Energy
FACTSHEET

BRITISH COLUMBIA
Ministry of Agriculture and Food

Order No. 210.510-2
Agdex: 763
May 1982

Propane as a Fuel for Vehicles and Tractors

Here are some of the facts to consider when evaluating propane as an alternative fuel for use in vehicles.

PROPERTIES

Propane (C_3H_8) is obtained as a by-product of oil refining operations, or by stripping natural gas. Under normal atmospheric conditions, propane vapor is 1.5 times heavier than air, but under moderate pressure it liquefies and weighs 0.51 kg/L (5.1 lb/gal). Below –42°C propane is a liquid and could be carried in an open bucket. Above the critical temperature, 97°C, the fuel cannot be stored as a liquid under any pressure. On changing to a vapor, propane increases in volume 270 times. Commercial propane (produced to industry standards H.D. 5) has a minimum of 90% propane and not more than 5% propylene together with various quantities of butane and other light gases. Propane has no odor, but an odorizing agent is introduced for safety reasons. Propane is stored in tanks as a liquid with the pressure varying from zero at –42°C to 1250 kPa at 40°C. Because of this increase in pressure with temperature, the tanks are only filled to 85% of capacity, the rest of the space being a vapor cushion to absorb any pressure increases. Tanks that are subjected to temperatures less than 40°C have a relief valve set to 1750 kPa (250 psi).

SAFETY

Propane has been rated as being 54% safer than gasoline by the Liberty Mutual Insurance Company. The tank is far more substantial than a gasoline fuel tank and is not likely to be punctured in the event of an accident.

All installations should be done in accordance with the Canadian Gas Association rules relating to propane use in vehicles. Some of the equipment requirements are discussed below.

EQUIPMENT NEEDED FOR CONVERSION

There are four main pieces of equipment used in the conversion: tank, fuel filter/shut off valve, vaporizer and mixer. See **Figure 1**.

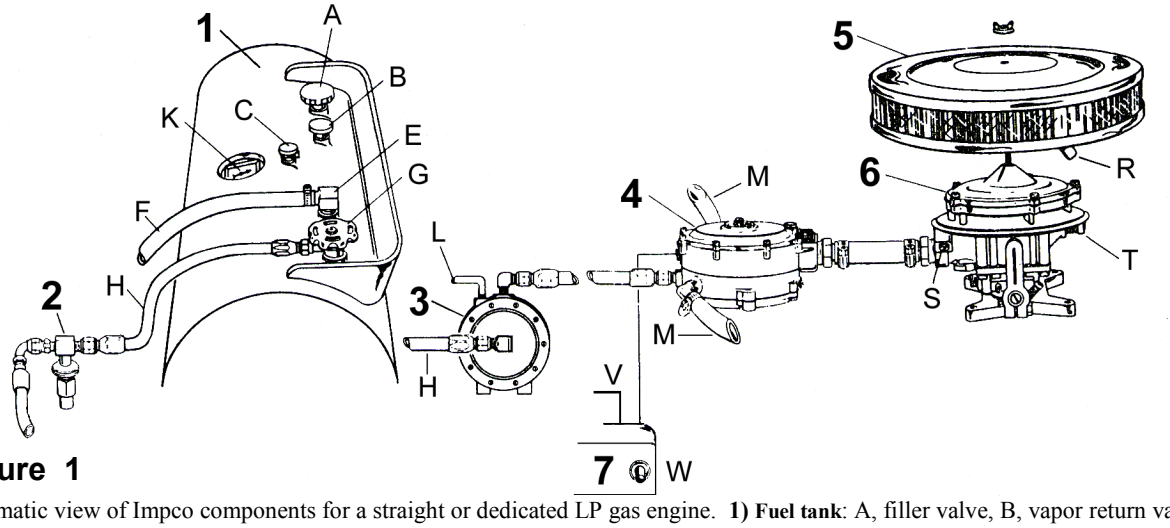


Figure 1

Schematic view of Impco components for a straight or dedicated LP gas engine. **1) Fuel tank**: A, filler valve, B, vapor return valve; C, 10% outage valve; E, relief valve; F, vent line to outside of vehicle; G, LP gas valve; H, LP gas high-pressure hose line; K, fuel gauge. **2) Relief valve**: vented to outside of vehicle. **3) Vacuum fuel lock and filter**; prevents flow of fuel with ignition on and engine stopped running; H, LP gas inlet line; L, connects to air valve vacuum port in miser. **4) Converter**: two-stage regulator and vaporizer; M, water inlet or outlet from engine; must be brass fittings. **5) Air cleaner. 6) LP gas carburetor**; T, idle adjustment screw; S, balance line connection. **7) Control panel**: V, 12-volt battery connection; W, push-button primer switch.

