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THE PRICE YOU PAY (FOR PREMIUM GASOLINE) – THE WIDENING PRICE DIFFERENTIAL BETWEEN PREMIUM AND REGULAR GASOLINE

August 4, 2017

Over the past five years, the price differential between regular and premium gasoline has been widening steadily. According to the Energy Information Administration (EIA), as of July 2017 the premium -vs.-regular differential reached $0.53/gallon — more than double the differential in 2012. This has produced cringe-worthy experiences at the pump for consumers requiring the premium grade and an incentive for refiners to optimize the gasoline pool. Consequently, refiners have been making operational adjustments and capital investments to squeeze additional high-octane components out of their feedstocks. Today we examine the premium-regular gasoline differential, provide a primer on gasoline blendstocks and octane levels, and discuss some contributing factors to the widening divide between the pump prices of 87- and 93-octane gasoline.

Between 1995 and 2007, the price differential between premium gasoline and regular gasoline at the retail level hovered around $0.20/gal — an amazingly stable run for the often wild-and-woolly commodities world. The $0.20/gal differential and the six octane-number spread between premium (93 Anti-Knock Index, or AKI) and regular (87 AKI) resulted in an octane value of $0.033/gal (20 cents divided by six octane numbers) or $1.40/bbl (3.3 cents times 42 gallons in a barrel) per octane number. From 2007 to 2012, the differential crept up slightly to around $0.25/gal, but since then it has been on a steady rise, as shown in Figure 1. Over the past 12 months, the premium-vs.-regular price spread at the pump has consistently exceeded $0.50/gal (more than $3.50/octane-barrel). At the bulk, or spot, point of sale, the same general trend can be seen, except that the increase begins a bit sooner (circa 2004-05), possibly driven by the phase-out of methyl tertiary butyl ether (MTBE) from gasoline, and the absolute price spread increase has been lower. Over the past two years, the premium price spreads at the pump and spot points of sale have been diverging, with retail maintaining high spreads.

