

BAKER & O'BRIEN
I N C O R P O R A T E D

Q3 2018: U. S. Refining Margins Remain Robust

Special Topic: Domestic Light Oil Processing in the U.S. Gulf Coast – Have We Hit the Limit?

Houston, October 30, 2018

Baker & O'Brien, Inc.'s 18Q3 *PRISM*¹ update showed continued improvement in U.S. refining cash margins compared to the prior quarter and third quarter 2017. With the exception of PADD 5, all PADDs showed quarterly increases versus the second quarter, with the biggest increase coming in PADD 2. Compared to a year ago, refining margins improved in all PADDs with refineries in PADDs 2 and 4 seeing the biggest improvements. EIA data indicated a 0.8% increase in gasoline and diesel consumption compared to the prior quarter and a 2.5% increase compared to 17Q3. Continued robust U.S. product demand coupled with discounted domestic and Canadian crude oil prices relative to other world crude oils contributed positively to refiners' 18Q3 earnings.

PRISM Cash Margins vs. Previous Periods (\$/Bbl.)

	<u>18Q3 vs. 18Q2</u>	<u>18Q3 vs. 17Q3</u>
PADD 1	0.46	0.20
PADD 2	4.30	7.01
PADD 3	0.19	1.57
PADD 4	2.89	8.91
PADD 5	-1.62	0.71
U.S. Overall	0.94	2.73

The major crack spread indicators showed similar trends. The USGC LLS 321 crack increased slightly from the previous quarter while the Chicago WTI 321 increased by almost \$0.50/Bbl. from the previous quarter. When compared to 18Q2, the light/heavy crude oil price differential decreased by \$3/Bbl. indicating lower margins for coking refineries.

Key Refining Margin Metrics, \$/Bbl.

	<u>2018</u>	<u>2018</u>	<u>2018</u>	<u>2017</u>	<u>2016</u>
	<u>Sept.</u>	<u>Q3</u>	<u>Q2</u>	<u>Annual</u>	<u>Annual</u>
WTI	68.74	69.20	67.98	50.87	43.24
LLS	75.99	73.78	73.09	54.11	44.92
Brent	77.18	74.71	74.34	54.26	43.72
LLS – Maya	9.33	8.25	11.28	7.01	8.50
USGC LLS 321*	11.50	12.98	12.86	13.34	10.66
USGC LLS 6321**	8.27	9.70	8.93	9.86	6.60
Chicago WTI 321***	22.21	20.62	20.17	17.71	14.26

* LLS deemed conversion to 67% conventional 87R gasoline and 33% ULSD

** LLS deemed conversion to 50% conventional 87R gasoline, 33% ULSD and 17% Fuel Oil

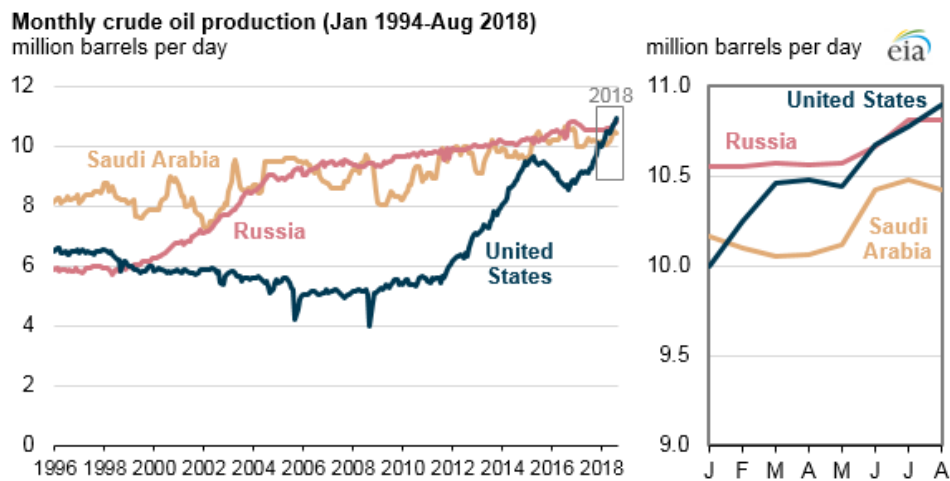
*** WTI deemed conversion to 33% conventional 87R gasoline, 33% RBOB and 33% ULSD

¹ *PRISM*TM is Baker & O'Brien's refinery modeling and database system that includes operational and economic performance details for refineries in the U.S., Canada, Europe, and Asia.

