



**THE EXPERT
STEWART
SANDERSON**

Having worked as a tuner for 17 years, Stewart 'Stu' Sanderson is one of the most-respected names in the business.

A Level 5-trained fuel-injection technician, Stu has worked for a Ford Rallye Sport dealer, a well-known fuel-injection specialist and various tuning companies.

Eight years ago he joined forces with Kenny Walker and opened up Motorsport Developments near Blackpool (01253 508400, www.remapping.co.uk), specialising in engine management live remapping, as well as developing a range of Evolution chips which are now sold all over the world.

He is the creator and administrator of www.passionford.com, which he started in 2003. It has grown rapidly from a few friends contributing, to one of the biggest Ford communities on the web.

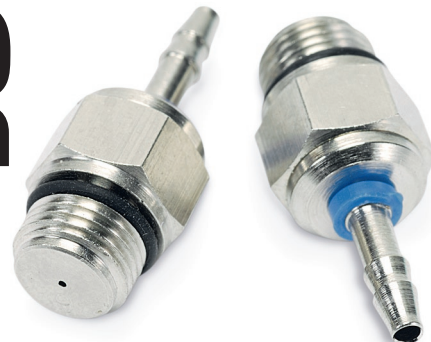
Stu's enviable knowledge of the workings of modern-day Ford performance engines means that every month he's just the man to explain how and why things work, and importantly how they can be improved.



Words: Stewart Sanderson

JUST ADD WATER

IT SOUNDS MAD BUT HERE'S WHAT YOU NEED TO KNOW ABOUT SQUIRTING WATER INTO YOUR ENGINE.





By injecting a fine mist of water the intake charge temperatures can be reduced significantly

using water injection as it allowed the engines to run a leaner air/fuel ratio without detonation. This meant that the planes could fly further on the same fuel load, which was a huge benefit! Water injection also allowed the aircraft engines to run more ignition advance without detonating which meant that they were able to take off from shorter runways using the extra power.

BENEFITS

Hopefully you have an understanding of how a four-stroke combustion engine works, so let's look at how the introduction of water is beneficial to your car.

On the intake stroke, the engine draws air in, or has air forced in by a turbocharger or supercharger. The cooler this air is, the higher the oxygen content and, as we all know, the more oxygen, the more fuel we can add and the more power we can achieve. On a hot day or after 20 minutes thrashing around the track, the air that is entering the engine will be hotter and contain less oxygen. At best, this can lead to a drop in power, at worst it can lead to the engine detonating.

Water injection can be used to present a fine mist of water in the intake pipe ready to be drawn into the engine. The effect of this mist is to cool the intake air as it meets the fuel from the injector in the inlet port. This increases the mixture density and on entering

the engine has the immediate effect of cooling the cylinder bore wall and combustion chamber.

Next comes the compression stroke. On a normal engine with very hot intake air, we can sometimes experience pre-ignition where the compression of hot air and fuel leads to spontaneous combustion, like in a diesel engine.

With a water injected engine, not only do we have cooler air entering the engine, but we also create what is effectively steam when we compress the mixture of air, fuel and water. This significantly lowers peak cylinder temperatures as a large percentage of the generated heat is absorbed by the water during

the vaporization process. It also has the beneficial side effect of steam cleaning the combustion chamber and piston crown, which removes and prevents the carbon build up that can lead to 'hot spots' and encourage pre-ignition. To cool the piston crown, a lot of manufacturers increase fuelling to richen the air/fuel mixture, the latent heat of water is six times more than that of petrol which means it consumes six times more heat energy.

WHEN WATER INJECTION IS USED

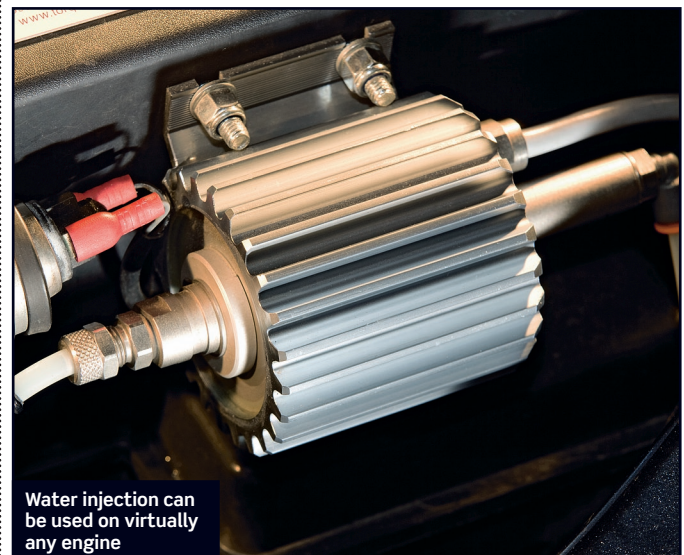
Water injection should never be used to mask an underlying detonation



