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Refining 101: Winter Gasoline

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One of the things I really like about The Oil Drum is that I learn something new here almost every day. So, I thought I would return the favor by explaining in a bit more detail something you may not know.

Every year in late summer, you will start hearing references in the media about the conversion to winter gasoline, such as the following (originally in the Bradenton Herald, but the link is long dead):

> Motorists can thank a mild hurricane season in the Atlantic for the lower gas prices, according to the American Automobile Association.
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> Other factors include the end of the summer driving season and a cheaper winter fuel mix.
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> Gas stations sell a special, more expensive fuel blend during the summer to cut down on smog during hot months. Stations nationwide will start selling a less-expensive winter fuel blend Friday, which could lead to even lower prices, analysts said.

So what does this mean, and why does it make winter gasoline less expensive?

A Primer on Gasoline Blending

Gasoline is composed of many different hydrocarbons. Crude oil enters a refinery, and is processed through various units before being blended into gasoline. A refinery may have a fluid catalytic cracker (FCC), an alkylate unit, and a reformer, each of which produces gasoline blending components. Alkylate gasoline, for example, is valuable because it has a very high octane, and can be used to produce high-octane (and higher value) blends. Light straight run gasoline is the least processed stream. It is cheap to produce, but it has a low octane. The person specifying the gasoline blends has to mix all of the components together to meet the product specifications.

There are two very important (although not the only) specifications that need to be met for each gasoline blend. The gasoline needs to have the proper octane, and it needs to have the proper Reid vapor pressure, or RVP. While the octane of a particular grade is constant throughout the year, the RVP spec changes as cooler weather sets in.

The RVP is the vapor pressure of the gasoline blend when the temperature is 100 degrees F.

Normal atmospheric pressure varies, but is usually around 14.7 lbs per square inch (psi). Atmospheric pressure is caused by the weight of the air over our heads. If a liquid has a vapor pressure of greater than local atmospheric pressure, that liquid boils. For example, when you heat a pot of water, the vapor pressure increases until it reaches atmospheric pressure. At that point, the water begins to boil.

In the summer, when temperatures can exceed 100 degrees F in many locations, it is important that the RVP of gasoline is well below 14.7. Otherwise, it can pressure up your gas tanks and gas cans, and it can boil in open containers. Gas that is boiled off ends up in the atmosphere, and contributes to air pollution. Therefore, the EPA has declared that summer gasoline blends may not exceed 7.8 psi in some locations, and 9.0 psi in others.

A typical summer gasoline blend might consist of 40% FCC gas, 25% straight run gas, 15% alkylate, 18% reformate, and 2% butane. The RVP of the gasoline blend depends on how much of each component is in the blend, and what the RVP is of each component. Butane is a relatively inexpensive ingredient in gasoline, but it has the highest vapor pressure at around 52 psi.

In a gasoline blend, each component contributes a fraction to the overall RVP. In the case of butane, if there is 10% butane in the blend, it will contribute around 5.2 psi (10% of 52 psi) to the overall blend. (In reality, it is slightly more complicated than this, because some components interact with each other which can affect the expected RVP). This means that in the summer, the butane fraction must be very low in the gasoline, or the overall RVP of the blend will be too high. That is the primary difference between winter and summer gasoline blends.

Why Prices Fall in the Fall

Winter gasoline blends are phased in as the weather gets cooler. September 15th is the date of the first increase in RVP, and in some areas the allowed RVP eventually increases to 15 psi. This has two implications for gasoline prices every fall. First, as noted, butane is a cheaper blending component than most of the other ingredients. That makes fall and winter gasoline cheaper to produce. But butane is also abundant, so that means that gasoline supplies effectively increase as the RVP requirement increases. Not only that, but this all takes place after summer driving season, when demand typically falls off.

These factors normally combine each year to reduce gasoline prices in the fall (even in non-election years). The RVP is stepped back down to summer levels starting in the spring, and this usually causes prices to increase. But lest you think of buying cheap winter gasoline and storing it until spring or summer, remember that it will pressure up as the weather heats up, and the contained butane will start to vaporize out of the mix.

And that's why gasoline prices generally fall back in the fall, and spring forward in the spring.