
		C9 - MonoNaph - 1	0.250	0.244	0.177
	7094-27-1	1,1,4-Trimethylcyclohexane	0.031	0.031	0.022
	3073-66-3	1,1,3-Trimethylcyclohexane	0.056	0.053	0.040
	7667-60-9	1c,2t,4t-Trimethylcyclohexane	0.312	0.302	0.221
		C9 - MonoNaph - 4	0.059	0.058	0.042
		1c,2t,4c-Trimethylcyclohexane	0.079	0.077	0.056
		Cyclohexane, 1,2,4-trimethyl-,	0.055	0.054	0.039
	3728-57-2	Cyclopentane, 1-methyl-2-propy	0.096	0.082	0.081
		trans-1,3-Diethylcyclopentane	0.213	0.183	0.151
	4926-90-3	1,1-Methylethylcyclohexane	0.113	0.106	0.080

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Cycloalkane (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Naphthene		1-ethyl-4-t-methylcyclohexane	0.029	0.027	0.020
	696-29-7	1-Methyl-2-propyl-cyclopentan	0.006	0.005	0.004
		1,2,3,5-t-Tetramethylcyclohex	0.049	0.048	0.035
	1678-98-4	i-Butylcyclohexane	0.026	0.025	0.017
		n-ButylCyclohexane	0.016	0.015	0.010
Di/Bicyclo-Napht					
Olefins					
n-Olefins	624-64-6	t-Butene-2	0.003	0.004	0.005
	592-41-6	Hexene-1	0.814	0.905	0.865
	4050-45-7	t-Hexene-2	0.006	0.006	0.006
	14919-01-8	t-Octene-3	0.003	0.003	0.002
	20063-92-7	t-Nonene-3	0.032	0.036	0.023
		C10-n-Olefin	0.008	0.008	0.005
	693-61-8	2-Undecene, (E)-	0.011	0.011	0.007
		5-Undecene	0.011	0.011	0.007
Iso-Olefins	625-27-4	2-Methylpentene-2	0.005	0.005	0.005
	922-62-3	3-Methyl-c-pentene-2	0.003	0.004	0.004
		C8 - Diolefin - 1	0.015	0.015	0.012
		C8 - IsoOlefin - 7	0.007	0.007	0.006
	4485-16-9	3-Heptene, 4-methyl-	0.214	0.211	0.171
	14850-22-7	C8-IsoOlefin-9	0.016	0.016	0.013
		2,3,3-Trimethylhexene-1	0.013	0.014	0.009
		C9 - IsoOlefin - 1	0.012	0.012	0.010
	2213-23-2	2,3-Dimethyl-3-heptene	0.016	0.018	0.011
	4588-18-5	2-Methyloctene-1	0.032	0.035	0.023
	33933-74-4	3-Heptene, 4-ethyl-	0.014	0.014	0.010
	19549-87-2	2,4-Dimethylheptene-1	0.022	0.025	0.016
		C9-IsoOlefin-3	0.025	0.024	0.018
	16993-86-4	2-Methyloctene-2	0.019	0.021	0.013
	3074-64-4	2,3-Dimethylheptene-2	0.012	0.014	0.009
		C10-IsoOlefin-4	0.006	0.006	0.004
		C10 Iso-olefin - 5	0.050	0.054	0.032
		C10 Iso-olefin - 6	0.007	0.008	0.005
		C10-IsoOlefin-7	0.011	0.012	0.007
		C10-IsoOlefin-12	0.014	0.015	0.009
	69405-42-1	3-Nonene, 3-methyl-, (E)-	0.005	0.005	0.003
Naphtheno-Olefin	693-89-0	1-Methylcyclopentene	0.007	0.007	0.007
		C9 - NaphOlefin - 2	0.040	0.041	0.029
		C9-NaphthenoOlefin-6	0.000	0.000	0.000
Di-Olefins					
Oxygenates					
Unidentified		Unidentified	0.005	0.005	0.004
		Unidentified	0.029	0.028	0.023

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Cycloalkane (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Unidentified		Unidentified	0.052	0.051	0.041
		Unidentified	0.006	0.006	0.005
		Unidentified	0.003	0.002	0.002
		Unidentified	0.011	0.011	0.008
		Unidentified	0.021	0.021	0.015
		Unidentified	0.083	0.086	0.060
		Unidentified	0.017	0.018	0.011
		Unidentified	0.006	0.006	0.004
		Unidentified	0.004	0.004	0.002
		Unidentified	0.032	0.035	0.021
		Unidentified	0.003	0.003	0.002
		Unidentified	0.033	0.028	0.025
		Unidentified	0.006	0.005	0.003
		Unidentified	0.007	0.006	0.004
		Unidentified	0.008	0.007	0.005
		Unidentified	0.023	0.019	0.014
		Unidentified	0.004	0.004	0.002
		Unidentified	0.013	0.011	0.007
		Unidentified	0.001	0.001	0.000
		Unidentified	0.009	0.009	0.004
		Unidentified	0.001	0.001	0.001
		Unidentified	0.012	0.012	0.005
		Unidentified	0.010	0.010	0.004
		Unidentified	0.002	0.002	0.001
		Unidentified	0.016	0.016	0.007
		Unidentified	0.011	0.010	0.004
		Unidentified	0.003	0.003	0.001
		Unidentified	0.011	0.010	0.004
		Unidentified	0.010	0.010	0.004
		Unidentified	0.005	0.005	0.002
		Unidentified	0.005	0.005	0.002
		Unidentified	0.003	0.003	0.001
		Unidentified	0.006	0.006	0.003
		Unidentified	0.002	0.002	0.001
		Unidentified	0.005	0.005	0.002
		Unidentified	0.004	0.004	0.002
		Unidentified	0.004	0.004	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.006	0.006	0.003
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.001	0.001

