

Propane Diesel Injection

BY KEITH LONG

The use of propane injected diesel or the precisely controlled injection of propane into the air intake chamber of a diesel engine is one of the most viable and promising new technology advancements in recent history. This technology will provide the customer with a safe, emissions reducing, cost effective fuel system alternative. It is also a highly performance enhancing system for on and off road diesel vehicles of nearly all type, model and year models. Basically, there are no limitations here.

Propane injection systems installed on diesel engines can be accurately controlled by the boost pressure of the engine and provides the appropriate amount of propane vapor into the pre-turbo air supply. This propane enriched air is then transported into the combustion chamber which causes the excited diesel fuel to be burned more completely. This is especially true while the diesel engine is under load. The resulting combustion process virtually eliminates any black smoke (unburned fuel) from the exhaust of some diesel engines. The resulting more efficient combustion process on each engine revolution provides better fuel economy and adds more miles to gallons of fuel consumed. Since a portion of the diesel fuel is being replaced with a much cleaner alternative fuel (Propane), carbon monoxide and hydrocarbons are reduced along with the nitric oxide and particulate matters. The ratio of this combined

mixture is approximately 70% diesel to 30% propane.

Popular Option: The higher combustion efficiency producing better fuel economy while reducing emissions and increased torque and horsepower for towing options is becoming more popular all the time with medium duty truck owners. Reports have been filed with some vehicle owners showing over 200,000 miles without any engine repairs. Fleet accounts who have existing LPG storage tanks are prime candidates, especially if they're also using diesel for some rigs.

Current federal laws allow for a \$.50 per gallon tax credit toward LPG purchases made for fleet use. The addition of propane to diesel fuel improves combustion efficiency, raising it from an average 75-77% to over 90% with propane. Better efficiency means less unburned diesel fuel polluting our atmosphere. Increasing the use of propane in fleets alone by 10% could displace one billion gallons of conventional fuels by the year 2017.

Let's get technical

Diesel engines typically inject diesel fuel into the engine's combustion chamber when that chamber's piston is near the end of the compression stroke. The high pressure present in the chamber ignites the diesel fuel. Due to the injection mixture

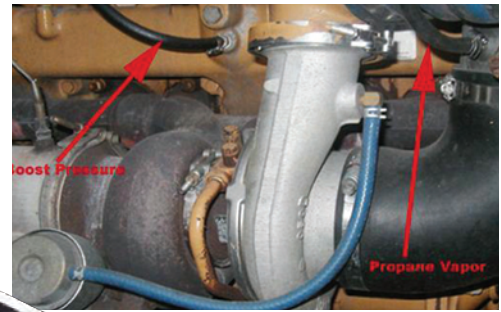
of diesel fuel and compressed intake air within the combustion chamber, a large fraction of the fuel exists at a very fuel-rich equivalence ratio. That is, the fuel and air in the combustion chamber are not necessarily a homogenous mixture. This may result in incomplete combustion of the diesel fuel, which tends to result in high particulate emissions. Furthermore, the fuel-rich equivalence ratio can also lead to high flame temperatures in the combustion process, which results in increased NO.sub.x emissions. As tougher environmental standards are being enacted for all internal combustion engines, users of diesel engines are looking for ways to lower emissions. One solution is to reduce the amount of diesel fuel injected into the combustion chamber, which reduces the equivalence ratio and works to reduce particulate and NO.sub.x emissions. Such a reduction in injected diesel, however, reduces engine power and nobody wants that.

Utilization of gaseous-fuels with diesel engines provides for more complete combustion of any diesel fuel consumed, can enhance fuel economy, and typically results in lower engine emissions. That is, in order to reduce particulate and NO.sub.x emissions levels from diesel engines and/or to increase fuel economy, such engines may be partially or completely converted for use with gaseous-fuels such as, compressed natural gas (CNG), liquid natural fuels (LNG)



Propane injection nozzle

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such as ethanol, and liquid or liquefied petroleum gas (LPG), such as propane. However, such gaseous-fuels typically do not alone have the centane value required to allow for their ignition through compression. Accordingly, diesel engines must be modified to use such fuels.

Methods for converting a diesel engine to consume gaseous-fuels typically fall into three categories. The first is to convert the engine to a spark-ignited engine; a second is to convert the engine to allow for the direct injection of gaseous-fuels into the combustion chamber with injected diesel; and a third is a dual-fuel technology, in which the gaseous-fuel is mixed with all or a portion of the intake air of the engine. As will be appreciated, the second and third methods utilize injected diesel (i.e., pilot diesel) to ignite the gaseous-fuel. In this regard, the combustion of the gaseous-fuel results in more complete combustion of the injected diesel. Furthermore, as the gaseous-fuel allows the engine to produce additional power, less diesel fuel is injected into the engine.

Conversion to a spark-ignition system and/or a direct gaseous-fuel injection system for utilizing gaseous-fuels with a diesel engine each typically require substantial modification to the diesel engine. Such modifications may include replacement of cylinder heads, pistons, fuel injection system and/or duplication of many engine components (e.g., injection

systems). Accordingly, these systems are typically expensive and oftentimes unreliable. On the other hand, dual-fuel systems require little modification to existing engines.

Why Propane?

