

Does LPG + Diesel = More Power + Improved Economy?

Introducing Liquid Petroleum Gas (LPG) into the intake air of a diesel engine isn't a new idea, but electronically-controlled systems for doing this 'fumigation' job are relatively new in Australia.



The concept of gas-boosting diesel performance is as old as The Man himself - Dr Rudolph Diesel. In his original manuscript the good doctor discussed the results of introducing 'erdgas' (marsh gas, or methane, now commonly known as Natural Gas) into the intake airstream. Around 35 percent methane improved engine power by almost 50 percent.

LPG fumigation became popular in the 1980s, as a way of improving the hill-climbing power of the generally underpowered trucks that were available at the time. Like most hot-rodding ideas, 'torque topper' systems originated in the USA.

The idea was simple: if the engine was getting maximum fuel and couldn't produce any more torque, 'spike' it's air supply with more fuel. The concept came straight from the drag-strip's 'nitrous' (nitrous oxide, N₂O) culture.

In practice, the torque topping job was ridiculously easy. All you had to do was clamp an LPG tank behind the cab, equipped with

a hose and barbeque regulator and then run the hose via a ball valve in the cab into the engine air intake, to control the gas flow.

When the truck driver encountered a climb he simply opened the valve and, presto, instant hill-conquering torque.

The LPG flow was arbitrarily driver-controlled and it was very easy to overdo the gas injection. Too much combustion heat had the inevitable consequences: stretched head bolts, cracked heads, burnt valves, cracked pistons and liners, blown manifolds and turbos and under-bonnet fires started by glowing exhausts.

The latest LPG-fumigation systems employ the torque-topper principle, but electronic control takes arbitrary gas-dosing out of the equation. The amount and timing of the LPG flow is out of the driver's hands and can be altered only by qualified distributors.

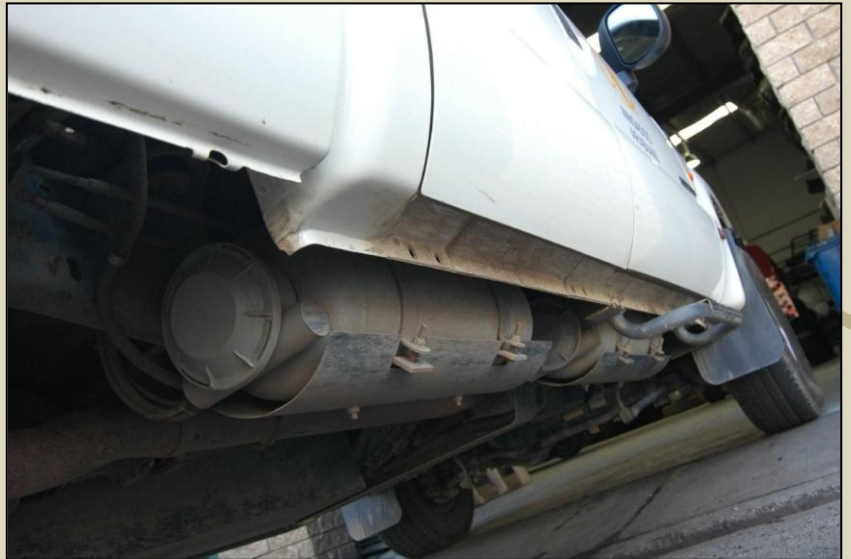
In place of dad's barbeque bottle is an Australian Standard AS1425-certified LPG tank and valve assembly. The cooker hose is replaced by SAA-compliant, flexible piping and the arbitrary ball-valve, by the combination of an LPG converter, a control valve and a gas lock-off valve, plus electronic control. There's also a dash-mounted LPG on-off switch, with integrated gas-level gauge.

The gas components are controlled by an under-dash electronic control unit (ECU) that acts on sensor inputs of throttle position, brake-pedal position, manifold pressure and engine speed. The engine fires up and idles on diesel. Gas enters the air intake in increasing volume as the accelerator pedal is depressed, up to a pre-determined level that is normally set between 20 percent and 30 percent of diesel flow rate.

In most LPG+diesel systems there is no reduction made to the normal diesel injection rate, so if the vehicle runs out of LPG it drives as a standard diesel.

The components fit unobtrusively into most 4x4s. In the engine bay there's the LPG converter that has an inlet line from the LPG tank, a gas supply line to the engine's inlet air plumbing and a water connection hose from the engine's cooling system. The coolant connection ensures the converter doesn't ice-up as it does its job. Also under-bonnet are the lock-off valve and the control valve.

The LPG tank is sized to be in proportion with the 4x4's fuel tank and is typically 40 litres' capacity. The tank can be mounted underneath the bodywork or inside the vehicle.



Dyno results show that a range of engine types can gain impressive power increases when operating on LPG + diesel.

So is it the answer for improved diesel performance and economy?

Let's consider what happens inside an LPG+diesel engine.

Once the engine is above idle revs the ECU 'tells' the LPG converter to send gas into the intake plumbing. The gas mixes with the air in the inlet manifold, with or without turbo-charging on the way, and is admitted into the cylinders via the intake valves.

As the rising piston compresses the air/gas mixture the temperature rises, but not to the point where the air/LPG will detonate. When diesel is injected it combusts and that process ignites the LPG as well.

Proponents of LPG fumigation claim that the combustion process is improved over that of straight diesel, but we've yet to see flame propagation photographs of test cylinders to prove that claim. The only engine test data we've seen indicates that the LPG+diesel combustion process still produces unburnt fuel.

What obviously does happen is that the increased fuel burn in the cylinder produces more power.