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Group	CASNO	Component	%Wgt	%Vol	%Mol
Paraffin	106-97-8	n-Butane	2.715	3.513	3.411
	109-66-0	n-Pentane	2.642	3.161	2.675
	110-54-3	n-Hexane	2.655	3.015	2.250
	142-82-5	n-Heptane	0.044	0.048	0.032
	111-65-9	n-Octane	0.887	0.945	0.567
	111-84-2	n-Nonane	1.182	1.234	0.673
	124-18-5	n-Decane	0.439	0.451	0.225
	1120-21-4	n-Undecane	0.411	0.414	0.192
	112-40-3	n-Dodecane	0.078	0.077	0.033
	629-59-4	n-Tetradecane	0.027	0.026	0.010
	629-62-9	n-Pentadecane	0.001	0.001	0.000
I-Paraffins	463-82-1	2,2-Dimethylpropane	0.005	0.006	0.005
	78-78-4	i-Pentane	2.042	2.469	2.067
	75-83-2	2,2-Dimethylbutane	0.327	0.377	0.277
	79-29-8	2,3-Dimethylbutane	0.787	0.891	0.667
	107-83-5	2-Methylpentane	1.654	1.897	1.402
	96-14-0	3-Methylpentane	1.452	1.637	1.231
	108-08-7	2,4-Dimethylpentane	0.706	0.786	0.515
	464-06-2	2,2,3-Trimethylbutane	0.054	0.059	0.040
	562-49-2	3,3-Dimethylpentane	0.107	0.116	0.078
	591-76-4	2-Methylhexane	1.104	1.218	0.805
	589-34-4	3-Methylhexane	0.481	0.524	0.350
	617-78-7	3-Ethylpentane	0.026	0.028	0.019
	540-84-1	2,2,4-Trimethylpentane	4.323	4.680	2.764
	564-02-3	2,2,3-Trimethylpentane	0.300	0.314	0.192
	592-13-2	2,5-Dimethylhexane	0.615	0.664	0.393
	589-43-5	2,4-Dimethylhexane	0.530	0.567	0.339
	563-16-6	3,3-Dimethylhexane	0.006	0.006	0.004
	565-75-3	2,3,4-Trimethylpentane	1.729	1.801	1.106
	560-21-4	2,3,3-Trimethylpentane	1.783	1.839	1.140
	584-94-1	2,3-Dimethylhexane	0.495	0.521	0.316
	592-27-8	2-Methylheptane	0.285	0.306	0.182
	589-53-7	4-Methylheptane	0.143	0.152	0.091
	583-48-2	3,4-Dimethylhexane	0.063	0.066	0.040
	589-81-1	3-Methylheptane	0.222	0.235	0.142
	619-99-8	3-Ethylhexane	0.278	0.292	0.178
	3522-94-9	2,2,5-Trimethylhexane	0.775	0.821	0.441
		C9-Isoparaffin-x	0.045	0.046	0.026
	1069-53-0	2,3,5-Trimethylhexane	0.118	0.123	0.067
	1071-26-7	2,4-Dimethylheptane	0.126	0.133	0.072
	16747-25-4	2,2,3-Trimethylhexane	0.010	0.010	0.006
	1072-05-5	2,6-Dimethylheptane	0.290	0.307	0.165
		2,5-Dimethylheptane	0.215	0.225	0.122
		3,5-Dimethylheptane	0.058	0.061	0.033
	2216-32-2	4-Ethylheptane	0.100	0.104	0.057
	2216-34-4	4-Methyloctane	0.318	0.331	0.181

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E30 (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
I-Paraffins	3221-61-2	2-Methyloctane	0.396	0.416	0.225
	2216-33-3	3-Methyloctane	0.885	0.920	0.504
		C10 - IsoParaffin - 1	0.128	0.132	0.066
	14720-74-2	2,2,4-trimethylheptane	0.279	0.287	0.143
		C10-isoparaffin-x	0.000	0.000	0.000
		2,3-Dimethyloctane	0.084	0.087	0.043
	15869-87-1	2,2-Dimethyloctane	0.042	0.043	0.021
	15869-89-3	2,5-Dimethyloctane	0.066	0.068	0.034
	2040-95-1	2,7-Dimethyloctane	0.017	0.018	0.009
	2051-30-1	2,4-Dimethyloctane	0.058	0.059	0.030
		2,6-Dimethyloctane	0.120	0.123	0.062
		3-Methyl-5-ethylheptane	0.072	0.075	0.037
	15869-85-9	5-Methylnonane	0.053	0.054	0.027
	917301-94-8	4-Methylnonane	0.118	0.121	0.061
		2,2,6-Trimethyloctane	0.218	0.225	0.112
	5881-17-4	3-Ethyloctane	0.029	0.029	0.015
	5911-04-6	3-Methylnonane	0.084	0.086	0.043
		C11-Isoparaffin-1	0.105	0.105	0.049
		C11-Isoparaffin-2	0.033	0.033	0.015
		C10 - IsoParaffin - 5	0.061	0.063	0.032
	62016-30-4	2,3,3-trimethyloctane	0.049	0.049	0.023
		C11-Isoparaffin-3	0.020	0.020	0.009
		C11 Isoparaffin-4	0.038	0.039	0.018
		C11-Isoparaffin-5	0.117	0.118	0.055
		2,5,6-Trimethyloctane	0.175	0.176	0.082
		C11-Isoparaffin-7	0.113	0.114	0.053
		C11-Isoparaffin-8	0.030	0.030	0.014
		C11-Isoparaffin-9	0.051	0.052	0.024
		C11- Isoparaffin-11	0.125	0.126	0.058
		C11- Isoparaffin - 12	0.044	0.044	0.020
		C11- IsoParaffin - 13	0.051	0.052	0.024
		C12 - IsoParaffin - 1	0.079	0.080	0.034
		C12 - IsoParaffin - 2	0.069	0.070	0.030
		C12 - Isoparaffin - 3	0.032	0.032	0.014
		C12 - IsoParaffin - 4	0.048	0.047	0.020
		C14-Isoparaffin-1	0.004	0.004	0.001
Aromatics					
Mono-Aromatics	71-42-3	Benzene	0.803	0.684	0.751
	108-88-3	Toluene	4.448	3.842	3.526
	100-41-4	Ethylbenzene	0.575	0.496	0.395
	108-38-3	m-Xylene	1.393	1.207	0.958
	106-42-3	p-Xylene	0.635	0.553	0.437
	95-47-6	o-Xylene	0.728	0.619	0.501
	98-82-8	i-Propylbenzene	0.019	0.017	0.012
	103-65-1	n-Propylbenzene	0.205	0.178	0.125
	620-14-4	1-Methyl-3-ethylbenzene	0.695	0.602	0.423