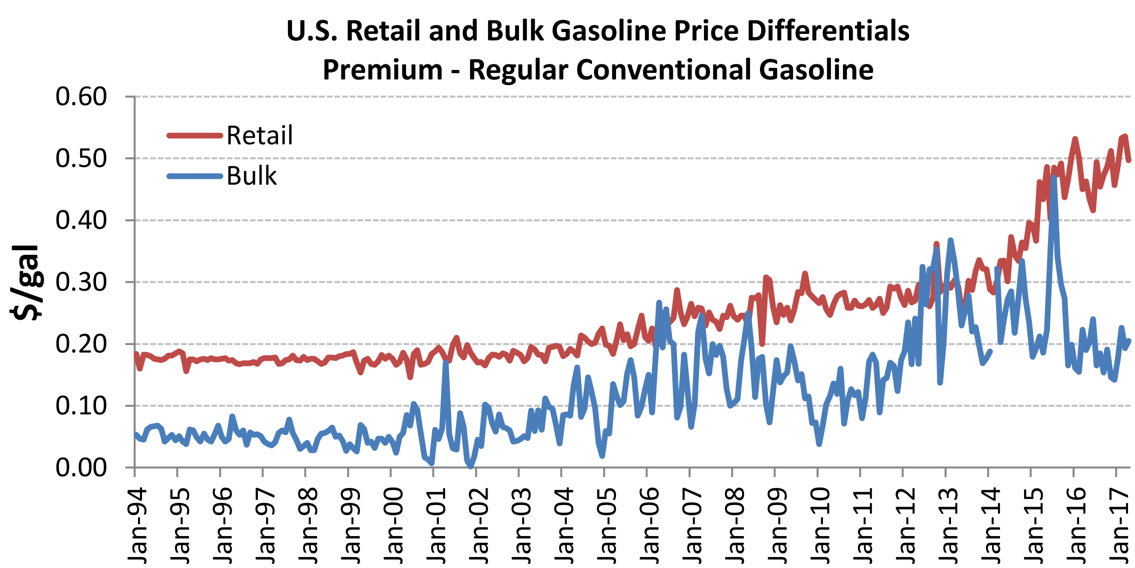

Figure 1. Source: EIA

In a moment we will discuss a few reasons why the premium-vs,-regular differential might be widening, but first we will cover some basics on the gasoline pool that relate to that discussion. As we said in Down to Gasoline Alley, varieties of component streams produced in a refinery are blended to make an optimal mix of regular (85-87 AKI), midgrade and premium (91+ AKI) grades that you purchase at the pump. Figure 2 (which we included in that earlier blog) shows the estimated gasoline-pool composition in 2015-16, with the most significant elements being reformate (blue pie slice) and fluid catalytic cracker (FCC) naphtha (red slice). With the exception of ethanol (teal slice), all these streams are petroleum-based and typically derived from an oil refinery.

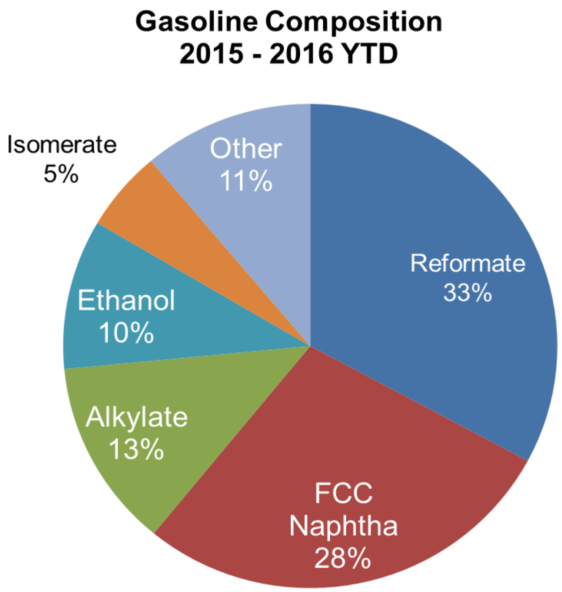

Figure 2. Source: Baker & O'Brien's PRISM Refinery Modeling Database. Note: The 2016 portion was through the middle of last year since this chart is from the Down to Gasoline Alley blog

So, let's dive into where each of these streams comes from and what the important qualities of the streams are. Figure 3 shows a simplified (okay, maybe not so simple) refinery flow diagram for a coking-type refinery — remember, each refinery has its own unique configuration and process units so they don't all look like this. Each of the gasoline blending components shown in the pie chart on Figure 2 has been highlighted in the diagram to show their flow, so reformate is blue, fluid catalytic cracking (FCC) naphtha is red, etc. Only focus on the highlighted and colored lines to the right; we'll save the rest for a masters-level blog. Each of these streams has a variety of characteristics that must be balanced to meet the final gasoline blend specifications. For this blog, we're focused on the octane component but we may mention some of the other relevant qualities as well.

