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THE THUNDER ROLLS –IMO 2020'S MARKET IMPACTS AND CHALLENGES TO REFINERS (PART 2)

December 4, 2018

The planned shift from 3.5%-sulfur marine fuel to fuel with sulfur content of 0.5% or less mandated by IMO 2020 on January 1, 2020, will require a combination of fuel-oil blending, crude-slate changes, refinery upgrades and, potentially, increased refinery runs, not to mention ship-mounted "scrubbers" for those who want to continue burning higher-sulfur bunker. That's a lot of stars to align, and even then, there's likely to be at least some degree of non-compliance, at least for a while. So, what's ahead for global crude oil and bunker-fuel markets — and for refiners in the U.S. and elsewhere — in the coming months? Today, we continue our analysis of how sharply rising demand for low-sulfur marine fuel might affect crude flows, crude slates and a whole lot more.

For the past few years, the International Maritime Organization (IMO), a specialized agency of the United Nations, has been ratcheting down allowable sulfur-oxide emissions from the engines that power the 50,000-plus tankers, dry bulkers, container ships and other commercial vessels plying international waters. In January 2012, the global cap on sulfur content in bunker (marine fuel) was reduced to 3.5% (from the old 4.5%), and 13 months from now — on New Year's Day in 2020 — the cap is set to be reduced to a much stiffer 0.5%. There is an even tougher 0.1%-sulfur limit already in place in the IMO's Emission Control Areas (ECAs) for sulfur, which include Europe's Baltic and North seas and areas within 200 nautical miles of the U.S. and Canadian coasts. (Bunker fuel demand for these ECAs comprises 10-15% of total petroleum-derived bunker fuels.) That standard will remain in force within the ECAs when the 0.5% sulfur cap for the rest of the world becomes effective 13 months from now.

There are three primary options for shipowners to achieve compliance with the IMO 2020 rule: (1) continue burning high-sulfur bunker (HSB; sulfur content up to 3.5%) and install an exhaust gas cleaning system (scrubber) to eliminate most of the sulfur dioxide emissions; (2) switch to marine distillates or low-sulfur bunker blends whose sulfur content is 0.5% or less; or (3) use alternative low-sulfur fuels like liquefied natural gas (LNG) or methanol. As for refiners, they're doing everything they can to optimize their output of low-sulfur distillates and minimize their production of "bottom-of-the-barrel" residual fuel oil (RFO; also known as resid), the primary source of high-sulfur marine fuel.

In the series we continue today, we're discussing Baker & O'Brien's latest analysis of how things may play out under the current plan for IMO 2020 implementation. As we said in Part 1, the analysis assumes that current global demand for HSB is about 3.2 MMb/d (black bar to far left in Figure 1), and that by 2020, demand for the new shipping pool consisting of low-sulfur bunker (LSB; 0.5% sulfur or less) and HSB would be 3.4 MMb/d (dark green bar to far right) with the incremental 0.2 MMb/d of demand (blue bar) representing a combination of demand growth and the lower energy density/bbl of the lighter LSB blends. While there's a good bit of uncertainty around all this, we noted seven primary factors --— plus the lower energy density/bbl we just noted — that will combine to bring the bunker market into something approaching balance: (1) non-compliance (red bar), (2) scrubbers (light green bar), (3) alternative fuels (minimal impact, so no bar), (4) blending of existing low-sulfur fuel oil with distillate (purple bar), (5) refinery upgrades (turquoise bar), (6) shifts in crude slates and crude oil flows (orange bar), and (7) increased global refining throughputs (blue-and-white striped bar).