Propane, also known as liquid petroleum gas (LPG), is odorless, non-toxic and is produced as a byproduct in the oil refining process. Propane is the fuel of choice because it is a readily available, high octane and clean burning fuel that cools dramatically when mildly compressed. The distinct odor of propane (Mercaptan) is added during refinement to allow sensory detection at concentrations that are below the lower flammability limit and much below the concentration needed for asphyxiation.

Propane is the nation's third largest motor fuel and the most widely used alternative transportation fuel in the United States and throughout the world. Clean-burning propane has been fueling automobiles since 1913. Most other alternative fuels are barely out of the laboratory, but propane gas has been used in cars and trucks for almost as long as gasoline.

Propane is a Safe Fuel

Like gasoline, propane is flammable, but has a much narrower range of flammability than gasoline and much

higher ignition temperature 920-1020 degrees vs. 80-300 degrees for gasoline. Propane will only burn with a fuel-to-air ratio of between 2.2% and 9.6% and will rapidly dissipate beyond its flammability range in the open atmosphere-making ignition unlikely.

Propane is non-toxic, unlike gasoline, diesel, methanol and ethanol. If a propane storage tank should ever leak, there would be no contamination danger to the surrounding soil or water.

Since 1984, all new propane tanks are required to have a device that shuts off the filling process when the tank reaches 80% of its liquid capacity. This allows for changes in fuel volume caused by temperature variations. Propane vehicle tanks are constructed from carbon steel under code developed by the American Society of Mechanical Engineers (ASME). A propane tank is 20 times more puncture-resistant and can withstand up to 4 times the pressure when compared to a typical gasoline, methanol, or ethanol tank. In addition, a properly installed propane tank can actually add to the structural strength of a vehicle.

Propane Advantages

Safety: Propane is considered a safe motor fuel by the federal government. School buses run on propane. Propane

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Pickup bed propane tank installation.



Large truck frame propane tank installation.

Fuel Consumption - Miles Per Gallon Comparison

Vehicle Type	2002 Cummins ISX (400 hp)	2005 780 Volvo	2000 Cummins ISX (525 hp)	1997 3406E Cat	1996 3126 Cat	2001 60 Detroit	2002 C-10 Cat	1986 425 Cat	1998 FL 60	2006 Int. DT466	2001 60 Detroit
Diesel	4.25-5.25 mpg	5.2-5.5 mpg	4.5-5.25 mpg	4.25-4.5 mpg	8.0-8.5 mpg	8.25-8.0 mpg	9.0-10.0 mpg	3.7-4.2 mpg	5.2-5.5 mpg	6.8-7.09 mpg	5.4-5.8 mpg
Diesel/Propane Mix	6.5-7.17 mpg	6.5-6.7 mpg	6.5-7.1 mpg	6.92-7.28 mpg	10.0-10.5 mpg	10.0-10.5 mpg	11.5-12.2 mpg	5.23-5.4 mpg	5.8-6.4 mpg	7.7-7.85 mpg	7.2-7.8 mpg

All trucks show less fuel usage and more miles per gallon gained with addition of propane.

vehicle tanks are tested to 4 times the normal operating pressures, and these tanks are 20 times more puncture-resistant than gasoline, methanol or ethanol vehicle tanks. Of methanol, ethanol, CNG or propane, propane has the lowest flammability range – a safety advantage.

Made in the USA: Over 88% of the propane used in this country (USA) comes from our own resources. Of this, 70% comes from the processing of natural gas. The U.S., Canada and Mexico have extensive natural gas reserves. More than half, 62% of the remaining 12% is imported from Canada and Mexico.

Engine Life: Propane's 104 pump octane rating and low carbon and oil contamination characteristics can result in documented engine life of 2 to 3 times that of gasoline. This is one of the prime reasons for propane's popularity in delivery fleets, taxis, buses and industrial engines.

Cost: Propane is one of the least expensive alternates to gasoline. Methanol and ethanol are among the most costly. Adding propane tanks to a vehicle depends on space available and many existing installation options are available to fill almost any need. Remember, the tank portion of this add-on is a pre-established market for more than 50 years. (See photos above.) A typical propane installation system cost ranges

from \$1600-1900 and pays for itself over time. Some states may even offer incentives under their Alternative Fuel rebates.

Dual-fuel operation where gaseous-fuels are mixed with intake air prior to the introduction of the air-fuel mixture into the cylinders of the engine is known in the art as fumigation. That is, the mixture of gaseous-fuel and intake air is introduced into each cylinder of the engine during the intake stroke. During the compression stroke of the cylinder piston, the pressure and temperature of the mixture are increased. Near the end of the compression stroke, a small quantity of pilot diesel fuel from the engine's existing diesel fuel injection system is injected into the cylinder. The pilot diesel ignites due to compression and in turn ignites the mixture of gaseous-fuel and intake air. As will be appreciated, such fumigation systems may be retrofit onto existing diesel engines with little or no modification of the existing engine. Furthermore, engines using such fumigation systems may typically be operated in a dual-fuel mode or in a strictly diesel mode (e.g., when gaseous-fuel is not available) when desired.

Many municipals, government and fleet accounts should be considering this add-on for cost saving measures that extend well beyond the fuel savings and cleaner burning engines tend to last longer. ■

Diesel Performance Products

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