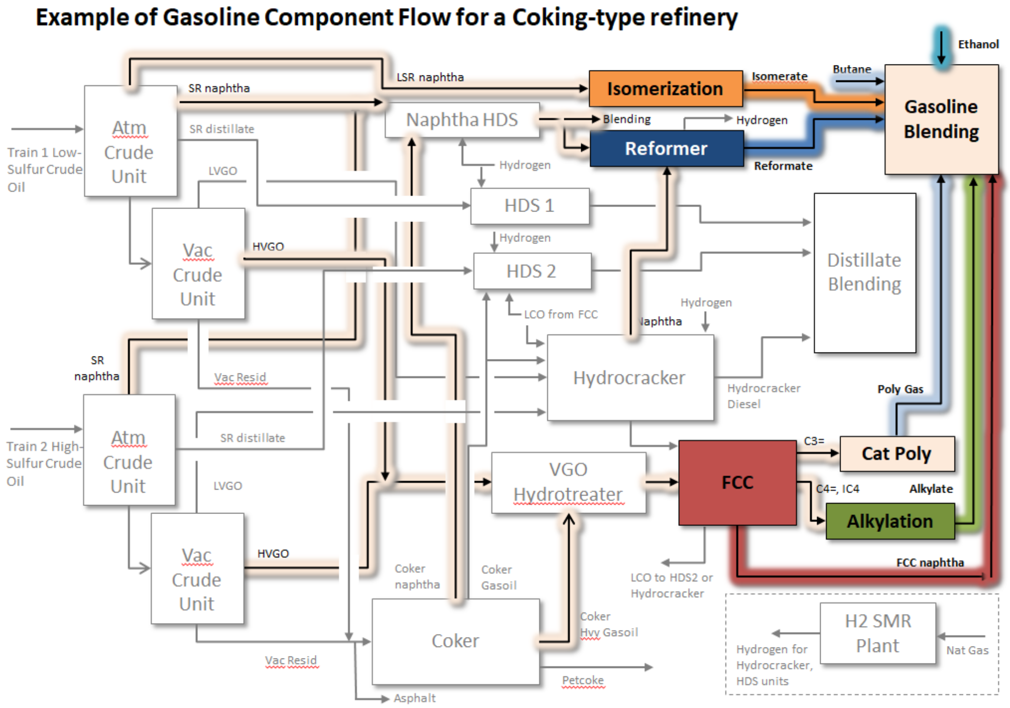

Figure 3. Source: Baker & O'Brien. Note: Ethanol is not typically blended at the refinery, but at a terminal just prior to loading into a tanker truck for delivery to a retail outlet.

So what is an octane number? Octane is the measure of a fuel's ability to withstand compression without pre-igniting. In a gasoline internal combustion engine, in which the combustion cycle can be repeated 100 times per second, the fuel must be able to be compressed until it is ignited by the spark plugs — and not before the spark; i.e., when the piston is compressing the fuel. Pre-ignition (which you don't want to happen) results in two simultaneous but opposing forces: (1) the compression forces the piston up, and (2) the pre-ignition forces the piston down. This results in the characteristic knocking or pinging sound and can, under certain conditions, lead to engine damage — sometimes severe.

Octane is tested by two different methods. The first method — to obtain the Research Octane Number (RON) — tests fuel at low engine loads by comparing it under variable compression ratios to mixtures of iso-octane (100 RON) and n-heptane (0 RON). In some parts of the world (Europe, for instance), the RON is what is posted on the pump. The second method — to obtain the Motor Octane Number (MON) — is similar to RON testing but at a higher engine load. The arithmetic average of RON and MON (RON plus MON divided by two) is known as the Anti-Knock Index (AKI) referenced above. The AKI is what is commonly seen on pumps in the U.S.

Among the color-coded elements of the gasoline pool in Figure 2, four have high octane: reformate, alkylate, ethanol and butane (the last being part of the other category). Of these, though, ethanol's role in ramping up gasoline's AKI is limited by the 10% cap on gasoline's ethanol content in most of the U.S., and butane's role is capped by its high Reid vapor pressure (RVP, a measure of gasoline's volatility; see Regulatory Gas Pressure Party for more), which limits its use in gasoline sold during the summer months. For that reason, we'll zero in on reformate and alkylate.

Reformate

Reformate (blue pie slice in Figure 1) is one of the largest components in the gasoline pool and is produced by a refinery's reformer (blue rectangle and line in Figure 2). Reformers convert low-octane (and consequently, low-value) naphtha distilled from crude oil (as well as cracked naphthas from other process units) into high-octane reformate. (Reformers also produce hydrogen used by a refinery for its hydrotreating processes to remove sulfur.) Reformate typically has a RON of 90-100 and a MON of 82-88, but the RON could be higher if some petrochemical components remain in the product. So, the AKI for reformate is generally in the range of the low to mid-90s — that favorable attribute is a primary reason why reformate is priced at a premium to some of the other streams. Other quality considerations for reformate are that it has a low RVP and low sulfur content (both good), but it does have a high level of what are called aromatic components, which can sometimes pose a challenge in meeting regulatory specifications for aromatics in the gasoline pool.

