LOOP SOUR CRUDE: A BENCHMARK FOR THE FUTURE

OIL SPECIAL REPORT
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INTRODUCTION

The US oil industry has changed dramatically in the past decade.

Driven by technological advancements in drilling, crude oil production has reached new record highs and currently hovers at around the 9 million b/d mark, up roughly 70% from 2007. But nearly three-quarters of oil production in the US is light sweet crude oil or condensate.

That is the kind of crude US Gulf Coast refineries typically do not consume.

The Gulf Coast refining region, which makes up more than half of overall US refining capacity, is still a consumer of medium to heavy sour crude. Globally, the US refining sector far exceeds the sour refining capacity of other countries and/or regions.

The average crude barrel refined on the US Gulf Coast in 2016 was a medium sour barrel with API gravity of 31.3 degrees and sulfur content of 1.49%, according to US Energy Information Administration data.

With so much heavy-to-medium sour crude consumed on the US Gulf Coast, there is a need for a representative pricing benchmark in the region.

LOOP Sour crude, which encompasses the value of both domestic US and imported medium sour crude, has increasingly become a key part of the USGC crude complex and provides a valuable price point for physical sour crude barrels traded and refined on the US Gulf Coast.

THE US REFINING SECTOR

The US has the largest refining capacity of any country in the world, with a combined operating capacity of 18.4 million b/d as of December 2016. Just over 50% of US refining capacity, or 9.6 million b/d, is located on the Gulf Coast, while another 21%, or 4 million b/d, is located in the Midwest.

US refineries process a wide range of crude oil grades, and some have been adjusting their crude slates to take advantage of the growing supply of light sweet crude in North America in recent years. But while a refinery can handle some variance in its crude slate, the combination of refining units installed limits to a certain extent how much a refinery can change its crude slate and still produce higher-value products efficiently.

Many refineries in the US for example, particularly in the Midwest and on the Gulf Coast, have invested in complex units designed to process medium to heavy sour crude oil efficiently. These refineries are optimally designed to run heavier crudes, and many continue to do so because any potential improvement in the value of the refined product slate from running light sweet crude in these refineries can often be negated by the higher cost of light crudes compared with heavy crudes.

USGC refineries continue to import significant volumes of heavy sour and medium sour crude. According to an analysis of EIA data, waterborne Gulf Coast imports of heavy sour and medium sour grades (excluding Canada) jumped to 77% of total USGC imports in 2016 from 54% in 2010.

GLOBAL REFINERY CRUDE SLATES*

Global refinery crude slates are dominated by light and medium crude grades, with heavy sour crude making up a smaller portion.

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GLOBAL REFINERY CAPACITY, RUNS*

Global refinery capacity runs are given in millions of barrels per day (MMb/d) for each region.

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Pipeline connectivity is also a key feature of the US refining sector. US refineries obtained 90% of their crude oil supplies from pipelines and tankers in 2015, with pipelines alone accounting for 60% of crude oil refinery receipts in the US, according to EIA data.

LOOP – THE ONLY US DEEPWATER OIL PORT

The Louisiana Offshore Oil Port, or LOOP, is an oil terminal located offshore and onshore in and around Port Fourchon and Galliano, Louisiana. The facility is owned and operated by LOOP LLC, a joint venture of Marathon Pipe Line LLC, Shell Oil Company and Valero Terminating and Distribution Company.

LOOP, which began operations in 1981, is the first and only deepwater oil port in the US. It is presently the only US oil facility capable of offloading vessels as large as VLCCs and ULCCs, as well as a range of smaller vessels such as Aframaxes, MR tankers and Articulated Tug Barges.

The facility received its first shipment of foreign crude oil in 1981 and, in 1996, began receiving its first domestic crude oil supplies from pioneering deepwater production in the Gulf of Mexico, like the Mars production platform. LOOP expanded its facilities to create the Clovelly Hub which is now an exchange point for domestically produced crude such as Mars, Thunder Horse and Poseidon, as well as internationally produced crude oil. Today, more than 65% of LOOP receipts are domestic crude.