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In September 2018, the United States Energy Information Administration (U.S. EIA) reported that the U.S. surpassed Russia to become the world’s largest producer of crude oil (Figure 1). Shale production, particularly from the Permian Basin in West Texas, is leading the charge and transporting this light sweet crude oil to the coast has created a flurry of logistics projects for midstream companies. The hefty WTI-Brent spread illustrates that the pipelines pointed towards the U.S. Gulf Coast (USGC), home of over half of the U.S. refining capacity and export terminals, are at capacity. However, new transport infrastructure is coming that will eventually open the floodgates to the coast again, providing options for coastal refineries to increase domestic input or for the crude oil to be exported. Given this backdrop, we thought now was a good time to look at the ability of USGC refineries to process these growing light and sweet domestic crude oils that have underpinned this production renaissance.

Figure 1: Monthly U.S. Crude Oil Production



Source: U.S. EIA September 12, 2018, Today In Energy

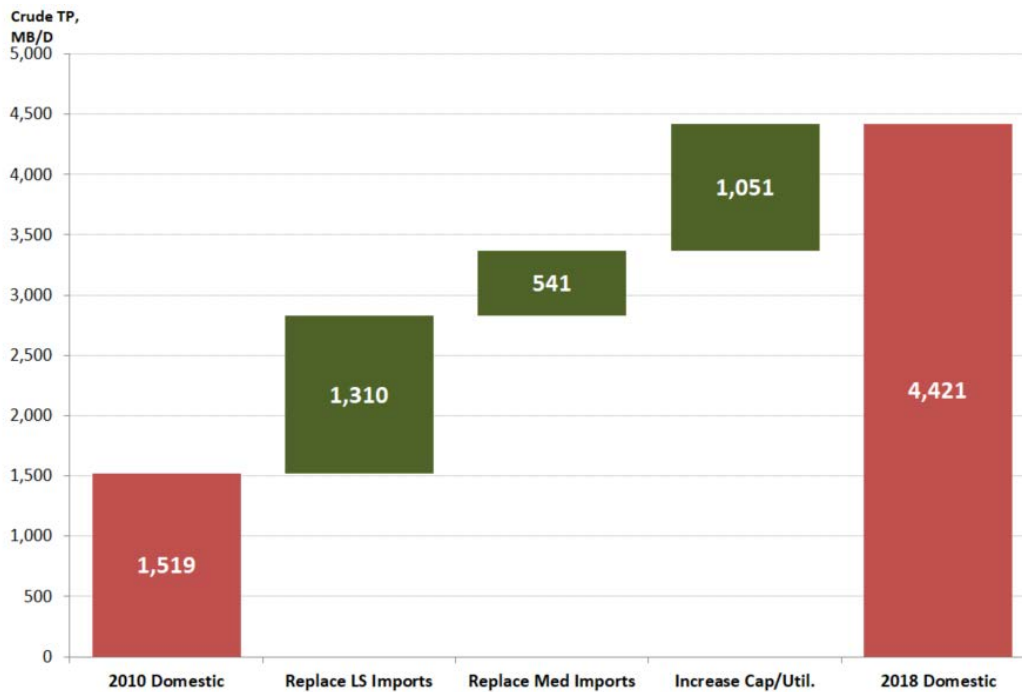
Refiners and industry experts agree that the USGC refining system is generally not configured to process large quantities of light sweet crude oil. However, USGC refiners are processing significantly more domestic light sweet crude oil today than before the U.S. oil production surge.

