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SUBJECT: OCTANE RATINGS

OCTANE

First of all, what do the octane ratings mean? If you have ever been bored enough while filling up your car at the local gas station, you may have noticed the stickers on the fuel pumps. One of them indicates that the method used for calculating the octane number is (RON+MON)/2. The RON refers to the Research Octane Number, and MON to the Motor Octane Number. The two numbers are derived from different test conditions. The RON method represents normal mild driving conditions, while MON tests are done under severe conditions and high engine speeds.

Sensitivity is the difference between the two octane ratings (RON - MON = Sensitivity), and indicates how the fuel will respond under different driving conditions. Gasoline in the United States is required to have a high MON, thus keeping the Sensitivity number low. This is important because it means the fuel will operate consistently despite changes in driving conditions. Now, with some of the basics out of the way, we can ask some more interesting questions about octane.

The formula (RON+MON)/2 is referred to as the anti-knock index. This leads us to ask exactly what knock is. A good description comes from E.F. Obert, in "Internal Combustion Engines and Air Pollution" (1973, Harper & Row).

"During the compression stroke of a spark ignited engine, the pressure, temperature, and density of the mixture are increased and, depending on the fuel, chemical reactions ... may begin. The spark ignites the mixture, then the flame travels across the combustion chamber at a more or less orderly pace with the pressure rising uniformly throughout the chamber. Ahead of the flame front, the unburned mixture ... is compressed by the rising pressure, with an accompanying rise in temperature and density. ... If the ignition delay (chemical) of the end gas is consumed before the flame arrives, autoignition takes place. With autoignition, the orderly process becomes uncontrolled and a violent rise in pressure may occur. Energy may be liberated at such a rate such that the walls of the chamber ... vibrate, and knock is said to be present."

The octane rating is the measure of the fuel's resistance to autoignition. When autoignition occurs the gas pressure wave it causes superimposes on the normal pressure wave of the combustion chamber. These two waves interact to create a third sawtooth-shaped wave pattern of pressure oscillations. The pressure oscillations create the knocking sound. Pressure waves caused by knock can build up quickly and shorten the life span of an engine.

Knock can be reduced by adding chemicals to the fuel. Common examples are tetra ethyl lead, aromatics, and oxygenates. While these substances increase the octane rating, their composition does not contribute to the energy of the fuel when it is burned. The result may be less energy per unit volume of fuel used, and thus less efficiency. In short, higher octane fuels may require more fuel to be burnt in order to produce the same amount of energy. But wait! Didn't I say at the beginning that we experienced a gain in power and fuel efficiency?

There is one piece of information we have been missing. The compression ratio of an engine has a lot to do with knock and the apparent effects of octane. Compression ratio can be thought of as the pressure in the combustion chamber. High compression ratio engines have more of a tendency to knock than lower compression ones. Given what we know, since a low compression engine is not as likely to knock, it does not require a fuel with as high of an octane rating. A high compression motor, however, needs more octane to reduce knock.

In such a case, switching to a higher octane fuel would reduce the effects of knock, leading to a more efficient combustion process. This creates more power and better fuel economy. Using a higher octane fuel in an engine that does not experience knock will not help performance. In fact, if the higher octane was achieved through the use of oxygenates, higher octane than necessary may actually hinder the performance of an engine!

The goal, then, is to find a fuel with an octane rating that is high enough to prevent knock, but not much higher. It is possible that the tiny performance boost we experienced with the drag car is related to the use of the higher octane fuel. The compression ratio of our motor may be a borderline case where it is able to use the slightly higher octane.

WARNING: Use extreme caution when attempting to use a fuel with a lower octane! If the octane you use is too low, knock will occur, and your engine can be damaged. Follow your manufacturer's guidelines as to what octane is suitable for your vehicle.

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