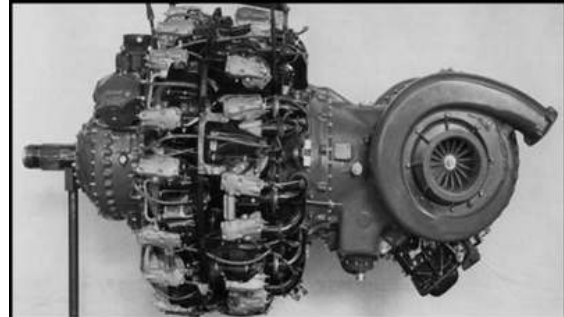


# WATER-METHANOL INJECTION 101 FOR GASOLINE ENGINES

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## History:

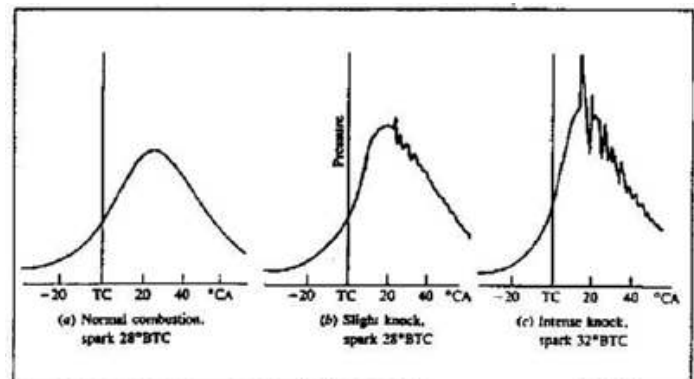
First off water-methanol injection is nothing new. Water Injection was first successfully implemented in WWII on the P-47 "Thunderbolt". The Turbo Charged Pratt & Whitney R-2800 engine normally produced 2000 HP, with water injection the engine could produce up to 3800 HP. With water injection, the P-47 had 20 minutes worth of high power output for combat situations. One initial problem was that at high altitudes the water would freeze. So to prevent freezing, methanol was finally added to the injection mixture. Later studies done by the Army Corp of Engines actually determined that with a 50/50 mix of water-methanol even more power could be produced over water injection alone.

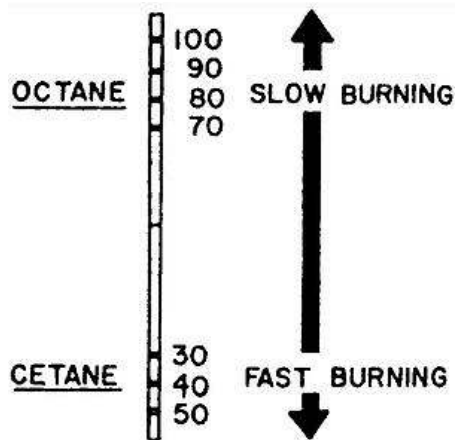


## On Demand Octane Boost:

Octane is simple a measure of a fuels ability to resist spontaneous combustion, also known as preignition. Due to high temperatures and pressures associated with forced induction, a fuel might ignite before the spark event. This results in a very fast flame and extreme combustion pressures that can destroy an engine. The higher the fuel octane, the slower the fuel will burn and less chance of preignition.

Engine knock is actually different then preignition. Knock is the result of the spontaneous combustion of left over gasses in the cylinder. The engine damaging effect is similar to preignition.





Higher octane will not make more horse power by itself. If an engine is tuned for 93 octane, and C116 race fuel is added to the tank, the engine will not make more power simply from the different fuel. If the engine is tuned for C116, then more power can be made, either by more spark advance or higher boost. Problem with C116 is one, it is expensive, and two you are wasting that high octane fuel at idle or low engine loads when it is not needed.

The octane rating of water is infinite. It can't spontaneously combust as you can't burn water. Methanol is also a high octane fuel in itself. Here are some octane ratings of various fuels:

Chemical / RON / MON

(The octane number you see in the US is  $[\text{RON} + \text{MON}]/2$ )

Methanol / 133 / 105

Ethanol / 129 / 102

Isopropyl Alcohol / 118 / 98

MTBE / 116 / 103

Toluene / 124 / 112

Meta Xylene / 164 / 124

Dicyclopentadiene / 229 / 167

As a rule of thumb, 50/50 Water/Methanol injection will increase the octane rating of pump gas by 25% during injection. (Note that C16 Race gas is already 116 octane, W/M will slow flame more). So with a load based injection system, you only get the octane increase when needed.

