Race Fuel

We thought that it might be a good idea to have some reference information on race fuels available to you. We are not recommending a particular brand, just informing you on what to look for when selecting your race fuel. If you get nothing from this except one thing it should be this - use the **"Motor Octane Rating"** when selecting fuel for your race or high compression engine.

Octane Rating - A number that represents the resistance of gasoline to premature detonation when exposed to heat and pressure in the combustion chamber. Such detonation is wasteful of the energy in the fuel and potentially damaging to the engine; premature detonation is indicated by knocking or pinging noises that occur as the engine operates.

At present, three systems of octane rating are used in the United States. Two of these, the research octane and motor octane numbers, are determined by burning the gasoline in an engine under different, but specified, conditions. Usually the motor octane number is lower than the research octane. The third octane rating, which federal regulations require on commercial gasoline pumps, is an average of research octane and motor octane (R+M)/2. Under this system a regular grade gasoline has an octane number of about 87 and a premium grade of about 93.

The higher the octane, the harder it is to get to ignite. A higher octane may be necessary to prevent pre-ignition and detonation in a high performance engine. Higher-octane fuel will generally burn slightly slower than a lower octane fuel, which could require a change in ignition timing. Using more octane than you need will not help power, the slower burn rate will actually cause you to lose some power.

Samples of gasoline are placed in a laboratory Knock Engine (this is a small, one cylinder engine with a variable combustion cylinder). While the engine is running, the combustion ratio is increased until the engine begins knocking. Now the gasoline is replaced with N-Heptane with an octane of zero (bad knock) and is mixed with the 100 octane ISO-Octane (minimal knock) at various ratios until the motor "knocks." If you end up with 10% N-Heptane and 90% ISO-Octane ratio, your test sample has an octane of 90.

Motor Octane Rating - Sometimes referred to as Motor Octane Number (MON), is the best rating to use when selecting fuel for your race or high compression engine. When testing MON, the fuel is heated to 300° F and the intake air is heated to 100° F. The test engine is a single cylinder 4-cycle engine that is run at 900 rpm. Ignition timing is varied with compression ratio. Engine load is varied during test. MON affects high-speed and part-throttle knock and performance under load, passing, climbing and other operating conditions. Motor octane is represented by the designation M in the (R+M)/2 equation, and is the lower of the two numbers. Motor Octane, measured under varying load is definitely the most representative octane measurement for real world high-performance engine applications.

Research Octane Rating - Sometime referred to as Research Octane Number (RON), should not be used when selecting fuel for a race or high performance engine. RON represents the octane as tested in a single-cylinder octane test engine operated at 600 rpm with a fixed timing of 13° BTDC. The fuel temp is not controlled at all and the intake air temp is varied with barometric pressure. This is done to covert everything to a SAE standard day, which is 60° F, 0% Humidity, and 29.92 inches barometric pressure, this is basically a no-load test. The RON will always be higher than the MON. RON affects low to medium-speed knock and engine run-on. Research Octane is presented by the designation R in the (R+M)/2 equation, and is the higher of the two numbers.

Note: The closer the motor and research octane ratings are to each other; the more stable the fuel is throughout the RPM range. This is very critical when running higher than 7500+ RPMs engine speed. What it tells you is that the octane rating is affected very little by heat (and race engines make plenty of heat).

(R+M)/2 Rating - This is what you get at the gas pumps. It is average of the RON and MON. It is ok to use this for lower compression motors. This number should only be used when determining which fuel to use in your stock motor. This method is NOT intended for correct use in your racing engine.

Reid Vapor Pressure (RVP) - Tendency of the gasoline to evaporate. Too high a RVP and fuel might boil or evaporate in the pump or fuel lines and a fuel pump won't pump vapors! Too low and the engine won't start when cold. Racing fuels have a RVP of approximately 5.0 PSI.

Specific Gravity (SG) - This is the weight of the fuel compared to water. If a race fuel has a .75 SG it is 3/4 of the weight of the same amount of water at the same temperature. Fuel with lower specific gravity will have a higher BTU content and will be more stable at high rpm's. Fuel with a lower specific gravity also makes jetting more critical because the engine will run leaner (less dense fuel). A fuel with a higher SG will run cooler (if no jetting changes have been made to compensate), because a denser fuel will make a richer mixture. A fuel air mixture is not measured in volume; it's measured in weight. For a 12:1 mixture, you have 12 lbs. of air to 1 lb. of fuel. The important thing is to always use the same density fuel. Changing fuels can richen or lean an engine. Good race fuels never change their density. Fuel density is kind of like oil viscosity. Heavier weights flow less volume through a given opening. This is the same with gasoline; change the density and you can flow less or more through the same carburetor jet.

Lead Content - When lead is added to fuel, the knock resistance (anti-knock value) is increased. Lead is also used to increase the octane to a higher number.

Consistency - It is very important that the fuel you use maintains its purity and consistency regardless of which brand fuel you use. Try NOT to purchase fuel that has been stored in bulk storage tank, or transferred from one bulk location to another. Bulk fuel storage tanks have a tendency to sweat or secrete moisture, therefore changing the consistency or purity of the fuel. If at all possible buy your fuel in a factory sealed drum (the cost is usually higher) but it is well worth it in the long run.

Detonation - This is an intense pressure wave within the cylinder. The sound you hear is from the actual vibration of the cylinder wall; or if the gas air mixture goes off by itself a microsecond before the spark plug fires, you have two intense high pressure waves clapping together and that energy wave hitting each other is the sound you hear.

Pre-Ignition - When the charge lights off before the spark, it's called pre-ignition. This can happen with or without detonation, but usually will cause detonation in a high performance engine. Hot spots in the combustion chamber are the usual cause of pre-ignition. A spark plug with a high heat range can cause a hot spot. When pre-ignition occurs, the charge begins to burn, then when the spark plug sparks there are two flame fronts. This is very unpredictable and can lead to detonation, because it will act just like too much ignition timing, but it is not controllable.

Flash Point - The lowest temperature at which the fuel vapors will burn. Gasoline's flash point is usually around minus 20f.