LOOP receives crude oil from three sources:
- Oil tankers, both large and small, carrying imported and domestic crude to the deepwater port.
- Production wells in the Gulf of Mexico through the 24-inch-diameter Mars/Amberjack pipeline and the 30-inch-diameter Endymion pipeline which land at Clovelly Hub.
- The Zydeco Pipeline (also known as the Ho-Ho) which moves domestic crude produced in the US and the Gulf of Mexico. The pipeline formerly connected LOOP’s Clovelly Hub to Texas, but was reversed in 2013 because of shifts in regional exploration and production. Importantly, the Zydeco connection handles the deepwater Gulf of Mexico’s Poseidon crude oil stream.

The LOOP deepwater port alone received 350,000-450,000 b/d of crude in 2016, according to US customs data, although it is capable of receiving as much as 2.4 million b/d. It is the single largest point of entry for waterborne crude oil entering the US and has received over 12 billion barrels of foreign and domestically produced crude oil since it began operations.

The LOOP deepwater port comprises three single-point mooring buoys and a marine terminal 18 miles offshore in 110 feet of water. A 56-inch-diameter line (100,000 barrels/hour) connects the marine terminal to an onshore pumping facility, which moves the oil 25 miles inland to a terminal with aboveground and underground storage, also known as Clovelly Hub. Total storage is now just over 71 million barrels in eight underground salt dome caverns and 21 aboveground tanks. The complex has pipelines connecting it to other terminals and refineries in the USGC and Midwest regions.

STORAGE AT LOOP RIVALS CUSHING

With US crude production increasing in recent years and imports falling, the LOOP storage facilities are now used for domestic as well as imported crude oil. LOOP’s underground caverns are the largest privately owned and operated crude oil storage facility in the US. Eight man-made underground caverns – built from a naturally occurring salt dome — hold about 60 million barrels, roughly split evenly between the caverns (about 7.5 million barrels/cavern).

LOOP CAVERN ASSIGNMENTS

<table>
<thead>
<tr>
<th>Cavern</th>
<th>Segregation number</th>
<th>General description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>17</td>
<td>Arab Medium, Basrah Light, Kuwait Export Crude</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>Mars Blend</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>Arab Light</td>
</tr>
<tr>
<td>8</td>
<td>34</td>
<td>LOOP Sour</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>Bonny Light, Eagle Ford crude, Forcados, Qua Iboe</td>
</tr>
<tr>
<td>12</td>
<td>14</td>
<td>Mars Blend</td>
</tr>
<tr>
<td>15</td>
<td>26</td>
<td>Thunder Horse Blend</td>
</tr>
<tr>
<td>11*</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*Details of what is stored in LOOP’s cavern 11 are not publically available
Source: LOOP LLC

LOOP: A STRATEGIC HUB FOR USGC REFINING SECTOR

ST. JAMES
LOCAP (operated by LOOP), Plains, NuStar, Sugarland terminals

Valero St. Charles
Motiva Norco
Shell St. Rose
24” Shell
24” CAM
24” HO-HO
48” MOL
24” Mars/Amberjack
30” Endymion

Phillips 66 Alliance
PBF Chalmette
Valero Meraux
Valero St. Charles
Motiva Norco
Shell St. Rose

St. James
ExxonMobil North Line
Motiva Convent
Marathon Garyville
ExxonMobil Baton Rouge

Source: LOOP LLC, Platts

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In addition, 15 above-ground tanks can each hold 600,000 barrels of oil, and LOOP has completed six of seven new tanks, each with 355,000 barrels of capacity. The remaining 355,000 barrel tank is expected to be completed by second-quarter 2017. Current storage capacity at LOOP is about 71.13 million barrels, which will rise to about 71.485 million barrels once the remaining tank under construction is completed.

In comparison, Cushing, Oklahoma, which is home to the world's largest oil storage complex, has a working crude oil storage capacity of 77 million barrels.