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E30 (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Aromatics	622-96-8	1-Methyl-4-ethylbenzene	0.342	0.298	0.208
	108-67-8	1,3,5-Trimethylbenzene	0.450	0.390	0.274
	611-14-3	1-Methyl-2-ethylbenzene	0.234	0.199	0.142
	95-63-6	1,2,4-Trimethylbenzene	1.107	0.947	0.673
	538-93-2	i-Butylbenzene	0.064	0.056	0.035
	526-73-8	1,2,3-Trimethylbenzene	0.237	0.199	0.144
	535-77-3	1-Methyl-3-i-propylbenzene	0.012	0.011	0.007
	99-87-6	1-Methyl-4-i-propylbenzene	0.029	0.025	0.016
	141-93-5	1,3-Diethylbenzene	0.054	0.047	0.030
	1074-43-7	1-Methyl-3-n-propylbenzene	0.276	0.240	0.150
	105-05-5	1,4-Diethylbenzene	0.106	0.092	0.058
	104-51-8	n-Butylbenzene	0.025	0.022	0.014
	934-74-7	1,3-Dimethyl-5-ethylbenzene	0.130	0.111	0.071
	135-01-3	1,2-Diethylbenzene	0.060	0.051	0.032
	1074-17-5	1-Methyl-2-n-propylbenzene	0.076	0.065	0.041
	1758-88-9	1,4,Dimethyl-2-ethylbenzene	0.106	0.091	0.058
	874-41-9	1,3-Dimethyl-4-ethylbenzene	0.121	0.104	0.066
	934-80-5	1,2-Dimethyl-4-ethylbenzene	0.255	0.219	0.139
	2870-04-4	1,3-Dimethyl-2-ethylbenzene	0.154	0.129	0.084
		1-Methyl-4-t-butylbenzene	0.049	0.043	0.024
		1-Ethyl-3-i-propylbenzene	0.052	0.044	0.026
	933-98-2	1,2-Dimethyl-3-ethylbenzene	0.087	0.073	0.047
	4218-48-8	1-Ethyl-4-i-propylbenzene	0.102	0.086	0.050
		1,2,4,5-Tetramethylbenzene	0.257	0.217	0.140
	527-53-7	1,2,3,5-Tetramethylbenzene	0.305	0.257	0.166
		C11 - Aromatic - 2	0.013	0.011	0.007
		C11 - Aromatic - 3	0.038	0.032	0.019
		1,2-Di-i-propylbenzene	0.045	0.037	0.020
	1595-16-0	1-methyl-4-(1-methylpropyl)be	0.072	0.060	0.035
		C11 - Aromatic - 4	0.083	0.070	0.041
	5161-04-6	Benzene, 1-methyl-4-(2-methylp	0.034	0.029	0.017
	538-68-1	n-Pentylbenzene	0.023	0.019	0.011
		tert-Pentylbenzene	0.063	0.053	0.031
	577-55-9	1-Methyl-2-n-butylbenzene	0.025	0.021	0.012
		C11 - Aromatic - 7	0.059	0.052	0.029
	100-18-5	1,4-Di-i-propylbenzene	0.051	0.043	0.023
		C12-Aromatic-1	0.012	0.011	0.006
		C11 - Aromatic - 10	0.019	0.017	0.010
		1,3-Di-n-propylbenzene	0.034	0.029	0.015
		C11 - Aromatic - 11	0.013	0.012	0.006
		C11 - Aromatic - 12	0.012	0.010	0.006
		C11 - Aromatic - 13	0.004	0.004	0.002
		C11 - Aromatic - 14	0.009	0.008	0.004
		C12 - Aromatic - 1	0.011	0.009	0.005
		C12 - Aromatic - 3	0.001	0.001	0.001
		C12 - Aromatic - 7	0.001	0.001	0.000
		C12 - Aromatic -8	0.001	0.000	0.000

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E30 (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Aromatics		C12 - Aromatic - 10	0.002	0.002	0.001
	877-44-1	1,2,4-Triethylbenzene	0.010	0.008	0.005
	700-12-9	Pentamethylbenzene	0.039	0.030	0.019
		C13 - Aromatic - 2	0.004	0.003	0.002
Naphthalenes	91-20-3	Naphthalene	0.133	0.097	0.076
	91-57-6	2-Methylnaphthalene	0.256	0.188	0.130
	90-12-0	1-Methylnaphthalene	0.125	0.092	0.064
		Dimethylnaphthalene-4	0.021	0.017	0.010
		Dimethylnaphthalene - 6	0.050	0.039	0.024
		Dimethylnaphthalene-5(1)	0.018	0.014	0.008
		Dimethylnaphthalene-6	0.012	0.010	0.006
Naphtheno/Olefin		Indan	0.114	0.088	0.070
		2-Methylindan	0.071	0.055	0.039
	874-35-1	5-Methylindan	0.120	0.101	0.066
	824-22-6	4-Methylindan	0.158	0.133	0.087
	824-63-5	2-Methylindan(1)	0.098	0.082	0.054
		4,7-Dimethyl Indane	0.024	0.019	0.012
		1,1-Dimethyl Indane	0.011	0.009	0.006
		Dimethyl Indane - 1	0.006	0.005	0.003
		C2 Indane - 1	0.005	0.004	0.003
		C3-Indane-2	0.002	0.001	0.001
		4,7-DimethylIndane	0.021	0.016	0.010
		Dimethyl Indane - 3	0.013	0.010	0.007
		Dimethyl Indane - 4	0.006	0.005	0.003
Indenes		Diimethyl Indene - 2	0.001	0.000	0.000
Naphthenes					
Mono-Naphthene	287-92-3	Cyclopentane	0.698	0.701	0.727
	96-37-7	Methylcyclopentane	1.155	1.156	1.003
	110-82-7	Cyclohexane	0.134	0.129	0.116
	1759-58-6	1t,3-Dimethylcyclopentane	0.031	0.031	0.023
	2532-58-3	1c,3-Dimethylcyclopentane	0.026	0.027	0.020
	822-50-4	1t,2-Dimethylcyclopentane	0.032	0.032	0.024
	108-87-2	Methylcyclohexane	0.130	0.127	0.097
	4516-69-2	1,1,3-Trimethylcyclopentane	0.016	0.016	0.010
	1640-89-7	Ethylcyclopentane	0.017	0.016	0.012
	4850-28-6	1c,2t,4-Trimethylcyclopentane	0.041	0.040	0.027
	15890-40-1	1t,2c,3-Trimethylcyclopentane	0.049	0.048	0.032
		1c,2t,3-Trimethylcyclopentane	0.008	0.007	0.005
		1,3-dimethyl-t-cyclohexane	0.714	0.695	0.465
		3c-Ethylmethylcyclopentane	0.087	0.085	0.057
		3t-Ethylmethylcyclopentane	0.094	0.092	0.061
	930-89-2	Cyclopentane, 1-ethyl-2-methyl	0.025	0.025	0.016
	2207-01-4	1c,2-Dimethylcyclohexane	0.170	0.160	0.110