Between 2010 and 2018, U.S. crude oil production grew from 5 MMB/D to over 10 MMB/D. As of summer 2018, the U.S. was exporting about 2 MMB/D, meaning that 3 MMB/D of this production growth has been absorbed into the U.S. refining system. Our *PRISM* data shows that USGC refiners have absorbed the lion’s share, boosting domestic crude oil throughput by 2.9 MMB/D. We can group how USGC refiners accomplished this increase into three main categories² (Figure 2), the timing of which was not necessarily sequential: (1) a reduction in imports of light sweet grades; (2) a reduction in imports of medium grades; and (3) increased utilization and expansion.³

² Some refineries have made configuration changes that are not captured separately.

³ Throughput estimates do not include the new standalone condensate splitters in Corpus Christi and Houston.

Figure 2: Increasing USGC Domestic Crude Oil Input, 2010-2018 YTD



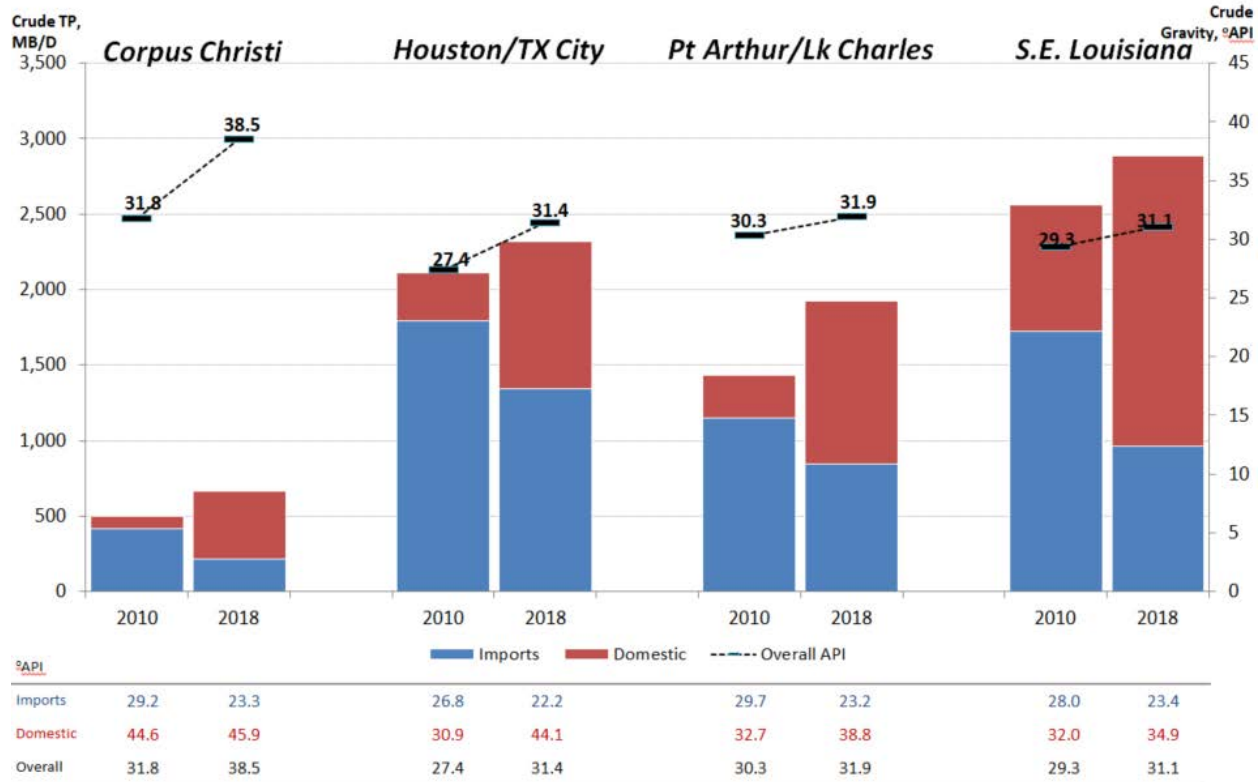
Source: PRISM.