WHAT IS LOOP SOUR CRUDE?

LOOP Sour is a fungible blend of two domestic US crude streams and three Middle Eastern crude import grades delivered into one of the eight underground caverns at the LOOP facility. LOOP Sour is currently held in cavern 8 at LOOP, although cavern assignments are subject to change.

The two domestic crudes in the LOOP Sour blend are Mars and Poseidon, both produced in the Gulf of Mexico. Mars is held in caverns 4 and 12 at LOOP, while Poseidon can be piped directly into the LOOP Sour cavern from the Zydeco pipeline. The three Middle Eastern grades in the LOOP Sour blend are Arab Medium, Basrah Light and Kuwait Export Crude, which comprise the Segregation 17 stream at LOOP and are stored together in cavern 3.

TOP 10 USGC/IMPORTED CRUDE GRADES (2016)

Of the 1.1 billion barrels of crude oil imported into the Gulf Coast in 2016, Arab Medium accounted for 130 million barrels (12%), Basrah Light accounted for 64 million barrels (6%) and Kuwait Export Crude accounted for 50 million barrels (5%).

LOOP does not publish the specifications of the LOOP Sour blend, beyond stating that any one of the five grades is deliverable into the blend. Thus the specification would be within the range of the five individual crude grades, and no API or sulfur escalators or de-escalators are applied in terms of pricing.

All five crude grades that make up LOOP Sour are essentially blends, coming from multiple fields in the Gulf of Mexico and the Middle East. While the quality of LOOP Sour has varied over time, it is relatively stable as a medium sour crude grade.

Since May 2015, the average API gravity of LOOP Sour has been 30.3 and the sulfur content 2.29%, both on a volume-weighted basis. During that period, about 967,000 barrels/month of LOOP Sour was delivered out of the LOOP Sour cavern into the connecting pipelines.

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LOOP CONNECTIVITY

Through a network of crude oil pipelines, LOOP has access to more than 2.5 million b/d of refining capacity in Louisiana. Three pipelines connect LOOP’s Clovelly Hub to regional refineries and terminals along the Gulf Coast: the 24-inch-diameter CAM pipeline, 24-inch-diameter Clovelly-to-Norco pipeline and LOCAP pipeline.

The 1.7 million b/d, 48-inch-diameter LOCAP pipeline connects the LOOP Clovelly Hub to the LOCAP terminal at St. James, Louisiana, which provides further access to refineries as far north as the Midwest. LOOP operates both the LOCAP pipeline and terminal.

LOOP has been exploring the possibility of adding crude loading abilities, although the project is likely years away, given the scope of the investment and current market dynamics.

HOW IS LOOP SOUR TRANSACTIONED?

Physical LOOP Sour is transacted in cavern, and is typically traded relative to WTI or Mars. It is traded in calendar months, one month ahead, in line with other USGC crudes. Although not in pipe, it follows US crude pipeline schedules (i.e. the spot-month changes on the first business day after the 25th of the calendar month), with the crude delivered into the cavern by the first day of the delivery month. The majority of physical LOOP Sour trades are understood to be scheduled out of the cavern.

Sellers of LOOP Sour are able to deliver any of the five crude grades – Mars, Poseidon, Arab Medium, Basrah Light or Kuwait Export Crude – into the LOOP Sour cavern, if they do not have any LOOP Sour barrels. This can be done by pumping over any of the five crude grades from the other LOOP storage caverns, tanks, or directly from a tanker docked at LOOP into the LOOP Sour cavern.

While a buyer of LOOP Sour is not technically receiving any one of the five grades that go into the LOOP Sour blend, but rather the blend itself, market dynamics often dictate what crude grade the seller is delivering into the LOOP Sour cavern, making it similar to the benchmark BFOE crude market in Northwest Europe.