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E30 (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Naphthene	1678-91-7	Ethylcyclohexane	0.922	0.881	0.600
		C9 - MonoNaph - 1	0.462	0.448	0.267
	7094-27-1	1,1,4-Trimethylcyclohexane	0.061	0.059	0.035
	3073-66-3	1,1,3-Trimethylcyclohexane	0.109	0.103	0.063
	7667-60-9	1c,2t,4t-Trimethylcyclohexane	0.650	0.624	0.376
		C9 - MonoNaph - 4	0.133	0.129	0.077
		1c,2t,4c-Trimethylcyclohexane	0.189	0.183	0.109
		Cyclohexane, 1,2,4-trimethyl-,	0.123	0.120	0.071
	3728-57-2	Cyclopentane, 1-methyl-2-propy	0.215	0.183	0.148
		trans-1,3-Diethylcyclopentane	0.422	0.359	0.244
	4926-90-3	1,1-Methylethylcyclohexane	0.203	0.188	0.117
		1-ethyl-4-t-methylcyclohexane	0.056	0.052	0.032
	696-29-7	1-Methyl-2-propyl-cyclopentan	0.008	0.007	0.005
		1,2,3,5-t-Tetramethylcyclohex	0.112	0.109	0.065
	1678-98-4	i-Butylcyclohexane	0.064	0.060	0.033
		C10 - MonoNaph - 2	0.013	0.012	0.007
		n-ButylCyclohexane	0.078	0.072	0.041
Di/Bicyclo-Napht					
Olefins					
n-Olefins	592-41-6	Hexene-1	3.577	3.952	3.105
	13269-52-8	t-Hexene-3	0.005	0.005	0.004
	4050-45-7	t-Hexene-2	0.014	0.015	0.012
	7688-21-3	c-Hexene-2	0.004	0.004	0.004
	14919-01-8	t-Octene-3	0.005	0.005	0.003
		C9-isoolefin	0.033	0.036	0.019
	20063-92-7	t-Nonene-3	0.069	0.076	0.040
		C10-n-Olefin	0.017	0.017	0.009
	693-61-8	2-Undecene, (E)-	0.035	0.036	0.018
		5-Undecene	0.048	0.049	0.025
Iso-Olefins	625-27-4	2-Methylpentene-2	0.008	0.009	0.007
	922-62-3	3-Methyl-c-pentene-2	0.007	0.007	0.006
		C8 - Diolefin - 1	0.022	0.021	0.014
		C8 - IsoOlefin - 7	0.008	0.008	0.005
	4485-16-9	3-Heptene, 4-methyl-	0.399	0.391	0.260
	14850-22-7	C8-IsoOlefin-9	0.033	0.032	0.021
		C8 - IsoOlefin - 10	0.025	0.024	0.016
		C9 - IsoOlefin - 1	0.022	0.021	0.014
	2213-23-2	2,3-Dimethyl-3-heptene	0.032	0.035	0.018
	4588-18-5	2-Methyloctene-1	0.064	0.070	0.037
	33933-74-4	3-Heptene, 4-ethyl-	0.028	0.027	0.016
	19549-87-2	2,4-Dimethylheptene-1	0.038	0.042	0.022
		C9-IsoOlefin-3	0.043	0.041	0.025
	16993-86-4	2-Methyloctene-2	0.040	0.044	0.023
	3074-64-4	2,3-Dimethylheptene-2	0.025	0.027	0.014
		C10-IsoOlefin-4	0.008	0.008	0.004

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E30 (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Iso-Olefins		C10 Iso-olefin - 5	0.083	0.088	0.043
		C10 Iso-olefin - 6	0.012	0.013	0.006
		C10-IsoOlefin-7	0.039	0.042	0.020
		C10 - IsoOlefin - 8	0.012	0.013	0.006
		C10-IsoOlefin-12	0.051	0.054	0.026
		C10-IsoOlefin -15	0.080	0.085	0.042
	69405-42-1	3-Nonene, 3-methyl-, (E)-	0.021	0.021	0.011
Naphtheno-Olefin	693-89-0	1-Methylcyclopentene	0.010	0.010	0.009
		C9 Naph-Olefin -1	0.174	0.178	0.103
		C9 - NaphOlefin - 2	0.088	0.090	0.052
		C9-NaphthenoOlefin-6	0.000	0.000	0.000
Di-Olefins					
Oxygenates	64-17-5	Ethanol	31.989	30.368	50.719
Unidentified		Unidentified	0.000	0.001	0.001
		Unidentified	0.017	0.023	0.022
		Unidentified	0.006	0.006	0.008
		Unidentified	0.008	0.009	0.006
		Unidentified	0.024	0.025	0.016
		Unidentified	0.058	0.056	0.038
		Unidentified	0.947	0.925	0.616
		Unidentified	0.407	0.398	0.265
		Unidentified	0.005	0.005	0.003
		Unidentified	0.021	0.020	0.012
		Unidentified	0.063	0.066	0.036
		Unidentified	0.036	0.035	0.021
		Unidentified	0.204	0.210	0.116
		Unidentified	0.048	0.046	0.028
		Unidentified	0.038	0.039	0.019
		Unidentified	0.003	0.003	0.001
		Unidentified	0.006	0.006	0.004
		Unidentified	0.006	0.007	0.003
		Unidentified	0.006	0.005	0.003
		Unidentified	0.008	0.008	0.005
		Unidentified	0.015	0.015	0.007
		Unidentified	0.015	0.015	0.009
		Unidentified	0.018	0.018	0.009
		Unidentified	0.014	0.015	0.007
		Unidentified	0.011	0.010	0.006
		Unidentified	0.008	0.008	0.004
		Unidentified	0.009	0.008	0.005
		Unidentified	0.022	0.022	0.010
		Unidentified	0.022	0.019	0.012
		Unidentified	0.008	0.006	0.005
		Unidentified	0.026	0.026	0.012