Figure 3 below shows the quantity of domestically-produced (red bar) and imported (blue bar) crude oil processed in 2010 versus 2018 (through Q3) at four key USGC refining centers: Corpus Christi, Houston/Texas City/Sweeny, Port Arthur/Lake Charles, and Southeast Louisiana. Some key observations are:

1. USGC refineries increased total crude oil input by 1.2 MMB/D between 2010 and 2018, with increases seen in each refining center. The surge in throughput, which is almost equal to the entire refining capacity of the Northeastern U.S., came through a combination of capacity addition and increased utilization.⁴
2. The share of domestically-produced crude oil has also increased in each location (red bar as a proportion of total input) and currently makes up 57% of the USGC crude diet (versus 23% in 2010). This domestic crude oil is predominantly light sweet grades from the Permian and Eagle Ford, with smaller amounts from Bakken and DJ/Niobrara. Crude imports into the USGC dropped from 5 MMB/D to approximately 3.4 MMB/D.
3. The resultant average crude quality has become lighter in each refining center (Figure 3, black lines). Corpus Christi, where two refiners made investments to handle large amounts of Eagle Ford crude, saw the largest API gravity increase. The Houston area, which has become well connected to most shale production areas, had the second largest increase in API gravity.

⁴ Throughput estimates do not include the new standalone condensate splitters in Corpus Christi and Houston.

Figure 3: Changing Quality of USGC Refinery Crude Oil Inputs, 2010-2018 YTD



Sources: PRISM database and U.S. EIA.

Could the USGC refineries process even more domestically produced light sweet crude oil? Perhaps – although the light-end systems (naphtha and lighter) in many Texas coastal refineries are probably near physical limits. Therefore, any material increases of light sweet crude oil processing capacity would require capital investment (e.g., pre-flash towers, new distillation capacity, and saturated gas plant expansions). To remove these light-end mechanical constraints, the economics of light domestic crudes displacing heavy oil imports, with the resultant underutilization of FCCs and cokers, will have to be compelling.

One important enabler for increased light oil processing is that pipeline connectivity into Louisiana will be improving in 2019 as Bayou Bridge comes online. This could increase domestic shale oil processing in that region through import replacement. Another longer-term step-change increase in light processing capacity could be the expansion of ExxonMobil’s Beaumont refinery, assuming it is sanctioned and is built to process domestic light sweet crude oil.

However, in general, USGC refiners will likely be hard-pressed to keep up with increasing production. The Permian bonanza is increasingly heading onto the water and is spurring numerous crude oil export projects. With IMO 2020 looming, this could well be beneficial to European refineries, as they will need the low-sulfur grades much more than their U.S. counterparts.

About Baker & O'Brien

Baker & O'Brien is an independent professional consulting firm specializing in technology, economics, and management practice for the international oil, gas, chemical, and related industries. With offices in Dallas, Houston, and London, the firm assists clients with strategic studies, mergers and acquisitions, and technology evaluations. The firm also provides expert services to support insurance claims, investigate operating incidents, and support a wide range of commercial and construction disputes in the energy industry.

About PRISM

Baker & O'Brien's *PRISM* software is used to perform detailed analysis of individual refineries and the refining value chain from crude oil load port to products truck rack. The system combines a large historical database with a robust refinery simulator to provide analytical support to competitive assessments, strategic planning, crude oil valuation, and delivered cost of supply. The *PRISM* database currently includes operational and economic performance details for all refineries in the U.S. and Canada, most refineries in Europe, and over 50 refineries in the Asia Pacific region. The *PRISM* system is available for license and is used in consulting assignments for Baker & O'Brien clients.

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