To deliver LOOP Sour crude into the cavern, a capacity allocation agreement, or CAC, is needed. Each CAC is 1,000 barrels and can be either a physical forward agreement (PFA), which is a bilateral contract, or a storage futures contract (SFC) on the CME. These CACs reflect the working capacity of the LOOP Sour cavern and are auctioned on the first Tuesday of the month by Matrix Markets.

A buyer of LOOP Sour does not need a CAC unless the buyer intends to keep the crude in cavern beyond the 15-day grace period LOOP LLC provides to allow the buyer to move the crude out. The monthly allocation of PFAs and SFCs are more or less split 50:50, and these include forward months and forward quarters. Platts understands these monthly auctions are often oversubscribed by at least three times and that between 30-40 companies participate in the auctions with regularity, reflecting interest in the underlying LOOP Sour physical market.

In addition to the physically settled LOOP Crude Oil Storage Futures contract listed by the CME Group, the latter also lists a physically-settled LOOP Gulf Coast Sour Crude Oil Futures contract.

The LOOP Gulf Coast Sour Crude Oil Futures contract trades in 1,000-barrel lots FOB at the LOOP Sour storage cavern at the Clovelly Hub, Louisiana, and it is listed for 36 consecutive months.

The LOOP Crude Oil Storage Futures contract was launched in March 2015 – at a time of growing US production and stockpiles, and a widening market contango – making it among the first successful, physically delivered futures contract for oil storage in the world. The storage contract, listed for 12 consecutive months, gives the buyer the right to store 1,000 barrels of LOOP Sour crude at the storage hub for one calendar month, helping market participants manage their physical crude storage price risk, while providing transparency and access to short-term storage capacity along the Gulf Coast. Platts understands more than 50% of the open interest on the LOOP Sour storage contract typically goes to delivery.

As of March 17, there was 22.55 million barrels of open interest on the LOOP Crude Oil Storage Futures contract and 2.694 million barrels of open interest across the front four months of the LOOP Gulf Coast Sour Crude Oil Futures contract, according to CME.

GLOBAL CRUDE OIL BENCHMARKS

Crude oil grades around the world differ widely in quality, but are often categorized broadly by two parameters — density and sulfur content. Density, measured by API gravity, ranges from light to heavy, while sulfur content is characterized as sweet or sour. As a result, the market value of an individual crude stream could differ widely from another, and benchmark crudes are often used as a reference to price the various crude oils produced around the world.
The most widely used benchmarks are typically associated with crude oils with the following qualities: stable and ample production; a transparent, free-flowing market located in a geopolitically and financially stable region; adequate storage to encourage market development; delivery points at locations suitable for trade with other market hubs; as well as a diverse ownership and market participation.

The three most important global crude benchmarks are Brent, West Texas Intermediate and Dubai/Oman. Other types of crude oil can be compared with these benchmarks by an agreed-upon differential in the marketplace, which takes a number of factors, including quality characteristics, transportation costs, and regional and global supply and demand conditions, into account.

**Brent** is a light sweet crude produced in the North Sea and is arguably the most widely used global crude oil benchmark. North Sea light sweet crude oil grades Forties, Oseberg and Ekofisk are also deliverable into Platts Dated Brent, and Platts recently announced it would include Troll deliveries from 2018. Brent is used to price crudes of varying qualities produced and traded not only in Europe, the Mediterranean, and Africa, but also in Australia and parts of Latin America and Asia.

**West Texas Intermediate (WTI)** is also a light sweet crude, produced in the US and priced at the crude oil trading hub of Cushing, Oklahoma. WTI is the most commonly accepted benchmark for crude sales in the Americas and is used as a benchmark for varying types of crude oil produced onshore and offshore in the US, such as Mars, a medium sour crude produced in the Gulf of Mexico, and Bakken, the light sweet crude produced in North Dakota. WTI is also used as a benchmark for crude oil produced in Canada, Mexico and South America.

**Dubai/Oman** is the third major benchmark crude. The prices of Dubai and Oman crudes, both of which are medium sour, are often used to price crude oil produced in the Middle East and exported to Asian markets. Saudi Arabia’s state-owned oil company, Saudi Aramco, uses the Platts Dubai/Oman benchmark when determining the price of its crude oil sold for delivery to Asia.

