

2011 FORD SUPER DUTY / 6.7L POWER STROKE PREVIEW

DIESEL TECH

MAGAZINE

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11 THINGS YOU NEED TO KNOW ABOUT WATER/METHANOL INJECTION BUT WERE AFRAID TO ASK

WHAT IS METHANOL?

Methanol is also recognized as wood alcohol, methyl alcohol, and methyl hydrate. It is the common alcohol used in "alcohol-burning" race cars. It is commonly used as anti-freeze in -20 degree f blue winter blend windshield washer fluid as well as a gas line dryer in Heet and for keeping air lines dry in trucks with airbrakes. If used as the sole fuel in a diesel, it requires an ignition source as it won't auto-ignite since its auto-ignition temperature is close to 900 degrees f.

HOW DOES METHANOL REACT TO THE COMPRESSION-IGNITION PROCESS OF A DIESEL ENGINE?

When injected before the intake manifold of a diesel (which is the method used in the Boost Cooler water-methanol injection system), the fact that it has a cetane rating of four means that it increases ignition delay (time from start of diesel injection to start of auto-ignition). After ignition, cylinder pressure

rises at a faster rate so "diesel noise" is slightly increased but peak cylinder pressure is only slightly higher due to ignition delay and the combustion conditioning effect (the available diesel is more efficiently burned in the later diffusion-controlled stage of combustion).

HOW DOES WATER/METHANOL INJECTION INCREASE HORSEPOWER OUTPUT?

More power is attained due to the fact that the diesel is more efficiently and completely burned and the added methanol is a fuel source. Also, the fact that more power is generated on the power stroke (as piston is going down after TDC) resulting in more net positive torque means more power is generated with a given amount of fuel. There is potentially more power also in that more diesel can be injected safely due to reduced combustion temps.

Many wonder how water can increase power since it isn't a fuel. Water increas-

es power through two main mechanisms. First, it lowers charge air temps which increases air charge density (more oxygen available for combustion). When water changes state from a liquid to a gas, it absorbs heat. How much heat depends on the total surface area of the droplets which is why atomization is so important. Volume constant, the more finely atomized the droplets, the more total surface area. Secondly, expansion takes place as the droplets change state during combustion creating the "steam effect" which pushes down on the piston creating additional torque. Also, this is "safe power" in that this torque is predominantly created as the piston is going down during the power stroke after TDC.

WHAT IS THE BEST RATIO OF WATER/METHANOL TO USE, FOR DIFFERENT APPLICATIONS (RACING, TOWING, STREET DRIVING, ETC.)?

For towing, the most cost-effective fluid

is like winter blend windshield washer fluid (approx. 30 percent methanol) because it is \$1.50 per gallon, and readily available. For all other applications, 50 percent methanol is the best mix of power, cost, safety (50 percent water keeps the flash point relatively high), EGT cooling and fuel economy. Some customers are using more methanol because power goes up with more methanol in the mix (over 100 horsepower increases with 75 percent methanol), but it is generally not recommended due to flammability issues.

CAN YOU JUST RUN WATER?

Many run 100 percent water to cool EGTs for a degree of safety while towing, racing or pulling. It's cheap insurance. Over-the-road class 7 and 8 trucks are also using 100 percent water to primarily increase fuel economy, as well as allow faster speeds on the mountain grades where high EGTs would normally require one to back off the throttle. As discussed above, the drawbacks to 100 percent water are: increased propensity to quench the fuel combustion—less can be injected so less total EGT cooling can be attained; freezing in cold climates; less power increase—8 percent compared to 20 percent increase with 50 percent methanol.

ARE THERE PARTICULAR TYPES OF METHANOL YOU SHOULD USE? AREN'T THERE DRAWBACKS TO WINDSHIELD WASHER FLUID?

Any fuels grade methanol is good (available at most tracks and racing fuels dealers). As mentioned, blue winter blend windshield washer fluid is a good source and \$1.50 per gallon at Wal-Mart. Many ask about the detergent commonly found in windshield washer fluid. It is such a small amount (less than 1 percent) that it doesn't seem to affect combustion. One of the drawbacks to windshield washer fluid is that it sometimes contains impurities that cause you to have to clean nozzle filters more often. Our Boost Juice is a premixed source of clean, standardized 49 percent methanol.