The tank is made of heavy gauge steel and is available in many sizes and shapes. It should be securely mounted outside the passenger compartment. It should have a filler valve, safety release valve, liquid level gauge and an outlet for liquid from the lower portion of the tank. (The outlets for heaters and appliances are from the vapor section.) Connecting pipes for liquid propane should be copper (Type K), steel (wall thickness at least 1.25 mm) or metal reinforced pressure hose. The lines should be securely clamped to prevent vibration.

The fuel filter/shut off valve filters the propane and controls the fuel flow. When the engine is not running, it shuts off the fuel by means of a vacuum operated valve. This is a safety feature so that no fuel will flow when the engine is stopped.

The vaporizer uses the heat from the engine coolant to vaporize the liquid propane. The vapor passes through a pressure regulator and then to the mixer unit to supply the engine's fuel requirement.

The type of mixer unit will depend on whether the engine uses propane only or propane and gasoline. If it is propane only, the carburetor can be removed and replaced by the mixer unit. This mixes the correct amount of air with the propane vapor in accordance with the inlet manifold vacuum of the engine. For dual fuel systems, the carburetor is left in place and the mixer unit placed on top (usually incorporated with the air filter). The dual fuel system requires an interlock so that both fuels cannot be supplied together.

ENGINE ADJUSTMENTS

For Engines Running Only on Propane

The octane rating of propane is 110 making it more suitable in high compression engines i.e. with a compression ratio of 10:1 to 11:1. Shaving the heads or altering the pistons to increase the compression is a questionable practice and would only be worth doing during an engine overhaul. In any case the compression ratio should not be increased by more than 1 point above the original.

Timing

Modifications to the distributor may be attempted if required. The ignition timing at low engine speed needs more advance than gasoline, and should be set at 12 to 18 BTDC. The total advance of initial plus centrifugal should not go beyond 30. A transistorized timing device that compensates for different fuels is now on the market. It is likely that variations in engines will affect the output more than the timing, and a dynamometer should be used to determine the optimum timing under load conditions.

Hot Spot

When propane enters the engine inlet manifold, it is already a gas and needs no further heating. Gasoline enters in the form of droplets, which impinge on the hot spot to aid in vaporizing them. This hot spot should be removed as it lowers the volumetric efficiency of the engine. The air for combustion should enter as cold as possible in order to increase its density. The hot spot can be disabled by removing the heat riser valve and blocking off the exhaust cross over in a V8 or insulating the inlet manifold from the exhaust in a straight 6 or 4 cylinder engine.

Emission Controls

A well tuned propane powered vehicle requires no emission controls, (catalytic converters, exhaust gas recirculation systems) and these can be removed.

DUAL FUEL SYSTEMS – GASOLINE / PROPANE

The engine cannot be altered too much or it will not perform satisfactorily on gasoline. As a result, the dual fuel system is a compromise between engine performance and convenience.

The vehicle should be run on gasoline at least every 2 weeks to prevent the gaskets drying out.

All conversion equipment has adjustment screws to alter the idle and full load fuel intake of propane. Propane will burn at a slightly leaner mixture than gasoline (14:1 versus 12.5:1 air to fuel ratio): 14:1 gives the best torque output, 17:1 gives the best economy. To aid in starting the spark plugs may be gapped .01 mm (.003 in.) smaller although modern ignition systems should have no difficulty producing the necessary spark for propane ignition.

It is false economy to convert a worn engine to propane in the hope that it will perform better. Propane is a 'cleaner' fuel than gasoline. As a result, old carbon deposits get burnt off and are not replaced. This usually means an increase in oil consumption.

GASOLINE TRACTOR CONVERSION

The majority of present day gasoline powered tractors are small (50 HP or less) and used for chores and light duties. Rarely do these get enough use to warrant changing them to propane.

DIESEL AND PROPANE

Manufacturers of diesel engines frown on the use of propane to boost the output of their engines. All warranties would be voided. A US company makes equipment that injects propane into the inlet manifold of the diesel engine when under load conditions. This is not saving fuel. It is subjecting the engine to more stress than it was designed for and may be very expensive in terms of overhauls.

Propane should be used in spark ignition engines and not diesels.

ENGINE OILS

Propane engines operate with high combustion temperatures, which give an increase in oxides of nitrogen. These

contaminate the oil and may lead to an increase in acidity and viscosity.
Engine oils suitable for use in natural gas and propane engines have been formulated to overcome these problems and should be used in place of ordinary engine oils.

COMMENTS, QUESTIONS AND ANSWERS

Propane smells. So does gasoline.

Propane is not as good a fuel as gasoline.
Propane has more energy for the same weight than does gasoline. However, propane fuel is sold by volume and has 25% less energy than gasoline on a volume basis. One can expect to get 10-15% less mileage with propane than gasoline. When related to engine wear, propane is a better fuel. It burns cleaner, so there is less fouling of plugs and contamination of oil. Most users find that engines require less maintenance with propane fuel than with gasoline.