So why bother with the considerable expense of an LPG+diesel kit that will set you back around \$3500 installed on the average 4x4? Why not simply wind up the fuel screw on a mechanical injection pump, or fit a performance-enhancing chip to an electronically controlled diesel?

The gas system certainly adds more fuel to the engine, but its proponents point out that LPG has less calorific value than diesel – you need around 38 percent more LPG than diesel for the same heat effect – so 20 percent gas injection isn't increasing combustion heat by as much as the same amount of diesel would.

In addition, because the kit includes a gas tank the system increases vehicle operating range, as well as improving performance.

Another advantage of the gas system over higher diesel injection levels is that LPG is half to one third the price of diesel, so there's an obvious running-cost saving at every fill.

LPG+diesel; fitters have the option of reducing diesel injection as part of the installation, but most won't do that because the performance on diesel alone is worse than standard. However, it's an economy option that buyers can choose.



Warranty

We don't know of any engine maker who warrants an engine that has after-market modifications carried out on it, or has been modified to increase its output.

In the USA and, increasingly in Australia, vehicle makers' workshop technicians are being trained to look out for signs of removed performance enhancers. Specifically they have been asked to look for signs of add-on system removal, including LPG tank mountings, engine induction system modifications, wiring splices and cooling system splices.

LPG+diesel kit warranties cover the integrity and installation of the LPG kit components, but don't cover engine damage, unless it can be shown that a kit component problem directly caused the damage. It's much the same as most after-market turbocharger and performance-chip warranties.

To a large extent, you can't blame after-market installers washing their hands of engine-damage claims, because they don't know the state of an engine's internals.

So, an LPG+diesel system improves engine outputs and response and has the potential to achieve that with lower total fuel costs than methods that increase the level of diesel injection. The system also improves touring range.

However, as with any method of increasing engine outputs, there are warranty and durability considerations that must be taken into account by prospective purchasers.

Myth-busting

A few urban myths have sprung out of the overseas LPG fumigation sites, so we'll dispel them.

The first one is that a diesel engine, without LPG fumigation, burns only 75-80 percent of the fuel that's injected, with the rest being burnt in the exhaust system or blown out as smoke.

Engine makers reject this assertion absolutely, but we'll let van Aaken Developments Ltd of Crowthorne in the UK – one of the world's largest producers of LPG-injection systems and one of the very few to warrant its truck LPG+diesel systems against engine damage – dispel this one for us:

“A quick calculation will reveal that if a diesel truck burned only 75 percent of the fuel injected it would leave a trail of diesel weighing some 90 grams per kilometre.

“As these vehicles are homologated to produce only a fraction of a gram of hydrocarbon (unburnt fuel) per kilometre, you can see why we shy away from this pseudo-science.”

Another myth is that LPG acts as a 'catalyst'. The Oxford Reference Dictionary tells us that a catalyst is: 'a substance that, without itself undergoing any permanent chemical change, increases the rate of a reaction'. It's patently obvious that LPG cannot be a catalyst; it's a fuel.

Types of LPG+dieasel Systems

In a full-vapour, fumigation system, LPG in its liquid form passes under its own pressure from the tank through special piping to a pressure reducer. Here it is reduced to normal pressure and reverts to its gas form, travelling to an ECU-controlled valve that regulates how much gas is introduced to the engine.

In a semi-vapour system the fuel remains in its liquid form until the injector stage. A pump maintains a constant pressure throughout the system and an ECU controls the LPG injector. The liquid turns back into a gas as it passes through the injectors and into the engine via the inlet manifold. The van Aaken Developments' SmartPower system is one of this type.

New technology will soon allow liquid-LPG-injection, with the claimed benefit of a much higher diesel substitution ratio; possibly as high as 50:50.

Emissions Ramifications

Many fumigation sellers claim reduced emissions for LPG/diesel engines, but we've yet to see any proof of these claims. Their theory is that if you take an emissions-compliant engine and boost it with clean-burning LPG the end result must be improved emissions.

The only emissions research data we've been able to locate was done in China and India – countries that are anxious to reduce their dependence on imported oil and are busily investigating alternative fuels.

The Chinese laboratory testing was done on a SOFIM (licence-built Fiat) 8140.27S, 2.7-litre Euro II diesel, with common rail injection. The engine was fitted with an LPG system that included a diesel-reducer: a device that cut back diesel injection in proportion to the amount of gas being injected. Thus there was a slight power drop in this engine.

The performance test results on this engine showed that with diesel/LPG combustion, the fuel consumption and engine noise had almost no change, pollutant emissions of smoke, CO and NO_x at full load were improved significantly, but the amount of unburned HC increased considerably.

The Chinese test engineers concluded that the increase in HC was caused by two factors: the compressed air/LPG mixture being displaced towards the cylinder sides during valve overlap; and the compressed, premixed gas/air in the combustion chamber crevices not being burnt completely.

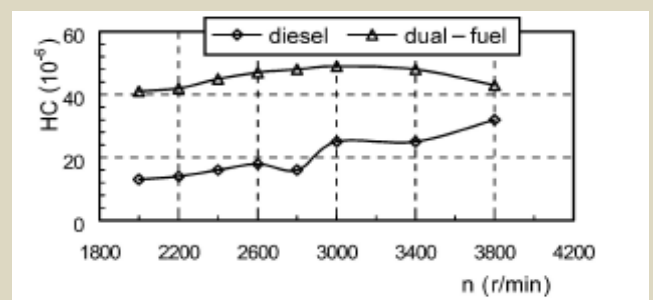


Diagram: The comparison of HC emissions at full load