Properties of Fuels (a)

Property	Gasoline	No.2 Diesel Fuel	Methanol	Ethanol	MTBE	Propane	Compressed Natural Gas	Hydrogen	Biodiesel
Chemical Formula	C4 to C12	C8 to C25	CH3OH	C2H5OH	(CH3)3COCH3	C3H8	CH4 (83-99%), C2H6 (1-13%)	H2	C12-C22 FAME
Molecular Weight	100–105	~200	32.04	46.07	88.15	44.1	16.04	2.02	~292(q)
Composition, Weight %									
>Carbon	85–88(b)	87(g)	37.5	52.2	68.1	82	75	0	77(g)
>Hydrogen	12–15(b)	13(g)	12.6	13.1	13.7	18	25	100	12(g)
>Oxygen	0	0(g)	49.9	34.7	18.2	–	–	0	11(g)
Specific gravity, 60° F/60° F	0.72–0.78(b)	0.85(g)	0.796(h)	0.794(h)	0.744(k)	0.508(m)	0.424	0.07(o)	0.88(g)
Density, lb/gal @ 60° F	6.0–6.5(b)	7.079(g)	6.63(b)	6.61(b)	6.19(k)	4.22	1.07(n)	–	7.328(g)
Boiling temperature, °F	80–437(b)	356-644(g)	149(h)	172(h)	131(h)	-44(m)	-263.2 to -126.4(m)	-423(m)	599-662(g)
Reid vapor pressure (100° F), psi	8–15(c)	<0.2	4.6(i)	2.3(i)	7.8(l)	208	2400	–	<0.04(r)
Heating value (2)									
>Lower (Btu/gal) (d)	116,090	128,450	57,250	76,330	93,540	84,250	–	–	119,550
>Lower (Btu/lb) (d)	18,676	18,394	8,637	11,585	15,091	19,900	20,263	52,217	16,131
>Higher (Btu/gal) (d)	124,340	137,380	65,200	84,530	101,130	91,420	–	–	127,960
>Higher (Btu/lb) (d)	20,004	19,673	9,837	12,830	16,316	21,594	22,449	59,806	17,266
Octane no.(1)									
>Research octane no.	88–98(c)	–	–	–	–	112	–	130+	–
>Motor octane no.	80–88(c)	–	–	–	–	97	–	–	–
Cetane no.(1)	–	40-55(g)	–	0-54(f)	–	–	–	–	48-65(g)
Freezing point, °F	-40(e)	-40–30(4)	-143.5	-173.2	-164(h)	-305.8(m)	-296	-435(p)	26-66(g)(7)
Viscosity, mm^2/s									
>@104 °F	–	1.3-4.1(g)	–	–	–	–	–	–	4.0-6.0(g)
>@68 °F	0.5-0.6(f)	2.8-5.0(f)	0.74(f)	1.50(f)	0.47(f)	–	–	–	–
>@-4 °F	0.8-1.0(f)	9.0-24.0(f)	1.345(f)	3.435(f)	0.77(f)	–	–	–	–
Flash point, closed cup, °F	-45(b)	140-176(g)	52(i)	55(i)	-14(c)	-156(m)	-300	–	212-338(g)
Autoignition temperature, °F	495(b)	~600	867(b)	793(b)	815	842(m)	900-1170(m)	932(m)	–
Water solubility, @ 70° F									–
>Fuel in water, volume %	Negligible	Negligible	100(h)	100(h)	4.8(f)	–	–	–	–
>Water in fuel, volume %	Negligible	Negligible	100(h)	100(h)	1.5(f)	–	–	–	–
Flammability limits, volume%									
>Lower	1.4(b)	1.0	7.3(i)	4.3(i)	1.6(c,e)	2.2	5.3	4.1(o)	–
>Higher	7.6(b)	6.0	36.0(i)	19.0(i)	8.4(c,e)	9.5	15	74(o)	–
Latent heat of vaporization									
>Btu/gal @ 60° F	~900(b)	~710	3,340(b)	2,378(b)	863(5)	775	–	–	–
>Btu/lb @ 60° F	~150	~100	506(b)	396(b)	138(5)	193.1	219	192.1(p)	–
Specific heat, Btu/lb °F	0.48(e)	0.43	0.60(j)	0.57(j)	0.50(j)	–	–	–	
Stoichiometric air/fuel, weight	14.7	14.7	6.45	9.00	11.7	15.7	17.2	34.3(o)	13.8(g)
Volume % fuel in vaporized stoichiometric mixture	2.0 (b)	–	12.3(b)	6.5(b)	2.7(l)	–	–	–	–