Propane powered vehicles won't start when it's cold.
Neither will gasoline ones. In cold weather the vehicle may need plugging in, and in this respect, it is no different from a gasoline engine. The line from the tank to the engine carries liquid propane, so all the vaporizing takes place in the engine compartment, which is usually the warmest place in the vehicle. Warm water from the engine helps to vaporize the propane and prevent ice formation.

A Propane vehicle needs costly extra equipment.
It's not extra, it's necessary. The conversion cost, using May 1982 prices, is from $1200 to $1800 depending on the vehicle type and size of tank. Truck conversions are usually the cheapest. Fittings, valves, lines, etc., cost $600. Labour $200 (usually takes about one day). The tank cost is anywhere from $350 to $800. For vehicles meeting certain requirements, i.e., used by corporations, municipalities, farmers, etc., there is a federal government grant of $400. This grant is available for propane only conversion. The equipment can be removed and transferred to another vehicle.

Propane vehicles have no "guts".
If properly tuned, a propane-powered vehicle will be very similar in performance to a gasoline one. Some vehicles are left with the capability of running with both fuels. This is a compromise and the performance on both fuels will suffer. At high speeds, propane engines have 4 to 6% less power than gasoline powered ones. This is primarily due to the decrease in volumetric efficiency (the propane vapor displaces the air going into the engine).

Propane gums up engine oils.
Special engine oils suitable for use in natural gas and propane engines should be used. The new generation of automotive oils meeting A.P.I. SF specifications may be used with caution if a check is kept on their viscosity.

Propane is not safe.
It is as safe as or safer than gasoline. The propane tank is much stronger than a gasoline tank. A vehicle in a rear end collision or overturned after an accident would be much safer with propane as a fuel than gasoline.

What are the economics of conversion ?
Prices in Edmonton as of May 1, 1982 were 15.8/L for propane and 33.4¢/L for gasoline. The farm price for purple gasoline was 25.2¢/L. If you average 32,000 km (20,000 miles) per year at 14 litres/100 km (20 mpg) and use farm fuel, the pay-back period is 4.25 years. Using orange gasoline, the pay-back period is 2 years. This is the period when the saving in fuel costs pay for the $1000 cost of conversion. This assumes you received the $400 grant and fuel prices rise by 16% each year. Any distance after this is done at nearly half the cost of using gasoline. As long as the prices stay in the same ratio (propane is half the cost of gasoline), the break-even point will not alter. Fuel consumption rate and distance traveled are the main factors. The opportunity cost of having $1000 invested in equipment when it could be earning 15% is assumed to be offset by the decrease in engine maintenance costs and longer engine life. The graph in **Figure 2** gives the pay-back period for any distance and fuel consumption.

Where can I get the conversion done ?
Most large propane dealerships have facilities to make the conversions or will know who can. Some private garages are also entering the field.

Can I buy the equipment and do the conversion myself ?
Yes. Safety is of prime importance. There are strict rules to follow when installing propane equipment. These are laid out in the code book put out by the Canadian Gas Association (CAN 1 –B149.2-M80). The installation cost of $200 is a small fraction of the total cost, and one should be aware that it may be false economy to do an inefficient conversion. One should have automobile testing equipment for timing etc. and a good understanding of the principles involved.