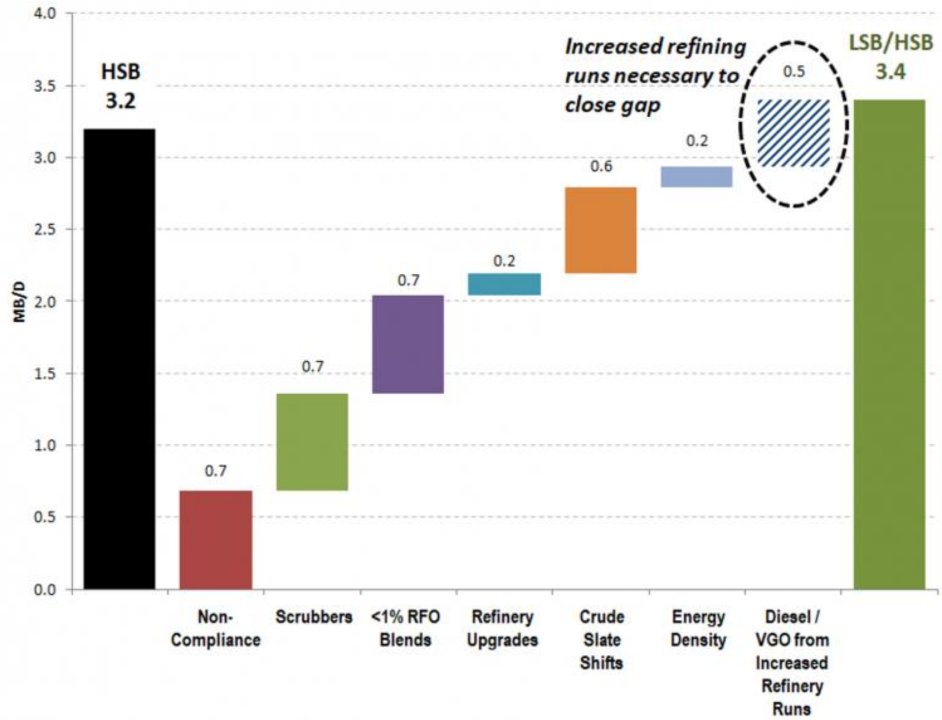

Figure 1. IMO 2020 Bunker Components. Source: Baker & O'Brien

<u>Shifts in crude slates</u> — changes in the types or blends of oil that refineries choose to process — are shaping up as an important element in the preparations for IMO 2020 implementation. As we've blogged about often, refineries around the world vary widely in the complexity of their equipment and operation and, with that, their ability to break down different types of crude into high-value refined products like gasoline, diesel and jet fuel. For example, a less complex refinery running a heavy, sour crude would produce relatively modest volumes of high-value products and perhaps 20% high-sulfur RFO, a low-value product typically used to make HSB or power plant fuels. If a more complex refinery — one with a coker, say — runs the same crude as the simple refinery, it can produce larger volumes of gasoline, diesel etc. and only minimal amounts of high-sulfur RFO.

Crude-slate selection is a complicated decision for each refinery, and is based on a matrix of considerations, including the refinery's equipment and capabilities and the ever-changing prices of various types of crude and specific refined products. Crude *transportation* costs are also an important determinant; often, crude is refined in relatively close proximity to where it is produced even though refineries in more distant locales are better-matched to that particular crude's quality. This is because the marginal benefit for quality in many cases is not sufficient to overcome the incremental transport costs. An obvious example of this is the light-sweet crudes produced in the Eagle Ford and Permian basins being processed in highly complex Gulf Coast refineries, most of which were built and designed to process heavy-sour grades.

Generally speaking, there are ample supplies of light-sweet oil around the world today, as evidenced by the relatively recent modest spreads between these crudes and sour crudes (both heavy and light). However, with IMO 2020 closing in, demand for light-sweet crudes that simpler refineries can run to maximize their output of distillates — and, just as importantly, minimize their output of high-sulfur RFO — is widely expected to increase. Likewise, the differentials between light-sweet and heavy-sour crudes are expected to rise.