CAN WATER/METHANOL INJECTION DAMAGE A DIESEL ENGINE CAN IT PROLONG ITS LIFE?

Water/methanol injection can be thought of as an insurance policy to guard against engine damage caused by high EGTs. Damage from prolonged high exhaust gas temperatures can be acute (e.g. turbo impeller shaft failure) or

chronic (exhaust manifold metal fatigue and cracking caused by heat effect on the silicon content of the metal). Injecting too much (which causes combustion quench) should be avoided. In actuality, mild quench is harmless but prolonged severe quench from over injection should be avoided. Most of the time when someone thinks they have experienced "diesel knock," it is actually quench they are hearing. Simply put, get out of the throttle and adjust your system to inject less. The benefits of a 2-D mapped controller (featured in the Snow Stage-3 and MPG-MAX systems) include a more correct injection quantity at all operating states resulting in more power, easier setup, and less propensity to quench.

Another key benefit is carbon removal from the tops of pistons, valves, intakes (important with EGR equipped vehicles) and EGR systems resulting in a smoother running engine and one that requires less maintenance (cleaning of the intake tract and EGR valve).

WHERE IS THE BEST LOCATION IN THE AIR SYSTEM TO MOUNT THE WATER/METHANOL INJECTION NOZZLES?

There has been more discussion recently (especially on the internet) advocating pre-turbo injection. Most of the debate centers around increased atomization. You can probably get away with this in the short run if you inject a small quantity of finely atomized fluid (less than 10-micron droplet) with a very low injection duty cycle. Also if you don't care about turbo longevity (like some competition diesels where the turbo is replaced frequently) or you have a system that doesn't atomize correctly and need the turbulence to help (low injection pressure and nozzles that aren't designed to atomize correctly). In diesels, especially where injection quantities are large in relation to fuel and where there is benefit to injecting at low/mid engine load-states on up, it becomes a question of when compressor wheel damage becomes too severe, as pre-turbo injection has been proven to cause compressor wheel erosion. The amount of erosion depends on the quantity injected, the size of the droplet injected, the speed of the compressor wheel, and the injection duty cycle (what percent of total engine operation is water/methanol injected). Also, the argument of reduction in compressor work per unit flow and the increase in mass flow rate doesn't hold water in a modern non-

wastegate turbo.

We have found the best results injecting pre-intake. For recommended locations, please see the instructions for the specific year and make on our web site in the products section.

WHAT IS MEANT BY "MICRO-EXPLOSIONS" WHEN WATER AND METHANOL CHANGE STATE FROM A LIQUID TO A GAS IN DIESEL COMBUSTION AND WHAT ARE THE BENEFITS?

There is evidence in the research journals indicating that during combustion, when methanol (and to a lesser extent water) changes state, each droplet explodes creating many micro-explosions. These micro-explosions help atomize the fuel droplets more, facilitating more and smaller droplets that are more "ready" to combust. This combustion conditioning results in more of the available diesel being burned (less going out the exhaust port burning or unburned), resulting in more power and less emissions (especially particulate matter and NOx).

FUEL ECONOMY IS BECOMING A HOT TOPIC AGAIN WITH DIESELS. HOW CAN WATER/METHANOL INJECTION HELP?

More power is developed from a given amount of diesel. Methanol is an additional source of fuel and water adds power via the steam effect. You are replacing expensive diesel with inexpensive water or water-methanol. To realize maximum fuel economy, water/methanol injection should take place at all engine load states and not just at high engine load states. This is the basis for the MPG-MAX systems. These systems have the greatest range of injection (command two nozzles independently and have special mapping that allows the correct injection quantity at all engine load states).

WHAT'S THE BEST WAY TO KEEP THE SYSTEM SAFE FOR WINTER?

To keep the injection fluid from freezing, methanol is added in various concentrations. 33 percent methanol has a freezing point of approx. -20 degrees F. 50 percent methanol lowers the freezing point to approx. -34 degrees F. ²¹

(Editor's Note: Diesel Tech would like to thank Matt Snow of Snow Performance for the information in this article. To learn more about Snow Performance water/methanol injection systems, visit www.snowperformance.net)