Pump Gas Versus Race Gas Versus Methanol

We have all seen it, heard about it, or done it ourselves: Filled up our street cars with race gas in the hope of seeing a performance gain. But what does it really do? If a motor is happy with 91 octane, what will race gas do to it? What possible changes would you need to perform to see a gain? We took a trip to Westech Performance Group to thoroughly test these issues on the dyno, and come to some sort of concrete conclusion.

The objective here is to find the truth, and either discourage or encourage the practice of putting race gas in a pump-gas motor at the track to gain optimum performance.

Tuning For Power

Tune for power-makes sense, right? Many engine tuners don't look at it that way. They have a misconception of using benchmark numbers, such as brake-specific fuel consumption and air/fuel ratio, to guide their adjustments. For example, if you were to decide that a 13:1 air/fuel (A/F) ratio was the optimum number for your engine, you would change jetting to achieve it, and then leave it at that. Engines don't create the most peak power or best curves at a predetermined A/F ratio. The A/F ratio is merely a number you should take into consideration when tuning to keep out of the danger zone. At the end of the day, you are looking for the best performance, not a specific reading on the A/F meter.

The first step is to add fuel until power starts to level out. Once it does, then perform what is called a timing sweep. To do this, pull two degrees of timing out to see if there is a change in power. If there is no change, add four degrees from there to see if more power is gained with the more advanced timing. If the motor likes the increase in timing, keep adding timing until there is no change, or until the motor approaches an unsafe level of ignition timing. Once the optimal total ignition timing setting is found, remove fuel by means of a jet change up to a point to a loss in power. On most engines, this is the path to finding the most power.

Pump Gas Versus Race Gas

Octane rating is defined as the resistance to detonation a fuel has in an internal-combustion engine. The higher the number, the more resistance it has. That is why engines with higher compression require higher-octane fuel. As a result of its resistance to detonation, it has a resistance to burn as well. This resistance to burn is a non-issue in motors tuned to the edge; the edge being just before detonation occurs. When a pump-gas engine is subjected to a higher-octane race fuel, it may result in a decrease in power from an incomplete burn.

Oxygenated Fuel

The theory is the more fuel you can pass through an engine and completely burn, the more power you can make. The fuel has to be matched with air to create a burnable mixture. Without a power adder such as a blower or a turbo, air is hard to add. That is where oxygenated fuel is helpful. It contains a higher percent of oxygen, creating a quicker, more efficient burn. In the state of California, 91-coctane pump fuel is oxygenated, so the gains between the two fuels due to oxygenation wouldn't be notable.

The Results

91 Octane Versus 100 Octane

The first test was to compare the difference between 91 and 100 octane without making any changes from the 91-octane baseline. The engine, with pump gas, responded the best to 37 degrees total advance, and 71/77 jetting. The same tune, with 100-octane fuel, showed no change. Through the same tuning processes used to find the most power from 91 octane, we were able to get up to 7 lb-ft of torque between 3,800 and 5,000 rpm. Horsepower gains were similar from 4,600 and 5,500 rpm. The only change made was going from 77 to 79 jets for the secondaries. At $60 for a 5-gallon can, I personally think that 7 horsepower worth of extra acceleration can more cost effectively come from lightweight parts.

100 Octane Versus 118 Octane
The first test we did with the 118-octane fuel was with the settings that worked best for 100 octane. We saw an across-the-board loss in horsepower and torque. Again, using the same procedure, we found that the 91 octane's best settings were the best for 118 as well.

Conclusion
Filling your tank with high-octane fuel, when your engine runs fine with 91 octane, is a waste of money. In this engine's case, minimal gains were achieved after a dozen dyno tests were made, and would be too small to notice at the track. The higher 118-octane fuel made less power than both the 110 and 91 octane.

Can you over-octane an engine? If so, what happens?
Yes you can over octane an engine. Generally you will get sluggish throttle response. Also you may get fouled plugs and deposits in the exhaust ports and headers. When an engine is trying to burn a fuel that has too much octane, the burn rate is incorrect and all of the fuel won't be used up. This excess usually gets left as a deposit or gets pushed out the exhaust. It is important to match your engine's needs with the correct fuel.

