# Water/Methanol Injection: Frequently Asked Questions

Water/methanol injection is nothing new. It has been used as far back as World War II to help power German fighter planes. Yet it never seemed to catch on as a mainstream power adder in the hot rodding world—until recent years.

Many companies are now offering easy to install water/methanol injections systems for affordable prices. Available for naturally aspirated or forced induction gasoline and diesel applications, these systems inject a roughly 50/50 mixture of methanol and water into the engine using a high-pressure pump. This magical mixture allows for more ignition timing, increases boost capability in supercharged or turbocharged applications, lowers air intake temperature, and provides an additional source of very high-octane fuel—all without increasing the chance of damaging detonation.

Water injection systems are predominantly useful in forced induction (turbocharged or supercharged), internal combustion engines. Only in extreme cases such as very high compression ratios, very low octane fuel or too much ignition advance can it benefit a normally aspirated engine. The system has been around for a long time since it was already used in some World War II aircraft engines, which allowed them to produce more power and therefore fly at higher altitudes.

A water injection system works similarly to a fuel injection system only it injects water instead of fuel. Water injection is not to be confused with water spraying on the intercooler's surface, water spraying is much less efficient and far less sophisticated.

A turbocharger or supercharger essentially compresses the air going into the engine in order to force more air than would be possible with the atmospheric pressure. More air into the engine means automatically more fuel has to be injected in order to maintain the appropriate stoechiometric value of the air/fuel ratio (around 14:1). More air and fuel into the engine leads to more power. However by compressing the inlet air the turbocharger also heats it. Higher air temperatures lead to thinner air and therefore an altered stoechiometric ratio which can lead to a lean mixture and detonation. Detonation, an effect also known as engine knock or pinging, occurs when the air/fuel mixture ignites prematurely or burns incorrectly. In normal engine operation the flame front travels from the spark plug across the cylinder in a predefined pattern. Peak chamber pressure occurs at around 12 degrees after TDC and the piston is pushed down the bore.

In some cases and for reasons such as a poor mixture, too high engine or inlet temperatures, too low octane fuels, too much ignition advance, too much turbo boost, etc., the primary flame front initiated by the spark plug may be followed by a second flame front. The chamber pressure then rises too rapidly for piston movement to relieve it. The pressure and temperature become so great that all the mixture in the chamber explodes in an uncontrolled manner. If the force of that explosion is severe some of the engine's moving parts (pistons, rods, valves, crank) will be destroyed.

Detonation, in any engine, should always be avoided by either lowering inlet temperatures, using higher octane fuel, retarding ignition (hence lowering engine output), lowering engine blow-by (a situation in which high crankcase pressure sends oil fumes back inside the combustion chamber), running the engine a little richer than at the stoechiometric ratio, lowering the compression ratio and/or boost pressure, ... Water injection is used to lower in-cylinder temperatures and burn the air/fuel mixture more efficiently thus helping avoid detonation.

In high pressure turbocharged and supercharged engines the air/fuel mixture that enters the cylinders can, in some cases, explode prematurely (before the spark plug ignites) due to the extreme engine environment conditions. This situation is extremely destructive and results in severe engine damage (piston piercing). To avoid damaging the engine by detonation or pre-ignition phenomena, water is injected, along with fuel, in the combustion chambers in order to provide a water/air/fuel mixture which not only burns more efficiently and avoids detonation or pre-ignition but also provides additional inlet air cooling and, hence, denser air. The sole functions of water injection is avoiding detonation by lowering air charge/cylinder temperatures along with increasing the effective octain of the air/fuel charge, so the ECU can advance timing and take advantage of the increased boost.

There are mainly three variations of water injection systems. They are dependent of the location of the water injectors. The first technique consists of injecting water at the entrance of the intake manifold. The second injects water at the exit pipe of the intercooler. The third technique injects water at the entry of the intercooler and is only used in competition vehicles. In this latter variation most of the in-cylinder detonation prevention is done by injecting additional fuel which is then used as coolant (i.e. is not burned) and runs the engine above the stoechiometric ratio (i.e. rich).

Water/Methanol Injection: How it Works

The secret to water/methanol injection lies in its key ingredients. Methanol is a high octane fuel that is also extremely resistant to detonation. It has a tendency to absorb heat out of the air—something known as “latent heat of vaporization.” The water also absorbs heat and provides a further cooling effect as the finely atomized water/methanol mix is pumped into the engine. The cooler, denser intake charge reduces the chances of detonation even as the high-octane methanol boosts power.

Water/Methanol FAQs

What are the benefits of water/methanol injection?

1) More power: the high-octane properties of methanol, along with air cooling properties of the methanol and water, help water/methanol systems produce more power. In addition, the cooler intake temperatures allow you to run more aggressive timing and/or boost (forced induction applications) without increasing the chance of detonation. 2) Reduced chance of detonation: the lower intake charge temperatures created by the methanol and water mean less chance for engine-damaging detonation. 3) Low cost: water/methanol systems start around $300. 4) More economical for the street: water/methanol is a less expensive high-octane alternative to pure race gas for guys running high compression engines on the street. 5) Built-in engine maintenance: in some cases, the atomized water effectively steam cleans the valves, valve seats, and even the piston tops and intake, reducing carbon buildup.