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E30 (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Unidentified		Unidentified	0.102	0.087	0.055
		Unidentified	0.030	0.023	0.017
		Unidentified	0.020	0.020	0.010
		Unidentified	0.016	0.016	0.007
		Unidentified	0.020	0.020	0.010
		Unidentified	0.061	0.056	0.029
		Unidentified	0.016	0.016	0.007
		Unidentified	0.065	0.055	0.036
		Unidentified	0.044	0.037	0.024
		Unidentified	0.042	0.035	0.020
		Unidentified	0.020	0.017	0.010
		Unidentified	0.008	0.007	0.004
		Unidentified	0.027	0.027	0.011
		Unidentified	0.013	0.013	0.006
		Unidentified	0.030	0.030	0.013
		Unidentified	0.008	0.008	0.003
		Unidentified	0.002	0.002	0.001
		Unidentified	0.004	0.003	0.002
		Unidentified	0.002	0.001	0.001
		Unidentified	0.001	0.001	0.000
		Unidentified	0.002	0.001	0.001
		Unidentified	0.004	0.003	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.010	0.010	0.004
		Unidentified	0.002	0.001	0.001
		Unidentified	0.001	0.001	0.000
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.020	0.015	0.009
		Unidentified	0.022	0.017	0.010
		Unidentified	0.004	0.003	0.002
		Unidentified	0.013	0.013	0.005
		Unidentified	0.002	0.002	0.001
		Unidentified	0.009	0.009	0.003
		Unidentified	0.003	0.003	0.001
		Unidentified	0.009	0.008	0.003
		Unidentified	0.008	0.008	0.003
		Unidentified	0.004	0.004	0.001
		Unidentified	0.004	0.004	0.001
		Unidentified	0.012	0.012	0.004
		Unidentified	0.010	0.010	0.004
		Unidentified	0.002	0.002	0.001
		Unidentified	0.007	0.007	0.002
		Unidentified	0.006	0.006	0.002
		Unidentified	0.004	0.004	0.001
		Unidentified	0.006	0.006	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.005	0.005	0.002
		Unidentified	0.004	0.004	0.002
		Unidentified	0.006	0.006	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.004	0.004	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.003	0.003	0.001
		Unidentified	0.002	0.002	0.001

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Olefin

Group	CASNO	Component	%Wgt	%Vol	%Mol
Paraffin	106-97-8	n-Butane	4.172	5.608	7.443
	109-66-0	n-Pentane	2.240	2.784	3.220
	110-54-3	n-Hexane	1.717	2.026	2.066
	142-82-5	n-Heptane	0.049	0.056	0.051
	111-65-9	n-Octane	0.275	0.305	0.250
	111-84-2	n-Nonane	0.558	0.605	0.451
	124-18-5	n-Decane	0.371	0.396	0.270
	1120-21-4	n-Undecane	0.174	0.182	0.116
	112-40-3	n-Dodecane	0.032	0.033	0.019
	629-59-4	n-Tetradecane	0.019	0.020	0.010
I-Paraffins	463-82-1	2,2-Dimethylpropane	0.005	0.007	0.008
	78-78-4	i-Pentane	1.879	2.360	2.701
	75-83-2	2,2-Dimethylbutane	0.014	0.017	0.017
	79-29-8	2,3-Dimethylbutane	1.036	1.219	1.247
	107-83-5	2-Methylpentane	0.929	1.106	1.117
	96-14-0	3-Methylpentane	0.855	1.002	1.029
	108-08-7	2,4-Dimethylpentane	0.944	1.092	0.977
	464-06-2	2,2,3-Trimethylbutane	0.069	0.078	0.072
	562-49-2	3,3-Dimethylpentane	0.058	0.066	0.060
	591-76-4	2-Methylhexane	1.042	1.194	1.078
	589-34-4	3-Methylhexane	0.377	0.427	0.390
	540-84-1	2,2,4-Trimethylpentane	17.116	19.248	15.538
	590-73-8	2,2-Dimethylhexane	0.106	0.119	0.097
	564-02-3	2,2,3-Trimethylpentane	0.616	0.670	0.559
	592-13-2	2,5-Dimethylhexane	1.055	1.184	0.958
	589-43-5	2,4-Dimethylhexane	0.898	0.998	0.816
	565-75-3	2,3,4-Trimethylpentane	3.189	3.452	2.895
	560-21-4	2,3,3-Trimethylpentane	3.335	3.574	3.028
	584-94-1	2,3-Dimethylhexane	0.843	0.921	0.766
	592-27-8	2-Methylheptane	0.121	0.135	0.110
	589-53-7	4-Methylheptane	0.107	0.118	0.097
	583-48-2	3,4-Dimethylhexane	0.079	0.086	0.072
	589-81-1	3-Methylheptane	0.091	0.101	0.083
	619-99-8	3-Ethylhexane	0.084	0.092	0.076
	3522-94-9	2,2,5-Trimethylhexane	1.207	1.328	0.976
		C9-Isoparaffin-x	0.037	0.039	0.030
	1069-53-0	2,3,5-Trimethylhexane	0.184	0.198	0.148
	1071-26-7	2,4-Dimethylheptane	0.054	0.059	0.043
	16747-25-4	2,2,3-Trimethylhexane	0.118	0.129	0.096
		2,5-Dimethylheptane	0.140	0.152	0.113
		2-Methyl-4-ethylhexane	0.030	0.033	0.025
	3074-71-3	2,3-Dimethylheptane	0.081	0.087	0.066
		3,5-Dimethylheptane	0.017	0.018	0.014
	1067-20-5	3,3-Diethylpentane	0.009	0.010	0.008
	2216-34-4	4-Methyloctane	0.091	0.099	0.074
	3221-61-2	2-Methyloctane	0.112	0.122	0.090

