Fuel Terminology & Definitions

The key to understanding racing fuels is to have a good understanding of the principles of combustion and fuels.

Let's look at some of these principles…..

OCTANE

Octane: A fuels ability to resist knocking (detonation). Engine knock is caused by fuel molecules breaking apart and detonating before the flame front in the combustion chamber reaches them. Not only will the engine not produce peak power, the engine may be irreparably damaged by the shockwaves from this detonation if it is allowed to continue.

Example – Think about throwing a firecracker into a campfire. What will happen? If the firecracker is big enough, most of the campfire will be blown out of the fire ring it is in, resulting in very little campfire left. The same thing happens in your engine. When fuel detonates (explodes) it blows the remaining fuel out of the flame front, against the cylinder walls where it cools and doesn't combust. It just ends up going out the exhaust without burning or producing power.

Octane ratings are referred to as anti-knock index. These are determined by a testing process that generates what we have come to know as "Pump Octane" This is the number displayed on the yellow sticker at the gas pump. **How is Octane Determined?** Pump octane is calculated by the R+M/2 method. This means: Research Octane + Motor Octane / 2 = Pump Octane. The R+M/2 formula is the average of two lab tests, Research Octane and Motor Octane.

The Research Octane Number (Ron) test is the "less stressed" of the two tests and is conducted at around 600 RPM with spark timing set at 13 degrees BTDC.

The Motor Octane Number (Mon) test is a "more stressed" of the two and delivers a lower number than the research octane number. It's based at 900 RPM. These tests are on single-cylinder, variable compression engines. The closer the Motor Octane number to the Research Octane number the more stable the fuel is throughout the RPM range . This is very critical when running higher that 7500+ RPM's engine speed.

The anti-knock properties of fuel are measured as an octane rating, with zero on the scale producing equivalent levels of knock to heptane (very poor) and 100 being equivalent to iso-octane (excellent). Pump gasoline with an octane rating of 90 has the same anti-knock properties as a mixture of 90% iso-octane and 10% heptane.

Is there such thing as Too Much Octane ?

- An engine only needs enough octane to prevent detonation.
- Adding octane beyond this point in small amounts adds a level of insurance, but is not otherwise beneficial.
- Too much additional octane could possibly reduce power due to the fuel resisting combustion from not enough heat and pressure in the cylinder for that level of octane.

BURN RATE

Racing engines accelerate rapidly and piston speeds are high. Therefore, it is important that the racing fuel being used burns fast. YOU DON'T WANT A SLOW BURNING FUEL. Maximum cylinder pressure occurs at approx. 20 ATDC, beyond this point, any additional burning fuel won't result in increased cylinder pressure. If a fuel burns too slowly it will leave unburned hydrocarbons in the exhaust. This means that the engine will not generate maximum power. A unique designed racing fuel will be formulated to be light and burn fast to generate a great consistent power curve. If fuels burn too slow or too late they will make great fire shows out of the pipes, but won't be fast on the track. The fuel needs to burn in the combustion chamber to create the hot expanding gas to push the piston down and drive the crankshaft.

ENERGY VALUE

Energy value is an expression of the potential energy in the fuel. This energy is measured in BTU's (British Thermal Units) per POUND of fuel, not per gallon. This data is important as Air Fuel (AF) ratio is measured in weight and not volume. This value may vary with compression ratio and engine speed. Typical BTU values are:

- Gasoline produces approx 116,000 BTU/gallon
- Ethanol produces approx. 76,300 BTU/gallon
- Methanol produces approx. 57,250 BTU/gallon

The components used to make up a racing fuel are many. By using the right combination of components we can achieve good BTU output for generating lots of power, but also a fuel that burns fast enough that it burns completely allowing it to extract all that BTU potential.

COOLING EFFECT

Cooling effect of the fuel is related to the latent heat of vaporization. The higher the latent heat of vaporization, the better effect it has on cooling the intake mixture for a denser charge. This is of some benefit in 4-stroke engines, but can be a large source of gain in 2-stroke engines.

Renegade Race Fuels run cooler and burn cleaner than other brands on the market. How do we do that? By using the appropriate chemicals with excellent vaporization rates we create a fuel that generates power and also cools the cylinder. How is this possible? By understanding latent heat of vaporization and maximizing it.

Example: Think about when you take a shower. You go into the bathroom and turn on the water. While it's warming up, you take off your clothes, (some of you may shower with your clothes on, that's your business, I'm not here to judge) but you are really not cold. Once you are finished with your shower, you turn the water off and step out of the shower and suddenly you are cold. Why are you cold now? The bathroom was warm, you turned on hot water and let the room steam up to an even hotter temperature than when you got in, yet now you are cold. This is due to the vaporization of the water on your body. As the water evaporates off of your body it carries a great amount of heat along with it causing your body temp to drop and you to feel cold.

We use the same vaporization principle when burning fuel in an engine to carry away heat.

DETONATION (also called Knock or Ping) -

Detonation is the uncontrolled burning of fuel. This leads to potential engine damage and most certainly a lack of optimum performance (remember the campfire example?). This could be caused by too low of an octane fuel for the application or incorrect tuning procedures. The sound you hear is from the actual vibration of the cylinder walls or the fuel exploding micro seconds prior to timed ignition firing, which may cause two intense high pressure waves to collide or clap together and the colliding energy wave produces the sound. This is hard on an engine. It is just like taking a ball peen hammer to the pistons. Use of proper fuel and tuning techniques will control this condition.