Your engine only knows when it does not have enough octane. That's when you have serious problems. "Over octaneing" is a term that comes up occasionally when someone thinks that their engine is making less power than it should because the gasoline has too much octane. When they switch to a lower octane gasoline, power increases. This can happen, but it is because of all of the differences in the gasolines that the user is not aware of, like the various types of hydrocarbons in the gasoline, distillation characteristics, etc.

Besides octane, what else do I need to consider when selecting a fuel ?
Too often, racers focus only on octane when evaluating the quality of a fuel. Octane is certainly important, but it's just one of several key fuel properties that should be considered when evaluating and selecting a fuel. <u>It's entirely possible to generate more horsepower with a lower octane fuel if it's designed properly with respect to its other key properties.</u> It's also possible for two fuels to have the same octane rating, but perform very differently due to their other key properties.

Mixing unleaded street gasoline with leaded racing gasoline seems to be the thing to do lately. We receive a lot of questions about this from racers trying to save money and/or reduce the octane number of the product. There are good and bad points in mixing these two very different types of gasoline.

The first problem is that if the product is for a street driven vehicle, the resulting gasoline is illegal since it will contain lead. The biggest part of the illegal issue is the $25,000 fine that one can incur. THIS WILL RUIN YOUR WHOLE DAY. If the gasoline is for a racecar, the legality is not an issue. By the way, leaded gasoline has been illegal for use in ALL street driven vehicles in all states in the US since January 1, 1996.

A good racing gasoline is designed to burn efficiently between 5,000 and 9,000 RPM. <u>A good street gasoline is designed to burn efficiently from idle to 3,000 RPM which is the highest speed most engines see during the EPA test for exhaust emissions.</u> Mixing the street gasoline with the racing gasoline compromises the good high-speed burn characteristics of the racing gasoline thereby reducing the potential engine output. This also reduces the octane quality of the blend.

On the subject of octane quality, it is essential that you have enough octane to satisfy your engine by keeping it free of detonation. Cutting down on the octane quality with street gasoline is okay if you can accept the side effects, and as long as you don't blend below the octane requirement of the engine. When you cut the octane down with street gasoline, you will compromise engine output.

Another potential problem is that each time that you blend racing gasoline and street gasoline, you do not necessarily get the same end results. This is because street gasoline is “seasonally varied” six or seven times per year based on the temperatures that are anticipated in your particular area. Racing Gasoline remains the same throughout the year, but with the variable of the street gasoline, one can get some less than ideal mixtures that can contribute to vapor lock and/or make consistent tuning difficult.

Methanol Injection as an octane booster

In Methanol Injection Systems, can I use pure methanol?
While all components of injection systems are designed to be able to handle pure methanol, it is not recommended for a number of reasons.

> **Safety:** Pure methanol is easy to ignite and burns with an almost invisible flame.
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> **Performance:** Water absorbs twice as much heat as methanol in the intake and inside the combustion chamber. Water cannot be flash-ignited, so has what is almost an infinite octane number. In the government studies for WWII piston-powered aircraft, 50/50 water-methanol was found to be the best fluid to use for auxiliary fluid injection.
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> **Tuning and Engine reliability:** Injecting 50/50 water-methanol will prevent over-injection. If too much is injected, it will quench the flame front and the engine will bog and lose power. If too much straight methanol is injected, this will not happen, as methanol is very forgiving of rich mixtures. This could instead lead to explosive backfires, cylinder wash, etc. which will not happen when 50% or more water is in the mixture.

Where should I mount the methanol injection nozzles?

Pre- or Post- throttle body?

Performance: It makes almost no difference. Before or after the throttle plate(s) won’t change the effectiveness of the fluid. A given amount of fluid will absorb a given amount of heat, whether it is done more before or after the throttle plate really doesn’t matter.

Installation: It is usually easier to inject pre-throttle body in the intake tube. Easy access, no solenoid required (unless rear-mounting a reservoir). In a blow-through carburetor setup with an air-box enclosure around the entire carburetor, injecting after the carburetor is preferable.

Pre- or Post- Supercharger/Turbocharger?

Positive Displacement Supercharger: Roots style (B&M, Eaton, Magnuson, etc.) or twin screw (Lysholm, Kenne Bell, Whipple, etc.) Mounting the nozzle before this style of blower is perfectly safe and actually provides some additional benefits. The small amount of water-methanol fluid isn’t harmful to any rotor seals or surfaces or coatings, and it helps to seal the clearances and condense the air some more, resulting in a more efficient output. Additionally, it keeps the rotors and housing MUCH cooler, which reduces heat transfer to the rest of the intake and air charge.