Why is methanol used?

Methanol is a very high-octane fuel that is extremely resistant to detonation. Its high latent heat of vaporization also makes it an excellent air charge cooler which means a denser mixture and more horsepower. Because of these characteristics, it suppresses detonation more effectively than ethanol or iso-propanol.

What type of power gains can I expect?

Depending on the system, timing can often be advanced 10 or more degrees when a water/methanol system is used. Boost can often be increased five or more psi. When combined with the cooler air intake charge created by the water and methanol, these changes can net a horsepower increase of up to 20 percent in power-adder applications. In naturally aspirated applications, horsepower gains of 5-10 percent are possible.

Do these systems work on naturally aspirated engines?

Yes.  With stock compression engines (10:1 compression or less), you gain up to 15 horsepower with full timing and achieve more effective air/fuel ratios and increase gas mileage. In naturally aspirated high compression engines, you can use of pump fuel in most situations, making it a more budget-friendly alternative to race gas. Plus, the colder, denser intake charge delivers more horsepower and allows for higher timing advances.

Can a water/methanol system improve my fuel economy?
Yes. The higher-octane methanol allows for more spark timing advance and a leaner air/fuel ratio with the use of a programmer. Additionally, most modern cars will detect the combustion of the methanol and reduce the injection of gasoline. This can positively impact gasoline fuel economy.

Where can I purchase Methanol?
Methanol can generally be purchased where racing fuels are sold. It is important to make sure that the methanol is "neat" and therefore has no additives or lubricants added by the supplier.

What ratio of water/methanol is recommended?
A 50/50 ratio is recommended, although ratios of anywhere from 30 percent to 50 percent methanol work well and deliver excellent octane gains and cooling. The 50/50 ratio has been demonstrated to be the best for charge/air cooling, excellent detonation control, and safety. It should be noted that methanol is easy to ignite and burns with a nearly invisible flame. For that reason, any ratio that far exceeds the recommended 50/50 ratio can be hazardous.

Why not run 100 percent methanol? First of all, methanol is extremely flammable, so safety is a concern. Also, too much pure methanol injected can create nasty backfires through the intake, so it's best to stay at a 50/50 mix, or 75 percent if you're willing to take the risk. It's the optimized controls of the Boost Cooler system (ramp rates, pressure activation) that make this percentage of methanol injection even possible, and with peak gains of 74 hp and 164 lb-ft at a safe 50/50 mix, the potential of this sophisticated system is proven.

Do I need an intercooler when I use water/methanol injection with another power adder?
50/50 water/methanol will provide all the density increase/detonation control needed to handle up to 30 psig of boost. However, an intercooler and water/methanol injection together would provide even greater benefits, especially beyond 30 psig of boost.

How long will a tank of water/methanol last?
This depends on a few variables—horsepower, injection system, settings, and driving style. A 3-quart tank will typically last around a tank of gasoline in most engines in the

200-500 horsepower range. Most systems include some sort of fail-safe device that reduces boost or adjusts timing curves in case the flow of water/methanol is exhausted or suddenly drops. It all depends on how often you use the system (it's only active under boost) and how big the tank is. Even the smallest tanks will last for 8 full 1/4 mile runs or so. In around town driving (aggressive driving) a windshield washer tank that is 1.5 gallon in size should out last a tank of gas.  If you do not drive aggressively (under boost) except when on the track, you should be able to go a full month without filling up your water/meth tank.

What size injector do I need?

Every engine is unique, however the general formula is 1.0 - 2.0 gallons per hour (gph) per 100 horsepower. It is recommended to start on the lower end, and then increase from there if needed. Keep in mind when buying or building a two stage system that both injectors are running when at high boost, so your total flow is the rating of each injector added together.

Does the water "burn" in the engine?

No. The water simply converts from a vapor to a gaseous state which absorbs huge amounts of heat, due to the energy required to transform it.

What size pump to I need?

The 100 psi pump is more than enough if you are running less than 20 PSI of boost. If you put out more than 20 PSI, then you must have the 150 PSI pump so the injector nozzles are pressurized enough for a completely atomized mist (pump pressure fights boost pressure). The 150 PSI pump produces an extremely fine mist. The more pressure the pump puts out, the finer, and more atomized the mist. The more atomized the mist, the more surface area a given amount of injected water has, and therefore getting better results.

Any recommendations about the placement of the pump?

Every car is different. The closer to the engine the better/easier/cheaper. If you need to/want to mount the pump in the trunk, there are no problems with this as the pumps are plenty strong enough to draw, and pump, any length that any car/truck could possibly have. The only difference with mounting the pump far from the engine is the extra wiring and tubing that will be required. Although not required, it is recommend to mount the pump lower than the tank, so if you do run the tank dry, priming is much quicker this way.

Can I use Washer Fluid?