There are many factors that can contribute to detonation, thus requiring more octane. Some of these are, but may not be limited to, engine compression, camshaft timing, ignition timing, combustion chamber design, spark plug location, valve adjustment, engine operating temperature, fuel mixture, and weather.

PRE-IGNITION (is not the same as detonation) -

Pre-ignition is the premature ignition or lighting of the mixture in the cylinder. This condition takes place *prior* to the spark plug firing. It is usually caused by a deposit or object glowing in the combustion chamber. An overheated spark plug or incorrect tuning parameters can cause pre-ignition. If these hotspots cause the fuel to ignite prior to the ignition event, the piston may not have reached top center and therefore may try to reverse direction. This will result in major mechanical damage within the engine.

Remember: Pre-ignition – Occurs before the spark event
Detonation – Occurs after the spark event

SPECIFIC GRAVITY (SG)

Refers to the density of a liquid, compared to the weight of water. Water has a value of 1. Since fuels are lighter than water, their specific gravity readings will be a number less than 1.

- Low specific gravity numbers typically indicate lighter components and a faster burning fuel
- High specific gravity numbers typically indicate heavier components and a slower burning fuel
- Incorrect burn rates will result in incomplete combustion and a loss of power.
- Specific Gravity can have an effect on fuel metering. Therefore, lighter fuels *may* require an increase in jetting.
- However, this is not always the case depending on how well the heavier fuels were combusting, the rate of fuel consumption (BSFC), fuel pressures and other factors.
- Like all other measurements, you can't judge a fuels performance on just one factor.

LEAD CONTENT (LC)

Amount of Tetraethyl Lead in grams per gallon. Tetraethyl lead has been used since the early 1900's to raise the octane of fuel. Why isn't it used in pump gas anymore? With the EPA requiring cars to have catalytic converters, the lead when burned poisons the active ingredients in the catalytic converter. However, since race cars don't have catalytic converters, lead is still the preferred octane enhancer in racing fuels.

REID VAPOR PRESSURE (RVP)

RVP is a common measure of the volatility of gasoline. It is defined as the absolute vapor pressure exerted by a liquid at 100 °F (37.8 °C) as determined by the test method ASTM-D-323.

- Too high of RVP can lead to vapor lock
- Too low of RVP can lead to a fuel not vaporizing properly resulting in incomplete combustion
- Racing fuel grades maintain a particular RVP value that matches up with a specific range of cylinder pressures and temperatures to insure proper combustion for the intended usage.

Vapor Lock -Vapor Lock normally occurs in carbureted engines equipped with mechanical fuel pumps. Due to:

- High fuel temperatures (above 120-degrees).
- Long suction lines, suction line restrictions caused by fittings and filters.

Remedy -

- Route lines away from heat/insulate fuel lines from heat
- Shorten suction lines and eliminate 90 degree fuel fittings.

COLOR

Simply the physical appearance color of the fuel. Fuels are dyed as a product identifier. The dye has no effect on power or performance of the product.

DIELECTRIC

Refers to the electrical charge of the molecules within the fuel. These are approximated numbers of the fuel dielectric value when using a HDE G-01 Fuel Analyzer. The accuracy of fuel checked should be within +/- 0.4 points. Sanctioning bodies use the dielectric numbers to spot check fuel to make sure racers are not running fuels that are not legal for their respective classes.

Things that can effect the dielectric value -

When 2-stroke oil is added to the fuel the meter reading will be INCREASED by 0.1 to 0.2 points depending on the type and ratio of the two-stroke oil. The 2-stroke oil may also significantly change the color. Fuel additives will also change meter reading from that of untreated fuel.

CONSISTENCY/QUALITY

It is very important that fuel maintains the purity and consistency regardless of brand. Purchase fuel that has been stored in sealed containers and a high volume dealer. Open or bulk fuel storage tanks may have a tendency to sweat and produce moisture, therefore changing the consistency or purity of the fuel. If at all possible, buy fuel in a factory sealed drum although the cost is generally higher but the quality may well be worth it in the long run.

ETHANOL and METHANOL

Do they make more power? Let's See…….

- Gasoline produces approx 116,000 BTU/gallon
- Ethanol produces approx. 76,300 BTU/gallon
- Methanol produces approx. 57,250 BTU/gallon
- Gasoline has an air/fuel ratio of 14.7:1
- Ethanol is 9.0:1
- Methanol is 6.4:1

Therefore, we can burn:
63% more ethanol = 124, 417 BTU's/gallon
129% more methanol = 131,102 BTU's/gallon
(Gasoline is 116,000 BTU's/gallon)

E85

Why does E85 contain 15% gasoline? Because passenger cars will not start well in cold climates on 100% Ethanol. If fact, in cold weather E85 becomes E70 as the gasoline content is increased for cold weather starting and driveability. Just like gasoline is seasonally blended for geographic areas, the percentage of gas in E85 fluctuates between as low as 15% to as high as 30%.

WHY RENEGADE, WHAT MAKES IT BETTER?

QUALITY CONTROLLED BLENDS

BETTER COMPONENTS- Better Cut Alkylate,
Premium Cut Paraffins, Premium Cut Lead.
HIGH QUALITY CHEMICAL MAKE UP
- Motor Octane- Higher
- Specific Gravity- Lower (Lighter)
- Controlled/ Consistent Burn Technology

LOCAL AND REAL TIME TECH SUPPORT BY RACER'S