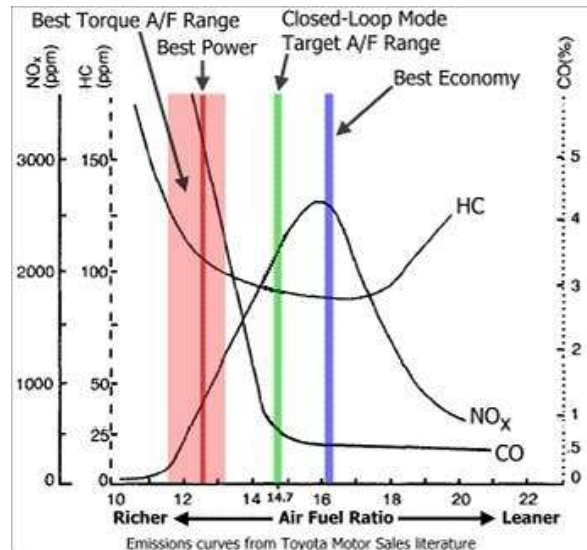
Water is capable of cooling the combustion chamber more efficiently than gasoline. Water has a higher Latent Heat of Vaporization than gasoline. When water is injected in very small droplet sizes into the combustion chamber, it readily absorbs heat as the partials go from

Fuel	Energy density	Air-fuel ratio	Specific energy	Heat of vaporization	RON	MON
Gasoline and biogasoline	32 MJ/L	14.6	2.9 MJ/kg air	0.36 MJ/kg	91-99	81-89
Ethanol fuel	19.6 MJ/L	9.0	3.0 MJ/kg air	0.92 MJ/kg	129	102
Methanol	16 MJ/L	6.5	3.1 MJ/kg air	1.2 MJ/kg	135	104

liquid to gas state. The water particles actually “pop” or create multiple micro explosions. These micro explosions help to slow the flame front, effectively increasing the octane rating. These micro explosions also help to “stir” the air fuel charge or create a swirl effect in the combustion chamber. This swirl effect results in a more complete combustion of the fuel, leading to lower emissions. With a more complete combustion, engine knock is reduced. This is due to the lower amount of gases available after combustion that could spontaneously combust.

**Air / Fuel Ratios:**

A gasoline engine will make the most power at an A/F of 12 to 12.5 to 1. The problem is that at this lean of A/F ratio, a forced induction engine will have a tendency for preignition when using regular octane pump gas. That is why most forced inductions engines are tuned for an A/F of around 11.5/1. At 11.5/ 1, 10-15% extra fuel is being added to cool the cylinder and top of the piston to prevent preignition. This extra fuel is not burned in the combustion process and goes out the tail pipe.



A 50/50 mix of water-methanol, when injected in the right quantity, will lower A/F by at least ½ point. Now the engine fueling can be reduced, more timing added, or boost pressure can be increased, allowing the engine to make more power.

**Chemical Intercooling:**

Most water-methanol injection systems are designed to spray the injection mix after the intercooler and before the throttle body. These systems are designed to inject the mixture with a high pressure pump and fluid atomizing nozzle. The smaller the injection particles, the more surface area there is of the small droplets, and the more heat that can be removed. As mentioned above, the high Latent Heat of Vaporization of water lowers the Intake Air Temp as the water absorbs heat going from a liquid to gas state. A cooler air charge reduces the chance of pre-ignition allowing for more timing or higher boost levels.

An intercooler does the same thing to lower air charge temperatures. One draw back of an intercooler is the boost pressure drop across the intercooler. A second is that in an air to air intercooler, cooling efficiency is limited to

that of ambient air temperatures. A third draw back is cost and weight of large front mount intercoolers.

### **Injection Fluids:**

The most common question we get is "Where can I buy Methanol". Most are surprised to find out that everyday window washer fluid is nothing more than water and methanol.

When using window washer fluid for injection, look for these items to insure you have a good product.

- The fluid is Blue
- The label says protects to -20 or -25F
- No soap bubble form when you shake the bottle.

Note you want to avoid mixtures that contain propylene glycol (anti-freeze). This is commonly added to window washer fluid to lower the temperature rating and is harmful to the engine if injected.

Here are some methanol ratios of commonly available washer fluids per the manufactures MSDS.

<b>Manufacture</b>	<b>Product</b>	<b>Metanol %</b>	<b>Additives</b>
Camco	-20	< 35	
Peak	-20	< 33	
Peak	-25	< 35	
Peak	-30	< 36	(<5 Propylene Glycol)
Prestone	De-Icer	30-60%	(3-7% Ethylene Glycol)
Super Tech	-25	38	
UNI-GAURD	-20, -25	30-40	<1 Surfactant Polyol)
HEET	Yellow	99	