### LOOP SOUR AS A PRICING BENCHMARK

The need for a crude benchmark on the Gulf Coast has been a subject of much discussion over the years. The USGC is a key US oil production and import region and home to the world’s biggest refining hub. In addition to supplying refineries in the Texas and Louisiana area, crude from the Gulf Coast also moves up north to the Midcontinent market.

Most of the crude sales in the US continue to be priced off WTI at the delivery hub of Cushing, Oklahoma, including LOOP Sour. Cushing is home to the world’s largest oil storage complex, with a working crude oil storage capacity of 77 million barrels. Cushing was chosen as the delivery location for NYMEX light sweet crude futures in 1983.

### US CRUDE OIL IMPORTS (TOP 15 SUPPLIERS)

<table>
<thead>
<tr>
<th>Country</th>
<th>2016 (‘000 b/d)</th>
<th>2015 (‘000 b/d)</th>
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</thead>
<tbody>
<tr>
<td>Canada</td>
<td>3,256</td>
<td>3,169</td>
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<tr>
<td>Saudi Arabia</td>
<td>1,097</td>
<td>1,052</td>
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<tr>
<td>Venezuela</td>
<td>741</td>
<td>776</td>
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<tr>
<td>Mexico</td>
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<td>Colombia</td>
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<td>11</td>
</tr>
<tr>
<td>Libya</td>
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</tr>
</tbody>
</table>

Source: EIA

### LOOP SOUR VS KEY USGC-CONSUMED CRUDES, BENCHMARKS

Source: Various published assays
Operations in Cushing are not dominated by one particular company or pipeline. The top three companies with storage at Cushing are Houston-based Plains All American Pipeline L.P. and Canadian Enbridge Inc., which each have storage capacity of around 20 million barrels, and Tulsa-based Magellan Midstream Partners LP, which has 12 million barrels in storage capacity.

But with constantly changing dynamics between light/heavy and sweet/sour crude differentials, there is scope for a new sour crude benchmark, particularly in the Western hemisphere. The current dominant sour crude benchmark – Dubai/Oman crude – involves contracts in a different geographic location. The US Gulf Coast in particular, would be an ideal location for a new sour crude pricing benchmark, given that many of Gulf Coast refineries are geared to efficiently process this type of crude.

This does not mean that WTI will no longer be a benchmark or a useful hedging tool, but it does encompass different basis risks in terms of location and crude quality for companies trading sour crude on the Gulf Coast.

According to an analysis of EIA data, crude imports into the US totaled 2.883 billion barrels in 2016, with sour crude imports (sulfur content of 0.5% or higher) accounting for 81%, or 2.34 billion barrels. Of the 1.152 billion barrels of crude imported into the US Gulf Coast region in 2016, sour crude imports accounted for 1.070 billion barrels, or 93% of the total.

Of total crude oil imports into the US in 2016, Saudi Arabia was the No. 2 supplier behind Canada, with Iraq and Kuwait coming in at No. 6 and No. 9, respectively.

Mars crude also is often used as an indication of sour crude value on the Gulf Coast. But Mars crude is owned by just two companies – BP and Shell – compared with a number of companies that have equity ownership of the five grades that go into the LOOP Sour blend. In addition, the LOOP Sour crude market also has broad diversity in terms of the trading of the five different crude grades as well as the LOOP Sour blend itself. Platts understands buyers and sellers of LOOP Sour include Shell, Valero, Marathon, ExxonMobil, PBF Energy, Motiva and PetroChina, among others.

Being a blend of five crude streams, LOOP Sour is also able to respond better to changes/disruptions in production, crude quality and trading patterns. In addition, LOOP Sour not only encompasses the price of domestic sour crude barrels, but also imported sour crude barrels that continue to comprise a key portion of US refining crude slates – allowing for a more robust pricing benchmark.