This potential for shifts in crude oil flows is best illustrated using a conceptual example. Baker & O'Brien examined a scenario in which the crude slate is adjusted at refineries in Western Europe that are large producers of RFO, in addition to fuel for land-based power generation. These refineries, in aggregate, produce approximately 600 Mb/d with an average sulfur content of 2.4%. Together, these refineries typically process up to 1.5 MMb/d of sour crude, including Russian Urals. Those sour grades were removed and replaced with a 50/50 mix of light-sweet Eagle Ford and West Texas Intermediate (WTI). This crude-slate swap results in about 200 Mb/d of low-sulfur bunker (LSB) that would comply with IMO 2020. The displaced sour crude barrels could likewise take the place of light-sweet barrels in complex refineries along the Gulf Coast, with most of the high-sulfur vacuum gas oil (VGO) and vacuum residue converted to clean transportation fuels. In fact, if the "switched volumes" were large enough, one might envision a dedicated route for a number of Very Large Crude Carriers (VLCCs) that would transport sour crude from Europe to the Gulf Coast, and return laden with sweet U.S. grades, as opposed to ballast, to Europe — reducing shipping costs in the process.

It certainly appears that refineries along the Texas and Louisiana coasts could shift toward higher-sulfur crude slates if there is a margin incentive to do so. According to the Energy Information Administration (EIA), the high point for crude-slate sulfur content in Texas coast refineries was 2.08% in December 2008; for coastal refineries in Louisiana, the peak was 1.82% in December 2005. Since then, the onslaught of readily available light-sweet crude from U.S. shale and tight-oil plays has reduced crude-slate sulfur content dramatically. As of September 2018 (the latest EIA data available), the sulfur content was down to 1.61% for Texas coastal refineries and 1.37% for Louisiana coastal refineries. During this same period, significant amounts of coking capacity have been added along the Gulf Coast, requiring additional hydro-desulphurization capacity. In other words, these refineries could handle a lot more heavy-sour and light-sour crude if the economics make sense. (A hint: they soon will.)

How much crude-slate switching occurs over the next year or two will, of course, depend on many factors, including light-heavy spreads, waterborne transport costs, and export capacity in the U.S. It is estimated that a total of about 600 Mb/d of LSB (orange bar in Figure 1) are capable of being produced for the global market by better matching — or optimizing — sweet grades with RFO-producing refineries in Europe and elsewhere.