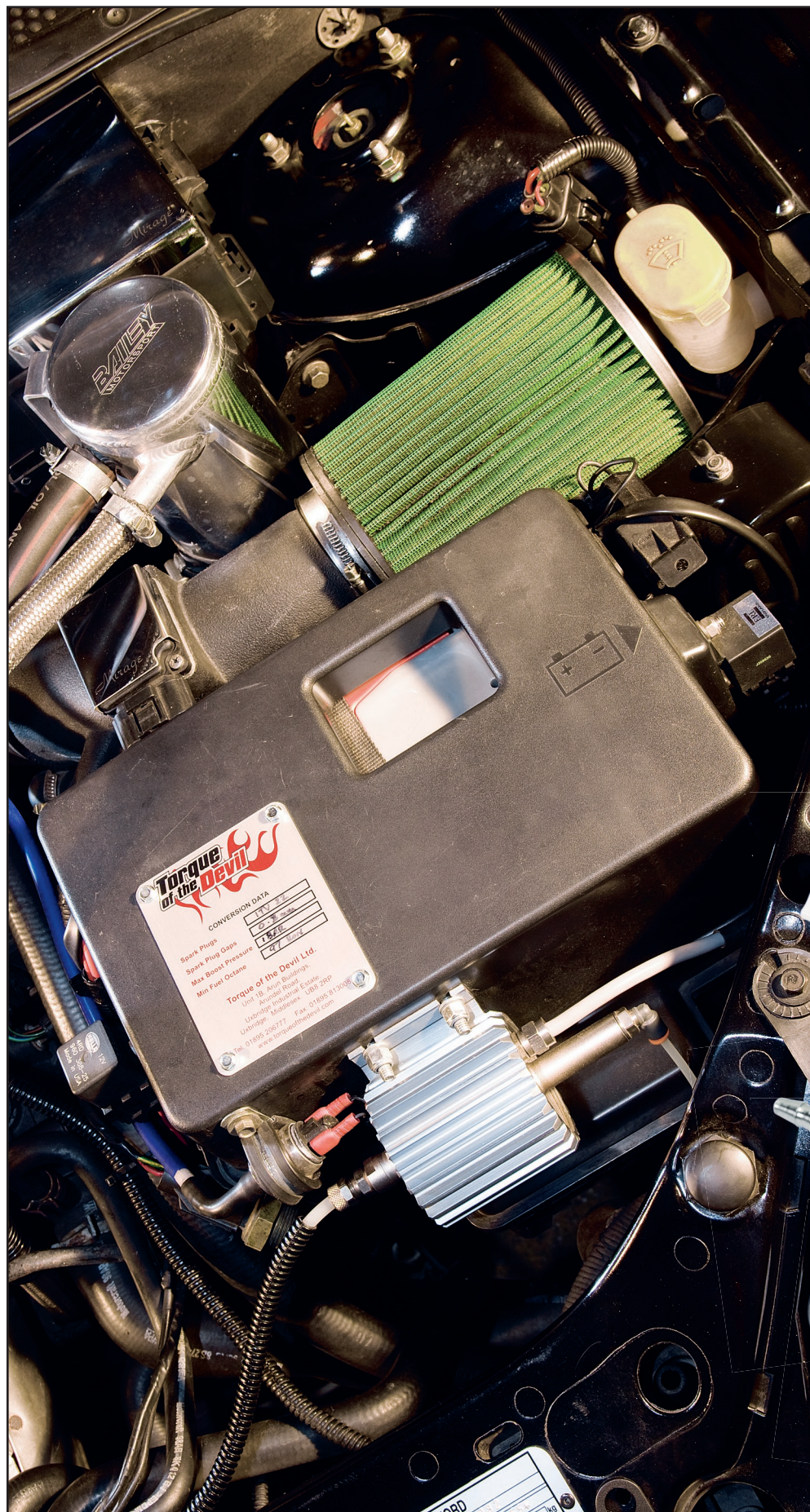
Put simply, water injection is designed to reduce or suppress detonation within a combustion engine. It works by drawing water from a reservoir into a pump where it is pressurised and under appropriate conditions allowed to enter the engine through a 'jet'.

