FUEL CHARACTERISTICS

What is LPG?

LPG is "liquefied petroleum gas" commonly known as propane (C_3H_8), a combustible hydrocarbon based fuel. It comes from the refining of crude oil and natural gas. At normal pressure (29.92" Hg) and temperatures above −44°F/−45°C, propane remains in its gaseous form. At lower temperatures and/or higher pressures, propane will become a liquid.

Propane is colorless and odorless. For safety reasons propane is required to be odorized as to indicate positively, by distinct odor, the presence of gas in air down to a concentration of not over 1/5th the lower level of flammability (0.4% in air). This is achieved by adding 1.0lbs. Of thiopane, or 1.4lbs of amyl mercaptan per 10,000 gallons of LPG. There are currently three grades of propane available, HD5 for internal combustion engines, commercial propane and propane/butane mix for other uses. The exact composition of propane varies slightly between different parts of the country and different refineries. Compared to gasoline, the energy of LPG is 74%.

What is CNG?

CNG is "compressed natural gas". Natural gas (CH_4) is naturally occurring mixture of combustible hydrocarbon gases found in porous formations beneath the earth's surface. Natural gas is created by the decomposition of plant and animal remains, under great heat and pressure, over very long periods of time. Natural gas can be found as:

Nonassociated gas–free gas not in contact with significant amounts of crude oil in the reservoir.

Associated gas–free gas in contact with crude oil in the reservoir.

Dissolved gas–gas in solution with crude oil in the reservoir.

For safety reasons propane is required to be odorized as to indicate positively, by distinct odor, the presence of gas in air down to a concentration of not over 1/5th the lower level of flammability (1.0% in air). This is achieved by adding ethyl mercaptan, or thiopane, or amyl mercaptan to the natural gas. Compared to gasoline the energy content of CNG is 25%.

Propane		
Component		Volume (%)
Propane	C_3H_8	90.00% min.
Propylene		up to 5.00%
Butane	C_4H_{10}	2.00%
Iso-Butane		1.50%
Methane	CH_4	1.50%
	Total	100.00%

Natural Gas		
Component		Volume (%)
Methane	CH_4	92.00%
Ethane	C_2H_6	3.60%
Propane	C_3H_8	1.00%
Butanes	C_4H_{10}	0.30%
Pentanes	C_5H_{12}	0.10%
Hexanes	C_6H_{14}	0.10%
Carbon Dioxide	CO_2	1.00%
Nitrogen	N_2	1.60%
	Total	100.00%

FUEL CHARACTERISTICS

FUEL CHARACTERISTICS OF VARIOUS FUELS

	METHANE	PROPANE	LNG	GASOLINE	DIESEL
FORMULA	CH_4	C_3H_8	CH_4	C_8H_{16}	$C_{12}H_{26}$
RESEARCH OCTANE	130	112	130	91-98	
MOTOR OCTANE #	130	97	130	83-90	
CETANE #	-10	5-10	-10	8-14	40-65
DENSITY OF LIQ. FUEL (lbs./ft.³) / (kg/L)		31.78 / .509	26.28 / .421	46.57 / .746	50.44 / .808
DENSITY OF GAS (lbs./ft.³) / (kg/m³)	.041 / .6512	.032 / .508		.275 / 4.4	
BOILING POINT (°F) / (°C)	-259 / -162	-44 / -42	-259 / -162	(81-464) / (27-240)	
LOWER HEATING VALUE (BTU/ft.³) / (kJ/L)	21,463 / 49,913	19,882 / 46,238	21,463 / 49,913	18,344 / 42,661	18,670 / 43,419
ENERGY CONTENT (VOLUME) (BTU/ft.³) / (kJ/L)	213,300 / 7875	637,500 / 25,535	569,200 / 21,013	862,100 / 31,825	950,400 / 35,082
ENERGY (wrt) GASOLINE	25%	74%	66%	100%	110%
ENERGY (wrt) DIESEL	22%	67%	60%	91%	100%
STOICHIOMETRIC A/F RATIO (mass)	17.30	15.70	17.30	14.70	15.00
HEAT OF VAPORIZATION (BTU/lb.) / (kJ/kg)	218 / 507	182 / 423	218 / 507	153 / 355	123 / 286
ENERGY OF STOICH. MIXTURE (BTU/ft.³) / (kJ/L)	97.0 / 3.58	103 / 3.79	97.0 / 3.58	106 / 3.91	
AUTO IGNITION TEMP. (°F) / (°C)	1004 / 540	842 / 450	842 / 450	428 / 220	437 / 225
PEAK FLAME TEMP. (°F) / (°C)	3254 / 1790	3614 / 1990	3254 / 1790	3591 / 1977	3729 / 2054
FLAMMABILITY LIMITS (Vol%)	5.3-15	2.1-10.4		1.4-7.6	
DETONATION LIMITS (Vol%)	6.3-13.5	3.4-35	6.3-13.5	1.1-3.3	
FLAME SPREAD RATE (ft./s) / (m/s)				(13.1-19.7) / (4-6)	
MAX. BURNING VEL. IN STP AIR (ft./s) / (m/s)	(1.21-1.48) / (37-45)	(1.41-1.71) / (43-52)	(1.21-1.48) / (37-45)	(1.21-1.41) / (37-43)	
SPECIFIC GRAVITY AT STP (lbs./ft.³) / (kg/m³)	.034 / .55	.095 / 1.52	.034 / .55	(.125-.250) / (2-4)	(.250-.375) / (4-6)
QUENCHING GAP IN STP AIR (in.) / (mm)	.080 / 2.03	.070 / 1.78	.080 / 2.03	.078 / 2	
FLAME VISIBILITY, RELATIVE	0.60	0.60	0.60	1.00	1.00
FLASH POINT (°F) / (°C)			-306 / -188		125 / 52

Comparison of Peak Flame Temperature

The flammability range is the distance from the leanest (LEL) to the richest (UEL) mixture of fuel and air that will burn. Fuel with narrower ranges are safer to work with but are less versatile because they offer less choice of air fuel ratios. CNG has a peak flame temperature of 1790°C/3254°F which is 187°C/337°F (9.5%) cooler than the peak flame temperature of gasoline at 1977° C/3591°F. The peak flame temperature of LPG at 1991° C/3614°F is only 13°C/23°F (less than 1%) higher than gasoline.

Volumetric Efficiency

The amount of air entering an engine at a particular throttle angle and load is fixed. Any fuel added to the air before it enters the cylinder will displace an equal volume of air and will reduce the volumetric efficiency and power output of the engine, reductions are as follows:
Diesel—less than 1% (approx.)
Gasoline—1-2% (approx.)
LPG—4% (approx.)
CNG—9% (approx.)

Comparison of Energy Content

Energy Content per unit of fuel (energy density) is an important factor affecting range and power output of internal combustion engines.

Comparison of Autoignition Temp.

The autoignition temperature is the temperature at which a fuel will ignite without safer than gasoline or diesel because the autoignition temperature is much higher. In respect to autoignition temperatures LPG, CNG and LNG are much safer than gasoline or diesel because the autoignition temperature is much higher.