Properties of Fuels

Property	Gasoline	No. 2 Diesel Fuel	Methanol	Ethanol	MTBE	Propane	Compressed Natural Gas (CNG)	Hydrogen
Chemical Formula	C_4 to C_{12}	C_3 to C_{25}	CH_3OH	C_2H_5OH	$(CH_3)_3COCH_3$	C_3H_8	CH_4	H_2
Molecular Weight	100–105[a]	≈200	32.04	46.07	88.15	44.1	16.04	2.02[x]
Composition, Weight %								
Carbon	85–88[b]	84–87	37.5	52.2	66.1	82	75	0
Hydrogen	12–15[b]	33–16	12.6	13.1	13.7	18	25	100
Oxygen	0	0	49.9	34.7	18.2	–	–	0
Specific gravity, 60° F/60° F	0.72–0.78[b]	0.81–0.89[d]	0.796[c]	0.796[c]	0.744[m]	0.508	0.424	0.07[u]
Density, lb/gal @ 60° F	6.0–6.5[b]	6.7–7.4[d]	6.63[b]	6.61[b]	6.19[m]	4.22	1.07[r]	–
Boiling temperature, °F	80–437[b]	370–650[d]	149[c]	172[c]	131[c]	-44	-259	-423[u]
Reid vapor pressure, psi	8–15[k]	0.2	4.6[o]	2.3[o]	7.8[e]	208	2,400	–
Octane no.[1]								
Research octane no.	90–100[u]	--	107	108	116[t]	112	–	130+
Motor octane no.	81–90[s]	--	92	92	101[t]	97	–	–
(R + M)/2	86–94[s]	N/A	100	100	108[t]	104	120+	–
Cetane no.[1]	5–20	40–55	--	--	--	--	--	--
Water solubility, @ 70° F								
Fuel in water, volume %	Negligible	Negligible	100[c]	100[b]	4.3[e]	–	–	–
Water in fuel, volume %	Negligible	Negligible	100[c]	100[b]	1.4[e]	–	–	–
Freezing point, °F	-40[g]	-40–30[4]	-143.5	-173.2	-164[c]	-305.8	-296	-435[v]
Viscosity								
Centipoise @ 60° F	0.37–0.44[3,p]	2.6–4.1	0.59[j]	1.19[j]	0.35[j]	–	–	
Flash point, closed cup, °F	-45[b]	165[d]	52[o]	55[o]	-14[e]	-100 to -150	-300	--
Autoignition temperature, °F	495[b]	≈600	867[b]	793[b]	815[e]	850–950	1,004	1,050–1,080[u]
Flammability limits, volume %								
Lower	1.4[b]	1	7.3[o]	4.3[o]	1.6[e,k]	2.2	5.3	4.1[u]
Higher	7.6[b]	6	36[o]	19[o]	8.4[e,k]	9.5	15	74[u]
Latent heat of vaporization								
Btu/gal @ 60° F	≈900[b]	≈700	3,340[b]	2,378[b]	863[5]	775	–	–
Btu/lb @ 60° F	≈150[b]	≈100	506[b]	396[b]	138[5]	193.1	219	192.1[v]
Btu/lb air for stoichiometric mixture @ 60° F	≈10[b]	≈8	78.4[b]	44[b]	11.8	–	–	–