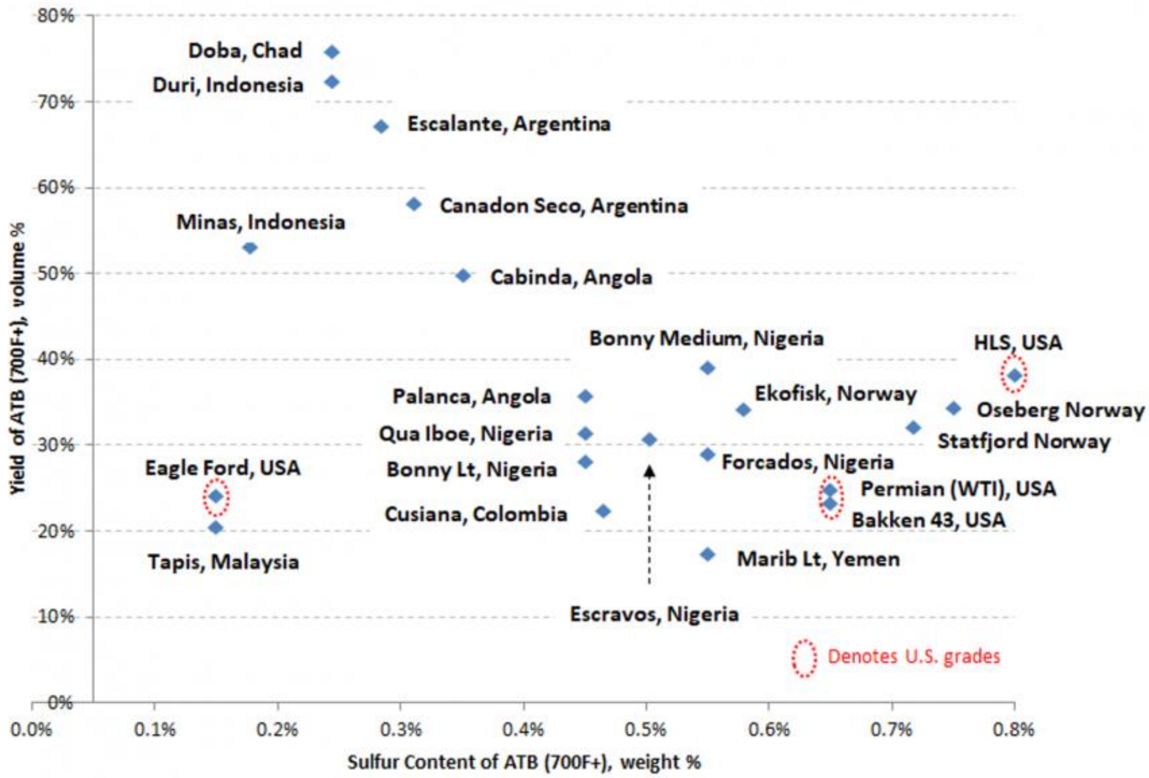

Figure 2. Source: Baker & O'Brien

The crude oil grades that will see the highest uptick in interest as the IMO 2020 becomes effective are those that produce low-sulfur RFO that could be used to make rule-compliant LSB. The blue diamonds in Figure 2 plot the percentage yield of Atmospheric Tower Bottoms (ATB) — the heaviest of the distillation cuts from these crudes (y-axis) — against their ATB sulfur content (x-axis). (The five U.S. crudes are highlighted by the three dashed-red ovals; HLS refers to Heavy Louisiana Sweet.) It's important to note that many of the grades in Figure 2 are already highly valued by refineries, given their intrinsic properties, and many already seek the best — and perhaps distant — refining centers for processing. However, that doesn't hold true for light-sweet shale grades in the U.S., the bulk of which is still processed in complex, deep-conversion refineries along the Gulf Coast due to location advantages, the former ban on most U.S. crude exports (lifted only three years ago), and the physical limits of crude oil export infrastructure.

One more note about Figure 2. The crudes toward the right side of the graph — that is, those with ATB sulfur content slightly higher than 0.5% (including Bakken and low-sulfur "new Permian" WTI) — could become compliant with IMO 2020 with only a modest amount of distillate blending. These grades and other similar-quality crude oils may serve to mitigate LSB supply shortages, if they can be positioned so that they contribute to the bunker pool.

There's one more question to consider here — what about shifts in the flows of intermediate feedstocks? The U.S. refining system, because of its extensive upgrading capabilities, processes a significant amount of imported refinery feedstocks, primarily VGO and RFO. These imported volumes

— from "nearby" refineries in Canada and Mexico, as well as from more distant sources in Russia, northern Africa, South America and Europe — peaked in the middle of 2000s at slightly over 1 MMb/d before trending lower. Most recently, that downward trend has reversed, primarily due to the lightening up of the crude slate at Gulf Coast refineries; last year an average of 800 Mb/d was imported. Figure 3 shows the historical import trends of VGO and RFO segregated by sulfur content. The green-shaded bars show lower-sulfur (LS) VGO and RFO imports, the gray bars show higher-sulfur (HS) VGO, and the black bars indicate higher-sulfur (HS) RFO. Of the total imported amount, LS feedstocks only comprised about 160 Mb/d — mostly VGO from Algerian refineries. But, with IMO 2020, higher prices may pull these LS stocks to more attractive destinations, including blending into bunker fuel. There will likely be some availability to replace this LS VGO with HS VGO, depending on the level of crude slate shifting mentioned above. Unfortunately, the relatively modest potential for feedstock reshuffling means that this mechanism's contribution to solving the global IMO 2020 puzzle will be small.