Alkylate

The alkylate stream (green pie slice in Figure 1) comes from a refinery's alkylation unit (green rectangle and line in Figure 2), which typically converts butylenes (C4s) and occasionally propylene (C3s) and amylenes (C5s) using a catalyst such as sulfuric acid (H2SO4) or hydrofluoric acid (HF). Alkylate is nearly the perfect blendstock, with a high-octane component (RON around 95 and MON around 91), low RVP and a low sulfur content — although the sulfur content can be above the regulatory spec (called Tier 3) limit of 10 parts per million (ppm; see Down to Gasoline Alley for more on the Environmental Protection Agency's (EPA) Tier 3 sulfur requirements).

Now that we've considered what octane is, why it's important to engine performance, how octane is measured, which gasoline-pool components have higher octane and how they are produced, let's look at what might be behind the widening spread between premium- and regular-grade gasoline. While we haven't quantified the extent to which each of the following items have contributed to the widening spread, here are some of the factors:

- ***Increased processing of lighter crude.*** As light crude production increased in the U.S. over the past few years due to the Shale Revolution (crude from shale tends to be lighter), steep price discounts for light crude in the 2013-14 timeframe encouraged refiners to modify some of their crude slates. However, when refined, light crude yields more light products, such as light straight run (LSR, part of the other category in Figure 1). LSR can be directly blended (in small amounts) into the gasoline pool but it has a very low octane rating. Therefore, if you blend in more LSR you need more high-octane components (such as reformate and alkylate) to continue to meet the specifications for regular and premium gasoline, putting further upward pressure on reformate and alkylate prices.

- ***The Tier 3 requirement.*** EPA's Tier 3 rule, which officially kicked in in January 2017 but allowed credits to be generated as early as 2012, requires the sulfur content of gasoline consumed in the U.S. to be below 10 ppm. As we mentioned in Down to Gasoline Alley,

some of the processes used to meet the sulfur specification result in octane loss, which is seen in the FCC naphtha component of the gasoline pool.

- ***Consumer preference.*** While difficult to quantify, some consumers whose vehicles don't require premium-grade gasoline may be electing to use premium because gasoline in general costs less than it has in some time — that is, with gas prices low, some are indulging in higher-grade fuel and enjoying the perceived better performance. The EIA's Prime Supplier Sales data indicate there was exceptionally strong growth in premium gasoline sales in 2015 and 2016 (12% in 2015 and 7% in 2016). Regular gasoline sales grew as well (3.3% in 2015 and 2.5% in 2016). However, premium gasoline sales are still well below the highs reached in the late 1980s and early 1990s.

- ***Corporate Average Fuel Economy (CAFE) standards.*** As the CAFE standards continue to increase, automakers have introduced more cars with high-compression engines, which typically require higher-octane fuel. As we mentioned in the consumer preference item, premium sales grew strongly in 2015 and 2016, but in fact premium sales have been growing every year since 2011. While CAFE standards might have influenced this growth, it is likely clouded by the other issues such as light crude growth and declining/flat prices. Still, the more stringent CAFE standards will likely be a contributor to future premium gasoline growth.

To sum up, it's difficult, if not impossible, to determine the degrees to which specific market and other forces have been driving a wider wedge between the prices for regular and premium gasoline. What seems clearer, though, is that these forces — light crude production, lighter crude slates, Tier 3 requirements and CAFE standards among them — aren't going away any time soon. If you drive a car or truck that needs only regular gasoline, enjoy the savings.

"The Price You Pay" is a cut from Bruce Springsteen's double album The River, which was released in 1980.

Note: The article was authored by Amy Kalt of Baker & O'Brien and published on RBN Energy's Daily Energy Post on August 3, 2017.