Sources:

(a) The basis of this table and associated references was taken from: American Petroleum Institute (API), Alcohols and Ethers, Publication No. 4261, 3rd ed. (Washington, DC, June 2001), Table B-1.
(b) “Alcohols: A Technical Assessment of Their Application as Motor Fuels,” API Publication No. 4261, July 1976.
(c) Petroleum Product Surveys, Motor Gasoline, Summer 1986, Winter 1986/1987, National Institute for Petroleum and Energy Research.
(d) Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model, Argonne National Laboratory, accessed 11-20-06
(e) “Status of Alcohol Fuels Utilization Technology for Highway Transportation: A 1981 Perspective,” Vol. 1, Spark-Ignition Engine, May 1982, DOE/CE-56051-7.
(f) American Petroleum Institute (API), Alcohols and Ethers, Publication No. 4261, 3rd ed. (Washington, DC, June 2001), Table 2
(g) J. Tuttle and T. von Kuegelgen, Biodiesel Handling and Use Guidelines--Third Edition, National Renewable Energy Laboratory, 2004.
(h) Handbook of Chemistry and Physics, 62nd Edition, 1981, The Chemical Rubber Company Press, Inc.
(i) API Technical Data Book – Petroleum Refining, Volume I, Chapter I. Revised Chapter 1 to First, Second, Third and Fourth Editions, 1988.
(j) “Data Compilation Tables of Properties of Pure Compounds,” Design Institute for Physical Property Data, American Institute of Chemical Engineers, New York, 1984.
(k) API Monograph Series, Publication 723, “Teri-Butyl Methyl Ether,” 1984.
(l) ARCO Chemical Company, 1987.
(m) Praxair, Inc. Material Safety Data Sheets for Propane, CNG, and Hydrogen. September 2004. Danbury, CT USA.
(n) Value at 80 degrees F with respect to the water at 60 degrees F (Mueller & Associates).
(o) C. Borusbay and T. Nejat Veziroglu, “Hydrogen as a Fuel for Spark Ignition Engines,” Alternative Energy Sources VIII, Volume 2, Research and Development (New York: Hemisphere Publishing Corporation, 1989), pp. 559-560.
(p) Technical Data Book, Prepared by Gulf Research and Development Company, Pittsburgh, PA, 1962.
(q) National Biodiesel Board, "Soybean Methyl Ester Formula and Molecular Weight". Accessed at www.biodiesel.org/pdf_files/fuelfactsheets/Weight&Formula.PDF on 11-20-06
(r) National Biodiesel Board, "Biodiesel Fact Sheet", accessed at www.biodiesel.org.au/biodieselfacts.htm on 11-20-06.

Notes

(1) Octane values are for pure components. Laboratory engine Research and Motor octane rating procedures are not suitable for use with neat oxygenates. Octane values obtained by these methods are not useful in determining knock-limited compression ratios for vehicles operating on neat oxygenates and do not represent octane performance of oxygenates when blended with hydrocarbons. Similar problems exist for cetane rating procedures.
(2) Since no vehicles in use, or currently being developed for future use, have powerplants capable of condensing the moisture of combustion, the lower heating value should be used for practical comparisons between fuels.
(4) Pour Point, ASTM D 97 from Reference (c).
(5) Based on cetane.
(6) For compressed gas at 2,400 psi.
(7) Cloud Point