Property	Gasoline	No. 2 Diesel Fuel	Methanol	Ethanol	MTBE	Propane	Compressed Natural Gas (CNG)	Hydrogen
Heating value (2)								
Higher (liquid fuel-liquid water) Btu/lb	18,800–20,400	19,200–20000	9,750[2]	12,800[q]	18,290[h]	21,600	23,600	61,002[v]
Lower (liquid fuel-water vapor) Btu/lb	18,000–19,000	18,000–19,000	8,570[b]	11,500[q]	15,100[h]	19,800	21,300	51,532[v]
Higher (liquid fuel-liquid water) Btu/gal	124,800	138,700	64,250	84,100	–	91,300	–	–
Lower (liquid fuel-water vapor) Btu/gal @ 60° F	115,000	128,400	56,800[3]	76,000[3]	93,500[4]	84,500	19,800[6]	–
Heating value, stoichiometric mixture								
Mixture in vapor state, Btu/cubic foot @ 68° F	95.2[b]	96.9[5,q]	92.5[b]	92.9[b]	–	–	–	–
Fuel in liquid state, Btu/lb or air	1,290[b]	–	1,330[b]	1,280[b]	–	–	–	–
Specific heat, Btu/lb °F	0.48[g]	0.43	0.6[j]	0.57[j]	0.5[j]	--	--	--
Stoichiometric air/fuel, weight	14.7[3]	14.7	6.45[l]	9[l]	11.7[j]	15.7	17.2	34.3[u]
Volume % fuel in vaporized stoichiometric mixture	2[b]	–	12.3[b]	6.5[b]	2.7[j]	–	–	–

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) The higher heating value is cited for completeness only. 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.

(3) Calculated.

(4) Pour Point, ASTM D 97 from Reference (c).

(5) Based on cetane.

(6) For compressed gas at 2,400 psi.

Sources:

(a) The basis of this table and associated references was taken from: American Petroleum Institute (API), Alcohols and Ethers, Publication No. 4261, 2nd ed. (Washington, DC, July 1988), Table B-1.

(b) "Alcohols: A Technical Assessment of Their Application as Motor Fuels," API Publication No. 4261, July 1976.

(c) Handbook of Chemistry and Physics, 62nd Edition, 1981, The Chemical Rubber Company Press, Inc.

(d) "Diesel Fuel Oils, 1987," Petroleum Product Surveys, National Institute for Petroleum and Energy Research, October 1987.

(e) ARCO Chemical Company, 1987.

(f) "MTBE, Evaluation as a High Octane Blending Component for Unleaded Gasoline," Johnson, R.T., Taniguchi, B.Y., Symposium on Octane in the 1980's, American Chemical Society, Miami Beach Meeting, September 10-15, 1979.

(g) "Status of Alcohol Fuels Utilization Technology for Highway Transportation: A 1981 Perspective," Vol. 1, Spark-Ignition Engine, May 1982, DOE/CE-56051-7.
(h) American Petroleum Institute Research Project 44, NBS C-461.
(i) Lang's Handbook of Chemistry, 13th Edition, McGraw-Hill Book Company, new York, 1985.
(j) "Data Compilation Tables of Properties of Pure Compounds," Design Institute for Physical Property Data, American Institute of Chemical Engineers, New York, 1984.
(k) Petroleum Product Surveys, Motor Gasoline, Summer 1986, Winter 1986/1987, National Institute for Petroleum and Energy Research.
(l) Based on isoctane.
(m) API Monograph Series, Publication 723, "Teri-Butyl Methyl Ether," 1984.
(n) BP America, Sohio Oil Broadway Laboratory.
(o) API Technical Data Book – Petroleum Refining, Volume I, Chapter I. Revised Chapter 1 to First, Second, Third and Fourth Editions, 1988.
(p) "Automotive Gasolines," SAE Recommended Practice, J312 May 1986, 1988 SAE Handbook, Volume 3.
(q) "Internal Combustion Engines and Air Pollution," Obert, E.F., 3rd Edition, Intext Educational Publishers, 1973.
(r) Value at 80 degrees F with respect to the water at 60 degrees F (Mueller & Associates).
(s) National Institute for Petroleum and Energy Research, Petroleum Product Surveys, Motor Gasolines, Summer 1992, NIPER-178 PPS 93/1 (Batlesville, OK, January 1993), Table 1.
(t) P. Dorn, A.M. Mourao, and S. Herbstman, "The Properties and Performance of Modern Automotive Fuels," Society of Automotive Engineers (SAE), Publication No. 861178 (Warrendale, PA, 1986), p. 53.
(u) 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.
(v) Technical Data Book, Prepared by Gulf Research and Development Company, Pittsburgh, PA, 1962.