What is the major advantage of methanol injection?

Simply put: it helps prevent detonation. Substances heat up when they're compressed, and in traditional gasoline engines, detonation-or "pre-ignition"-occurs when a cylinder's air/fuel charge compresses and heats to the point of auto-ignition during the compression phase, before it can be lit at the proper time by a spark plug. If this occurs a few degrees of crank rotation in advance, the consequences may not be bad. But if it occurs farther back in the compression stroke, in high-horsepower instances, it can easily destroy an engine's internal components. Water/methanol injection systems deliver a finely atomized mist of a water/methanol mixture to an engine's cylinder charge, and as the mixture absorbs heat and vaporizes, temperatures inside the cylinder are reduced and the propensity for detonation is decreased. Today's newer, knock-sensor-equipped vehicles are very good at staving off detonation by retarding ignition timing the moment detonation-also known as "knock"-is detected, but do so at the cost of severely decreased power output and fuel economy.

116+ Octane With Water Injection!

For many of you reading this, you may already be familiar with the substantial octane increases possible with a simple water methanol injection system (methanol can be substituted for other forms of alcohols such as ethanol, isopropanol, etc.). While for many others, you are just becoming aware of water injection for the first time and what it has to offer.

Water injection isn't new. It actually dates far back to the 1930's where it was extensively used for the first time in WWII on supercharged and turbocharged fighter aircraft to increase power on take off and increasing the altitude for which a plane could climb. In 1942, the German Luftwaffe increased the horsepower of the Focke-Wulf 190D-9 fighter aircraft from 1776HP to 2240HP using 50/50% water methanol injection. Likewise, the turbocharged Pratt & Whitney R-2800 engine picked increased it horsepower output from 2000 horsepower to 3800 horsepower with the use of water injection. Manufactures such as Chrysler, Saab, Porsche and GM also used water injection on various large displacement, high compression or turbo charged motors such as the Saab 99 Turb. As well as 1962 and 1963 GM Oldsmobile Jetfire with it's turbocharged 10.25:1 compression aluminum V8. To keep detonation under control Oldsmobile used water injection and a fluid called "Olds Turbo Rocket Fluid" which was nothing more then a blend of water and methanol and a corrosion inhibitor. It was also used in Formula 1 racing for a short period of time before being banned for adding too much horsepower.

In recent years, water methanol injection has become ever more popular and recognized as an invaluable tool for both gasoline and diesel forced induction engines. As well as normally naturally aspirated applications. While often times referred to as a "chemical intercooler" it is more commonly used in forced induction applications due to it's substantial cooling effects and added octane increase it adds to pump gas. Reducing air intake charge temperatures by 50-200+ degrees F almost instantly. Providing a substantially cooler denser intake air charge for a greater expansion of power within the combustion chamber. While also largely eliminating the problem of engine "knocking" and allowing user to run higher levels of boost, compression and increased timing.

As previouisly mentioned already, water methanol injection has become a tried-and-true proven way for users to effectively increase their 87-93 octane pump gas. Depending on the amount injected and the type of mix used (pure water, pure methanol or a mix of the two), gains up to 10-25+ points in octane can be achieved. **Thus making 91 octane pump gas act like 105-116 octane racing fuel in their engines.** Thereby eliminating our dependency for notoriously expensive racing fuels, which can cost upwards of $8.00-$12.00 per gallon as so many of us have reluctantly had to use in the past. Costing only pennies to operate when using 100% water, its also a far more effective, affordable and convenient to those expensive octane booster fuel additives as well.

While once believed impossible several years ago. It is now possible and becoming quite common to find individuals using 91-93 octane combined with water methanol injection to support engines well over 1000+ horsepower. One top engine builder, Steve Morris of New Era Performance, has already made upwards of 1700+ horsepower with a non-intercooled carbureted big block Chevy ProCharged engine on 93-pump gas using only 100% water injection .

Below is a brief summery of the various types of fluids you can use with our water methanol injection systems.

What types of fluids can I use?