Some engines get the best gains from straight water, and some with straight methanol, and some with a water/methanol mix. How much methanol, well that is up to what your engine prefers, and every engine is different.  The “norm” is a 50-50 mix of water and methanol.  Try a 10% meth/water mix and then see the results.  Do this for 20%, 30%, 40%, and 50%, 60% etc.... If during this process, you notice your performance decrease, then don't try any higher of a mixture. Revert back to the previous amounts and use what works best.

There are many places to buy straight methanol, but if you are going to use a water/methanol mixture, the easiest (and cheapest) is to buy the blue windshield washer fluid that is used during winter time to prevent the fluid from freezing. It may sound cheap ($1.29-$1.99 per gallon), but it is just as good as any methanol/water mixture you would make otherwise. The blue is just a dye, and an extremely insignificant amount (<1%).  If you want a 50-50 mix, then add 4 bottles of HEAT, which can be purchased at any auto parts store or Walmart.  HEAT is pure methanol and 4 bottles to one bottle of windshield washer fluid will bring you up to the 50-50 mix of water and methanol.

Some of the washer fluids, such as RainX, contain cleaning additives, but this is easily determined by shaking the bottle and seeing if it suds up like soapy water. If it does, don't buy it, but if it doesn't, then it is good to use. There are many different brands out there, but they all have common amounts of methanol for their respective temperature rating, regardless of the brand.   Here’s how much methanol is typically in washier fluid so the amount of HEAT required is based on which washer fluid you purchase.

+20 F Washer Fluid - Contains approximately 7% methanol.

0 F Washer Fluid - Contains approximately 23% methanol.

-10 F Washer Fluid - Contains approximately 28% methanol.

-20 F Washer Fluid - Contains approximately 35% methanol.

-25 F Washer Fluid - Contains approximately 38% methanol.

-50 F Washer Fluid - Contains approximately 62% methanol.

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Snow Performance [http://www.snowperformance.net](http://www.snowperformance.net)

**Here are some interesting facts:**

**The main benefits of water injection are:**

- *Will significantly help to prevent detonation especially in a supercharged or turbocharged engine.*
- *Will raise the octane of the gas you are using.*
- *By reducing detonation, this will allow you to increase boost or run lower octane.*
- *Lowers air intake temperatures which keep the engine cooler from the inside out.*
- *Will literally steam clean the carbon deposits from within the engine.*

1. Maximum Torque occurs at a 13.2:1 Air Fuel Ratio.
2. Transitional Fueling and Maximum Boost Air Fuel Ratios are about 12.5:1.
3. Water Injection is most efficient with a 50/50 water alcohol mixture.
4. Methanol is the most common and best alcohol to use if you will be using an alcohol/water mixture.
5. Denatured (will eat your pump in 2 months and is not covered by warranty) alcohol, typically 95%, is cheap and is available in paint, hardware, and Home Depot type stores in gallon containers for about $10.00. Isopropyl alcohol can be used but it is often 30% or more water by content.
6. Water Injection allows ignition timing to be more aggressive. In other words boost does not automatically mean pulling your timing.
7. Excessive amounts of ignition retard will cause a loss of power and overheating.
8. Water to Fuel ratios should be based on weight and not volume.
9 . Water weighs 8.33 lb per gallon.
10. Alcohol weighs 6.63 lb per gallon.
11. Air weighs .080645 lb per cubic foot. It takes about 150 cubic feet of air per 100 horsepower. It takes about 12 lb of air per 100 horsepower.
12. Water or Water / Alcohol to Fuel Ratios are between 12.5% to 25%. This means Air to Fluid Ratios are between 11.1:1 and 10.0:1 with water injection, when your fuel system goes into closed loop (ie. when you floor the throttle).
13. Maximum water delivery should be in higher load scenarios, such as when torque is highest.
14. Atomization of the water mixture is directly related to it effectiveness. Finer droplets cool the inlet charge better and with less mass they navigate the inlet plenum easier for more equal water distribution.
15**.** Don’t flow water through an intercooler.
16. Atomized water, just like fuel , does not like to make turns thus making accurate distribution something to think about. This is why port fuel injection is the norm. Water is a fluid just like your fuel. Multiple nozzles, equally spaced in the plenum, although it complicates

things, is a superior design.
17. The introduction of water will allow higher boost pressures to be run without detonation. Higher pressures will increase torque. It's always about torque.
18. Racing high octane gasoline should be used for all forms of competition and for higher than normal boost levels if possible. Water injection as well as charge cooling (intercooler) should be used with racing gas when used for competition.
19. Fuel Injectors should not be used to deliver the water in a water injection system since they are more susceptible to corrosion.
21. Fuel Injection pumps cannot be used for water injection. Water is conductive. Gasoline is not. Water will corrode an efi pump shut in a very short period of time.
22. Water injection has a cooling effect on the engine head, valves, and cylinder. Exhaust temperatures (EGT) can be reduced from 50 to 150 degrees Celsius.
23. The cooling of potential hot spots in the combustion chamber defeats pre-ignition, the most destructive form of uncontrolled or unplanned combustion.
24. Higher static compression ratios will require a higher percentage of water or water / alcohol.
25. No, water does not burn. We are not combusting the hydrogen in the H2O.
26. At around a 13.2:1 air/fuel ratio, exhaust gas temperatures will peak.