This jet is designed to allow the water to exit the water injection line as a mist rather than in larger droplet form. Much like air and fuel entering an engine, for the water to work correctly, it needs to atomise and thoroughly mix with the air and fuel.

Water injection was used during World War 2 in aircraft engines for a number of reasons. Fuel economy was improved when



Water injection can be used on virtually any engine



problem. If your engine is detonating then you need to address the root cause of that before fitting water injection. Water injection should only ever be used as a safeguard to keep your intake air temperatures cool in extreme environments.

Water injection can be used on virtually all petrol engines, rotary, naturally aspirated, turbocharged, supercharged and believe it or not, it can also be used on diesel engines. In a diesel engine the volume of water that enters the combustion chamber raises the compression, which when done correctly can increase power and torque while allowing the engine to run cleaner and more efficiently.

METHANOL

Methanol is an alcohol-based liquid that can be used as a fuel, and is mainly found in the drag racing scene. It burns almost colourlessly in daylight and burns at a very low temperature inside an engine. When added to your water reservoir, it can be used as part of your water injection system. It is most effective when used in a 50/50 ratio with water. If you're mixing it yourself, it's worth adding a very



Water injection kits can also be used to inject methanol

HISTORY

In terms of car engines, the notable use of water injection came in 1983 when Renault turned up to the first grand prix of the year with its turbocharged V6 engine and a 12-litre water tank! Running a simple electric pump and a water pressure regulator it saw over 600bhp from that engine! However, as tends to happen in Formula One, rule changes saw it phased out three years later as fuel mixes were potent enough to reduce the occurrence of detonation through increased octane rating.

During those three years though, a number of other teams explored water injection and variations of it, most notably Ferrari. Its fuel



supplier at the time managed to suspend water droplets in the fuel itself to save the weight of a reservoir and pump. Not something you should try at home folks...

The next significant appearance came from Saab in the mid-1990s on its 2.3-litre, four-cylinder Ecopower engine. It was not

for performance as such, but Saab found that by using water injection it could run its engine at an air/fuel ratio of Lambda 1.00 throughout the entire rev range, even under full load! This meant a 15-25% increase in fuel economy and a significant reduction in hydrocarbon and nitrogen oxide emissions. Unfortunately

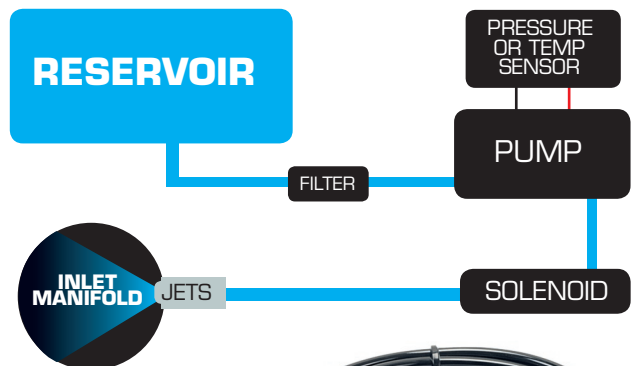
around this time there was a management changeover and the concept never made it to production.

World Rally Cars started to run water injection in 1997 and the tuning scene sat up and took notice, what we have today has evolved dramatically from those initial systems.

Water injection tanks are often mounted alongside the fuel system



WATER INJECTION SHOULD ONLY BE USED AS A SAFEGUARD TO KEEP INTAKE AIR TEMPERATURES COOL IN EXTREME ENVIRONMENTS.



Kits are quite simple and consist of a tank, pump, solenoid, jets and a switch to activate it all



small amount of water-soluble oil as methanol is very corrosive and will damage the water injection reservoir and pump.

The methanol in the mixture is burnt alongside the fuel in your engine but is very, very resilient to detonation, so in essence increases the octane rating of your fuel.

IN THE KIT

A very basic kit will consist roughly of the following: a high pressure pump (in the region of 5-8bar), a line from your reservoir to the pump with an inline filter, a line from your pump to a jet and a few different diameter jets. A simple kit like this will have a 'trigger' either in the form of a pressure sensor or a temperature

sensor so that if it sees a certain boost pressure or air temperature it will activate.

More advanced kits include everything the simple kit does, but some include control units that monitor fuel injector duty cycle and activate the water injection and increase the volume flowed in relation to fuel injector duty cycle increases. It's not uncommon to find water level sensors, water flow sensors and gauges to inform you of water flow rates and blockages. It depends on your application as to which kit is right for you.