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Olefin (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
I-Paraffins	2216-33-3	3-Methyloctane	0.241	0.261	0.195
	922-28-1	3,4-Dimethylheptane	0.048	0.051	0.039
		C10 - IsoParaffin - 1	0.167	0.178	0.121
		C10-isoparaffin-x	0.000	0.000	0.000
		2,3-Dimethyloctane	0.088	0.095	0.064
	15869-87-1	2,2-Dimethyloctane	0.038	0.041	0.027
	15869-89-3	2,5-Dimethyloctane	0.060	0.064	0.044
	2040-95-1	2,7-Dimethyloctane	0.015	0.016	0.011
	2051-30-1	2,4-Dimethyloctane	0.053	0.057	0.039
		2,6-Dimethyloctane	0.104	0.110	0.075
		3-Methyl-5-ethylheptane	0.064	0.068	0.046
	15869-85-9	5-Methylnonane	0.044	0.047	0.032
	17301-94-8	4-Methylnonane	0.099	0.105	0.072
		2,2,6-Trimethyloctane	0.295	0.316	0.215
	5881-17-4	3-Ethyloctane	0.024	0.025	0.018
	5911-04-6	3-Methylnonane	0.068	0.072	0.049
		C11-Isoparaffin-1	0.121	0.127	0.080
		C11-Isoparaffin-2	0.038	0.040	0.025
		C10 - IsoParaffin - 5	0.057	0.061	0.042
	62016-30-4	2,3,3-trimethyloctane	0.059	0.062	0.039
		C11-Isoparaffin-3	0.022	0.023	0.014
		C11 Isoparaffin-4	0.035	0.036	0.023
		C11-Isoparaffin-5	0.104	0.108	0.069
		2,5,6-Trimethyloctane	0.253	0.264	0.168
		C11-Isoparaffin-7	0.132	0.139	0.088
		C11-Isoparaffin-8	0.022	0.023	0.015
		C11-Isoparaffin-9	0.050	0.052	0.033
		C11- Isoparaffin-10	0.027	0.029	0.018
		C11- Isoparaffin-11	0.157	0.164	0.104
		C11- Isoparaffin - 12	0.063	0.066	0.042
		C11- IsoParaffin - 13	0.033	0.035	0.022
		C12 - IsoParaffin - 1	0.030	0.032	0.018
		C12 - IsoParaffin - 2	0.036	0.037	0.022
		C12 - Isoparaffin - 3	0.010	0.010	0.006
		C12 - IsoParaffin - 4	0.018	0.019	0.011
		C14-Isoparaffin-1	0.006	0.006	0.003
Aromatics					
Mono-Aromatics	108-88-3	Toluene	7.631	6.849	8.589
	100-41-4	Ethylbenzene	0.513	0.461	0.501
	108-38-3	m-Xylene	1.280	1.153	1.251
	106-42-3	p-Xylene	0.580	0.524	0.567
	95-47-6	o-Xylene	0.514	0.454	0.502
	98-82-8	i-Propylbenzene	0.009	0.008	0.008
	103-65-1	n-Propylbenzene	0.101	0.091	0.087
	620-14-4	1-Methyl-3-ethylbenzene	0.304	0.273	0.262
	622-96-8	1-Methyl-4-ethylbenzene	0.162	0.146	0.140

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Olefin (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Aromatics	108-67-8	1,3,5-Trimethylbenzene	0.238	0.214	0.205
	611-14-3	1-Methyl-2-ethylbenzene	0.110	0.097	0.095
	95-63-6	1,2,4-Trimethylbenzene	0.516	0.459	0.445
	538-93-2	i-Butylbenzene	0.050	0.045	0.038
	526-73-8	1,2,3-Trimethylbenzene	0.138	0.120	0.119
	535-77-3	1-Methyl-3-i-propylbenzene	0.027	0.024	0.021
	99-87-6	1-Methyl-4-i-propylbenzene	0.040	0.036	0.031
	141-93-5	1,3-Diethylbenzene	0.027	0.025	0.021
	1074-43-7	1-Methyl-3-n-propylbenzene	0.280	0.253	0.216
	104-51-8	n-Butylbenzene	0.011	0.010	0.009
	934-74-7	1,3-Dimethyl-5-ethylbenzene	0.050	0.044	0.039
	135-01-3	1,2-Diethylbenzene	0.052	0.046	0.040
	1074-17-5	1-Methyl-2-n-propylbenzene	0.043	0.038	0.033
	874-41-9	1,3-Dimethyl-4-ethylbenzene	0.256	0.227	0.198
	934-80-5	1,2-Dimethyl-4-ethylbenzene	0.136	0.121	0.105
	2870-04-4	1,3-Dimethyl-2-ethylbenzene	0.195	0.170	0.150
		1-Methyl-4-t-butylbenzene	0.034	0.031	0.024
		1-Ethyl-3-i-propylbenzene	0.050	0.044	0.035
	933-98-2	1,2-Dimethyl-3-ethylbenzene	0.044	0.039	0.034
	4218-48-8	1-Ethyl-4-i-propylbenzene	0.075	0.066	0.053
		1,2,4,5-Tetramethylbenzene	0.146	0.128	0.113
	527-53-7	1,2,3,5-Tetramethylbenzene	0.187	0.163	0.145
		C11 - Aromatic - 2	0.007	0.007	0.005
		C11 - Aromatic - 3	0.020	0.018	0.014
		1,2-Di-i-propylbenzene	0.027	0.024	0.017
	1595-16-0	1-methyl-4-(1-methylpropyl)be	0.043	0.038	0.030
		C11 - Aromatic - 4	0.038	0.033	0.026
	5161-04-6	Benzene, 1-methyl-4-(2-methylp	0.027	0.023	0.019
	538-68-1	n-Pentylbenzene	0.015	0.013	0.010
		tert-Pentylbenzene	0.039	0.034	0.027
	577-55-9	1-Methyl-2-n-butylbenzene	0.017	0.015	0.012
		C11 - Aromatic - 7	0.034	0.031	0.024
	100-18-5	1,4-Di-i-propylbenzene	0.033	0.029	0.021
		C12-Aromatic-1	0.008	0.008	0.005
		C11 - Aromatic - 10	0.010	0.009	0.007
		1,3-Di-n-propylbenzene	0.021	0.018	0.013
		C11 - Aromatic - 11	0.008	0.007	0.006
		C11 - Aromatic - 12	0.007	0.006	0.005
		C11 - Aromatic - 13	0.004	0.003	0.003
		C11 - Aromatic - 14	0.005	0.004	0.003
		C12 - Aromatic - 1	0.004	0.004	0.003
		C12 - Aromatic -8	0.000	0.000	0.000
		C12 - Aromatic - 10	0.003	0.002	0.002
		C12 - Aromatic - 11	0.005	0.004	0.003
	877-44-1	1,2,4-Triethylbenzene	0.011	0.010	0.007
	700-12-9	Pentamethylbenzene	0.022	0.017	0.016
		C13 - Aromatic - 2	0.006	0.005	0.003