Water and various grains of alcohol, methanol, ethanol and isopropanol, are the primary fluids which are commonly used in a water methanol injection systems. Unlike most other competitors systems on the market, who still continue to use the "silver" agricultural pumps which can only tolerate mixtures up to 50/50 mix of methanol, our pumps are specifically designed for 100% use of methanol, ethanol, isopropanol and other similar forms of alcohol. Depending on the application, we have found mixtures of 40/60 water and methanol to perform the best without the risk of being a flammable fluid. We do not recommend using mixtures greater then 40/60 water methanol as it will become a flammable liquid with added risks and hazards associated with it.

This surprises many the first time they hear it. **When injected properly into the air charge of an engine, water and water alone, is a remarkable detonation suppressant.** The most notable advantages of using water injection is it's inability to detonate as well as it's substantial cooling effect it has on air charge temperatures, combustion temperatures and exhaust gas temperatures. Best of all...it's basically free. Water has a high latent heat of vaporization. Approximately, 8 times that of gasoline and can reduce intake charge temperatures by 50-150+ degrees F on supercharged and turbocharged engines almost instantly when sprayed properly. It's also an extremely effective octane booster. As you may have already read in our article, "Knock Knock…Who's There?". Since water does not burn "per' say, when atomized properly with pump gas, it will effectively increase the fuels octane. Doing so, by improving the fuels ability to resist self-ignition under higher cylinder pressures and hotter cylinder temperatures thus suppressing detonation.

Through testing and research, comparing high-octane fuels vs. 87-93 octane pump gas combined with 100% water injection (no alcohol mix added). Depending on the build of the motor and volume injected, we estimate octane increases of 10-20+ points can be achieved by using 100% water injection with 87-93 octane gas. This is after evaluating maximum allowable total timing advance and maximum attainable boost levels without detonation or pre-ignition.

Methanol, ethanol and isopropanol, all forms of alcohol, are commonly mixed with water or used pure with our water methanol injection systems. With octane ratings from 105-130+, depending on the form of alcohol used, 10-20+ points in octane can be achieved when combined properly with 87-93 octane pump gas.

The most common types of alcohol used in water methanol injection systems are methanol grains. Methanol is produced primarily from natural gas, wood or coal. While ethanol is produced from sugarcane or corn. Methanol is far cheaper to produce than ethanol, thereby making it the more desirable between the two to use. Water injection is also often known as water methanol injection, owing to the fact that the alcohol mixed into the injection solution is often methanol and not ethanol or isopropanol.

The main distinction between methanol and ethanol is that methanol has a lower caloric weight (or the amount of energy available to burn when combusted), higher specific heat (takes more heat to burn the mixture) and a high heat of vaporization (when vaporized can cool down intake air temps dramatically). Ethanol is generally the same characteristics and properties as methanol, but does not cool down the intake charge as well and as mentioned above costs substantially more then methanol.

For engines that are fueled solely by methanol, such as race engines, it's quite common to see ice form on the outside of the intake manifolds during operation. Methanol is able to cool down the intake air temperatures entering the cylinder head so well, that when used as the primary fuel on a forced induction engines, an intercooler is not needed no matter what the boost levels are. Most surprisingly, engines can also be ran without a radiator. This being a true testament to the cooling effects offered by methanol when.

It should be noted that while water methanol injection can be extremely beneficial to both naturally aspirated and forced induction applications, proper installation, delivery, control and tuning are imperative. Not all water methanol injection systems are the same. AlcoholInjectionSystems.combrings you the best quality and most advance systems in the industry. Along with the easiest to install systems on the market.

We recommend a maximum mixture of 50/50 mixed of water and alcohol, as it will not be a flammable liquid in this state. Using mixtures with greater percentages of alcohol will become a flammable liquid and use of stainless steel lines should be used.

Tuning Tip Since alcohol is a fuel, when using mixes with higher percentages of alcohol, expect air/fuel ratio to richen up more than when used with mixes containing lesser percentages of alcohol with greater percentages of water. For this reason, many user's will actually prefer using a much lower percentage of water/alcohol or 100% water. Depending on the application this can be just as effective while not affecting the air/fuel ratio as greatly as does mixes with greater percentages of alcohol. We highly recommend the use of a wide band o2 system to monitor air/fuel ratio and aid in tuning your engine.