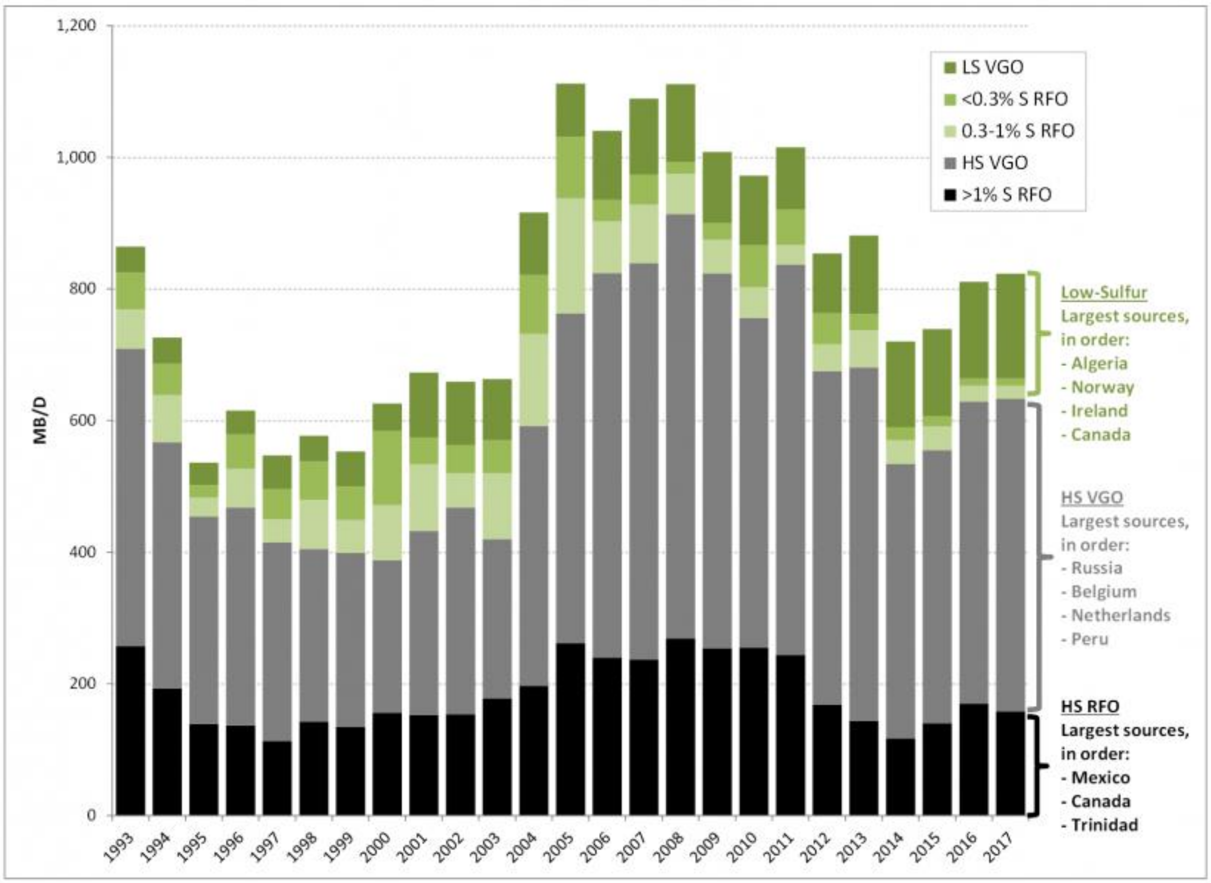

Figure 3. U.S. Imports of Vacuum Gas Oil (VGO) and Residual Fuel Oil (RFO). Sources: EIA, Baker & O'Brien

To summarize, shifting crude flows and refinery slates may help close 15-20% of the IMO 2020 bunker fuel requirement gap. Shifting intermediate feedstock flows, while another piece of the puzzle, is likely to have a lesser impact. In Part 3, we will examine the changes that will likely be required in the global refining system to provide additional distillate for meeting the IMO 2020 challenge.

"The Thunder Rolls" was a #1 hit single for country music star Garth Brooks in 1991. The song, off of Garth's No Fences album, was co-written by him and Pat Alger. It was originally recorded by Tanya Tucker, but her version was not released until 1995 as part of a self-titled box set.

Note: The article was authored by Amy Kalt of Baker & O'Brien and published on RBN Energy's Daily Energy Post on December 4, 2018.