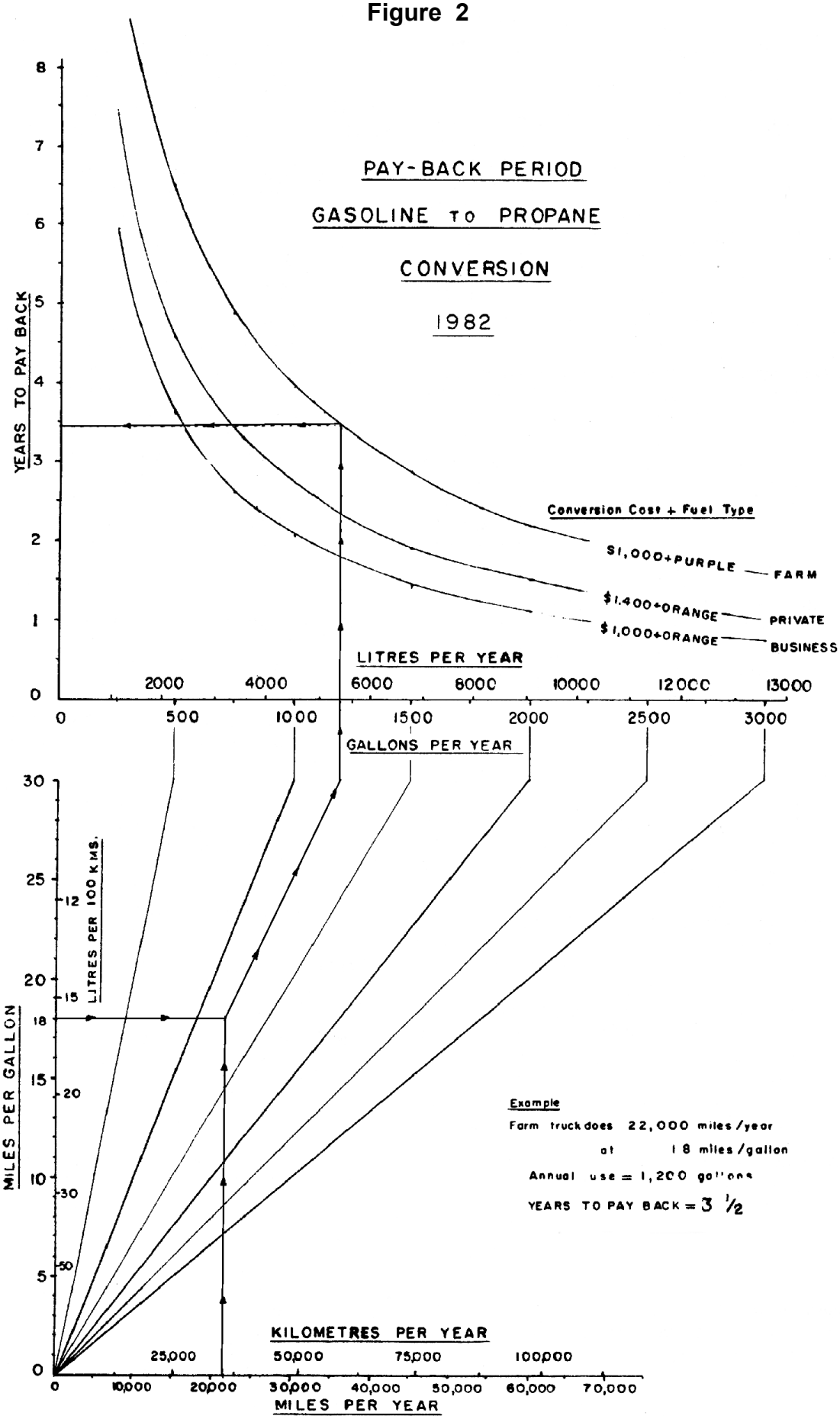
Where can I buy the equipment?
Contact your local propane dealer, who should be able to give you this information.

How do I get the federal grant of $400?
The grant is available for propane only vehicles and not dual fuel. The conversion must be acceptable to the provincial gas protection branch. Information and an application form is available from:

Propane Grant Program
22 Sir Winston Churchill Avenue
Room 200 Grandin Park Plaza
St Albert, Alberta T8N 1B4

Propane Grant Program
Energy, Mines and Resources
Box 3500
Ottawa, Ontario K1S 5K6

Figure 2


PAY-BACK PERIOD
GASOLINE TO PROPANE
CONVERSION
1982
YEARS TO PAY BACK
Conversion Cost + Fuel Type
$1,000+PURPLE — FARM
$1,400+ORANGE — PRIVATE
$1,000+ORANGE — BUSINESS
LITRES PER YEAR
2000 4000 6000 8000 10000 12000 13000
0 500 1000 1500 2000 2500 3000
GALLONS PER YEAR
LITRES PER 100 KMS.
MILES PER GALLON
KILOMETRES PER YEAR
25,000 50,000 75,000 100,000
0 10,000 20,000 30,000 40,000 50,000 60,000 70,000
MILES PER YEAR
Example
Farm truck does 22,000 miles/year
at 18 miles/gallon
Annual use = 1,200 gallons
YEARS TO PAY BACK = 3 1/2

PROPANE AS A VEHICLE FUEL

ADVANTAGES

Cheaper – half the cost of gasoline

Safe fuel – robust tanks

No choke required

Less maintenance required and longer engine life.

Large tanks may permit 1600 km before refueling.

No fuel spillage or evaporation.

Fuel theft is minimized.

Fewer noxious fumes in exhaust gases.

May be used in vehicles inside buildings.

Emission controls are not required when using propane.

Information prepared by:
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DISADVANTAGES

Initial conversion cost $1200 - $1800.

Heavy tanks, may take up cargo space.

Very cold starts (below –30°C) may be a problem if there is no plug-in.

Below –30°C exposed propane tanks may not have enough vapor pressure to provide the fuel flow under full load conditions.

Not as readily available as gasoline

Inconvenient to fill.

Propane powered vehicle is not allowed in an underground garage.

FOR FURTHER INFORMATION CONTACT
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