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Olefin (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Aromatics					
Naphthalenes	91-20-3	Naphthalene	0.102	0.078	0.083
	91-57-6	2-Methylnaphthalene	0.151	0.115	0.109
	90-12-0	1-Methylnaphthalene	0.074	0.056	0.054
		Dimethylnaphthalene-3	0.012	0.010	0.008
		Dimethylnaphthalene-4	0.012	0.009	0.008
		Dimethylnaphthalene-5	0.030	0.024	0.020
		Dimethylnaphthalene - 6	0.014	0.011	0.009
		Dimethylnaphthalene-5(1)	0.011	0.009	0.007
		Dimethylnaphthalene-6	0.008	0.006	0.005
Naphtheno/Olefin		Indan	0.077	0.062	0.068
		2-Methylindan	0.055	0.045	0.043
	874-35-1	5-Methylindan	0.071	0.062	0.056
	824-22-6	4-Methylindan	0.092	0.080	0.072
	824-63-5	2-Methylindan(1)	0.061	0.053	0.048
		4,7-Dimethyl Indane	0.023	0.018	0.016
		1,1-Dimethyl Indane	0.007	0.006	0.005
		Dimethyl Indane - 1	0.004	0.003	0.003
		C2 Indane - 1	0.005	0.004	0.004
		4,7-DimethylIndane	0.012	0.010	0.008
		Dimethyl Indane - 3	0.008	0.006	0.006
		Dimethyl Indane - 4	0.004	0.003	0.003
		C3 Indane - 6	0.002	0.002	0.001
Indenes		Diimethyl Indene - 2	0.000	0.000	0.000
Naphthenes					
Mono-Naphthene	287-92-3	Cyclopentane	0.013	0.013	0.019
	96-37-7	Methylcyclopentane	0.805	0.837	0.992
	110-82-7	Cyclohexane	0.099	0.099	0.122
	1759-58-6	1t,3-Dimethylcyclopentane	0.030	0.032	0.032
	2532-58-3	1c,3-Dimethylcyclopentane	0.026	0.027	0.027
	822-50-4	1t,2-Dimethylcyclopentane	0.052	0.054	0.055
	108-87-2	Methylcyclohexane	0.087	0.088	0.092
	4516-69-2	1,1,3-Trimethylcyclopentane	0.010	0.010	0.009
	4850-28-6	1c,2t,4-Trimethylcyclopentane	0.027	0.028	0.025
	15890-40-1	1t,2c,3-Trimethylcyclopentane	0.023	0.024	0.022
		1,3-dimethyl-t-cyclohexane	0.211	0.214	0.195
		3c-Ethylmethylcyclopentane	0.056	0.057	0.052
	624-29-3	1c,4-Dimethylcyclohexane	0.115	0.115	0.107
		C9-Naphthene	0.007	0.007	0.005
	1678-91-7	Ethylcyclohexane	0.264	0.262	0.244
	1795-27-3	1c,3c,5-Trimethylcyclohexane	0.009	0.009	0.008
	2040-96-2	n-Propylcyclopentane	0.135	0.136	0.125
	7094-27-1	1,1,4-Trimethylcyclohexane	0.017	0.017	0.014
		C9 - MonoNaph - 3	0.017	0.017	0.014

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Olefin (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Mono-Naphthene		C9 - MonoNaph - 4	0.031	0.031	0.026
		C9 - MonoNapth - 5	0.026	0.026	0.021
		Cyclohexane, 1,2,4-trimethyl-,	0.014	0.014	0.012
	3728-57-2	Cyclopentane, 1-methyl-2-propy	0.062	0.055	0.060
	6236-88-0	Cyclohexane, 1-ethyl-4-methyl-	0.154	0.156	0.127
	7094-26-0	1,1,2-Trimethylcyclohexane	0.184	0.179	0.151
		C10 - MonoNaph - 1	0.014	0.014	0.010
	4926-90-3	1,1-Methylethylcyclohexane	0.110	0.106	0.090
		1-ethyl-4-t-methylcyclohexane	0.028	0.027	0.023
	696-29-7	1-Methyl-2-propyl-cyclopentan	0.006	0.005	0.005
		1,2,3,5-t-Tetramethylcyclohex	0.094	0.095	0.078
	1678-98-4	i-Butylcyclohexane	0.058	0.057	0.043
		C10 - MonoNaph - 2	0.027	0.026	0.020
		n-ButylCyclohexane	0.070	0.067	0.051
Di/Bicyclo-Napht					
Olefins					
n-Olefins	592-41-6	Hexene-1	2.151	2.469	2.651
	4050-45-7	t-Hexene-2	0.007	0.008	0.009
	111-66-0	Octene-1	2.064	2.100	1.908
	14919-01-8	t-Octene-3	0.003	0.003	0.003
	111-23-6	t-Octene-2	0.002	0.002	0.002
		C9-isoolefin	0.086	0.099	0.071
	20063-92-7	t-Nonene-3	0.022	0.025	0.018
		C10-n-Olefin	0.014	0.015	0.010
	693-61-8	2-Undecene, (E)-	0.027	0.028	0.020
		5-Undecene	0.032	0.034	0.024
Iso-Olefins	625-27-4	2-Methylpentene-2	0.004	0.004	0.005
	922-62-3	3-Methyl-c-pentene-2	0.004	0.004	0.005
	107-39-1	2,2,4-Trimethyl-1-Pentene	21.249	16.534	19.674
	4914-91-4	2-Pentene, 3,4-dimethyl-, (Z)-	0.032	0.035	0.034
	107-40-4	2.2.4-Trimethyl-2-Pentene	5.590	4.350	5.176
		C8 - Diolefin - 1	0.008	0.008	0.007
	4485-16-9	3-Heptene, 4-methyl-	0.118	0.120	0.109
	14850-22-7	C8-IsoOlefin-9	0.009	0.009	0.008
		C8 - IsoOlefin - 10	0.006	0.006	0.006
		C9 - IsoOlefin - 1	0.006	0.006	0.006
	19550-75-6	t-2,2-Dimethylheptene-3	0.052	0.059	0.043
		C9 - IsoOlefin - 2	0.177	0.176	0.145
	33933-74-4	3-Heptene, 4-ethyl-	0.008	0.008	0.006
	19549-87-2	2,4-Dimethylheptene-1	0.014	0.016	0.012
		C9-IsoOlefin-3	0.016	0.016	0.013
	3074-64-4	2,3-Dimethylheptene-2	0.010	0.011	0.008
		C10-IsoOlefin-4	0.006	0.006	0.004
		C10 Iso-olefin - 5	0.049	0.055	0.036
		C10 Iso-olefin - 6	0.009	0.010	0.007

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Olefin (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Iso-Olefins		C10-IsoOlefin-7	0.034	0.038	0.025
		C10 - IsoOlefin - 8	0.009	0.010	0.007
		C10-IsoOlefin-12	0.046	0.051	0.034
		C10-IsoOlefin -15	0.090	0.100	0.067
	69405-42-1	3-Nonene, 3-methyl-, (E)-	0.016	0.017	0.012
Naphtheno-Olefin	693-89-0	1-Methylcyclopentene	0.005	0.005	0.007
		C9 Naph-Olefin -1	0.059	0.062	0.049
		C9 - NaphOlefin - 2	0.021	0.022	0.018
		C9-NaphthenoOlefin-6	0.000	0.000	0.000
Di-Olefins					
Oxygenates					
Unidentified		Unidentified	0.038	0.053	0.068
		Unidentified	0.003	0.004	0.004
		Unidentified	0.004	0.004	0.004
		Unidentified	0.013	0.014	0.013
		Unidentified	0.016	0.016	0.016
		Unidentified	0.024	0.026	0.022
		Unidentified	0.054	0.054	0.050
		Unidentified	0.012	0.012	0.010
		Unidentified	0.015	0.015	0.012
		Unidentified	0.032	0.032	0.026
		Unidentified	0.006	0.006	0.005
		Unidentified	0.006	0.007	0.005
		Unidentified	0.006	0.005	0.005
		Unidentified	0.008	0.008	0.007
		Unidentified	0.012	0.013	0.009
		Unidentified	0.012	0.012	0.010
		Unidentified	0.016	0.017	0.012
		Unidentified	0.013	0.014	0.009
		Unidentified	0.006	0.006	0.005
		Unidentified	0.007	0.007	0.005
		Unidentified	0.015	0.016	0.010
		Unidentified	0.020	0.020	0.013
		Unidentified	0.025	0.026	0.017
		Unidentified	0.092	0.084	0.071
		Unidentified	0.055	0.048	0.047
		Unidentified	0.024	0.019	0.019
		Unidentified	0.010	0.011	0.007
		Unidentified	0.008	0.008	0.005
		Unidentified	0.030	0.029	0.020
		Unidentified	0.006	0.006	0.004
		Unidentified	0.025	0.022	0.020
		Unidentified	0.027	0.024	0.019
		Unidentified	0.012	0.011	0.008
		Unidentified	0.010	0.009	0.007

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Olefin (cont.)

Group	CASNO	Component	%Wgt	%Vol	%Mol
Unidentified		Unidentified	0.008	0.008	0.005
		Unidentified	0.009	0.009	0.005
		Unidentified	0.003	0.003	0.002
		Unidentified	0.002	0.001	0.001
		Unidentified	0.004	0.004	0.003
		Unidentified	0.003	0.003	0.001
		Unidentified	0.005	0.004	0.003
		Unidentified	0.002	0.002	0.001
		Unidentified	0.007	0.007	0.004
		Unidentified	0.010	0.010	0.005
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.003	0.003	0.002
		Unidentified	0.006	0.005	0.004
		Unidentified	0.002	0.002	0.001
		Unidentified	0.007	0.007	0.004
		Unidentified	0.006	0.006	0.003
		Unidentified	0.004	0.004	0.002
		Unidentified	0.005	0.005	0.003
		Unidentified	0.004	0.004	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.006	0.006	0.003
		Unidentified	0.006	0.006	0.003
		Unidentified	0.002	0.002	0.001
		Unidentified	0.003	0.003	0.002
		Unidentified	0.003	0.003	0.002
		Unidentified	0.002	0.002	0.001
		Unidentified	0.003	0.003	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.002	0.002	0.001
		Unidentified	0.001	0.001	0.001

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