Domestic Sweet / WTI Specifications

COQA- October 2009
Dennis Sutton- Marathon Petroleum
Domestic Sweet / WTI Specifications

- Brief Review of the History
- Current Work
- Future Plans
A Decade Ago

- Development of LLS Specifications
  - API Gravity, Sulfur, Metals, MCRT, HTSD, Light Ends, TAN (added later)

- Extensive Basin Quality Work Led by Aaron Dillard and Others
COQG Efforts

- January 2005 - John Maurer of Valero initiated discussion on specs for major crudes at Domestic Trading Centers
- A subcommittee was formed to pursue this work
- West Texas Intermediate (WTI) and Cushing, OK were agreed to be our greatest interest and impact
- High Temperature Simulated Distillation (HTSD), acidity (TAN), API gravity, sulfur, carbon residue (MCRT) and metals were identified as important quality parameters
Data was obtained that showed Domestic sweet to be a light, sweet, very low TAN stream but there was a great deal of variability in the metals and HTSD data. Also, some uncertainty about exactly where and how some samples were obtained.

An article in the July 17, 2008 Oil Daily highlighted COQG’s efforts in developing more comprehensive Domestic Sweet specifications.

Clifford Mills (consultant) has been invaluable in handling the data.
2009

- John Maurer reassigned within Valero
- In 2009, conference calls have been used to complement the COQG meetings to progress in a more timely manner.
- In order to set appropriate specification limits, we agreed further analytical testing was needed with tightly defined sampling and lab procedures.
- Commercial labs were surveyed to determine their capabilities and interest in conducting analyses.
2009 March ASTM Crude Oil Sample (CO0903) was WTI/Domestic Sweet

- Over 80 labs worldwide submitted data on this sample
- Data was provided for a wide slate of parameters by multiple test methods including all of the tests we are interested in
- While only one sample, this provided excellent information on the reproducibility of the methods
API Gravity and Sulfur are tests we are concerned about that currently have specifications defined by NYMEX.

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Sample: CO0903

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Number of Valid Results</th>
<th>ASTM Reproducibility</th>
<th>Reproducibility This Sample</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>API Gravity, by D287</td>
<td>39.4</td>
<td>64</td>
<td>0.50</td>
<td>0.44</td>
<td>NYMEX has 37-42; no concern.</td>
</tr>
<tr>
<td>Sulfur, wt %, by D4294</td>
<td>0.424</td>
<td>86</td>
<td>0.042</td>
<td>0.037</td>
<td>NYMEX has ≤0.42 wt%; no desire to change; what happens when it exceeds 0.42%? Over half the labs reported &gt;0.42%.</td>
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</table>
While we are not seeking to add specifications for Viscosity, RVP, or Pour Point, NYMEX does have published specs for these parameters. Are these monitored at Cushing?

### Sample: CO0903

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<tr>
<td>RVP, by D5191</td>
<td>6.07</td>
<td>32</td>
<td>0.296</td>
<td>1.479</td>
<td>This sample reproducibility is much worse than quoted ASTM value; NYMEX has a published spec of ≤9.5 psi</td>
</tr>
<tr>
<td>Pour Point, °F, by D97</td>
<td>-3</td>
<td>61</td>
<td>9.0</td>
<td>16.3</td>
<td>NYMEX has a published spec of ≤ 50°F. WTI should be nowhere near this limit.</td>
</tr>
</tbody>
</table>
CO0903 Results - Yields

<table>
<thead>
<tr>
<th>Sample: CO0903 - HTSD by D7169</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>20% point (°F)</td>
</tr>
<tr>
<td>50% point (°F)</td>
</tr>
<tr>
<td>% at 1020°F</td>
</tr>
<tr>
<td>% &gt;1020°F</td>
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</tbody>
</table>

- While the precision from this large group is poor, some labs do quite well.
CO0903 Results - Others

<table>
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<th>Sample: CO0903</th>
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<tbody>
<tr>
<td><strong>Parameter</strong></td>
</tr>
<tr>
<td>TAN by D664</td>
</tr>
<tr>
<td>MCR by D4530</td>
</tr>
<tr>
<td>Nickel by D5708B</td>
</tr>
<tr>
<td>Vanadium by D5708B</td>
</tr>
</tbody>
</table>

- TAN, Carbon Residue (MCR) and Metals (Nickel & Vanadium) are parameters for which we desire to implement specifications. These four parameters are part of the LLS specifications.
In Progress

- Thanks to the efforts of various companies, we are collecting and analyzing approximately 40 Domestic Sweet/WTI samples, taken at Cushing.
- Samples are being collected from multiple operators, over several weeks time, utilizing three different commercial labs.
- Data is flowing to Clifford Mills for workup. Clifford has received about half of the data so far.
Domestic Sweet - Lab Testing

The following slate of analytical testing is being conducted on the whole crude sample as received:

1. API Gravity by ASTM D287
2. Total sulfur by ASTM D4294
3. Total Acid Number (TAN) by ASTM D664 using the first inflection point
4. Nickel by ASTM D5708B
5. Vanadium by ASTM D5708B
6. MCRT by D4530
7. High Temperature GC Simulated Distillation (HTSD) by ASTM D7169. Report 20% point, 50% point, and Recovery @ 1020F.
COQG Domestic Sweet Project

Preliminary Data Review
Status of project

- Some data received from four sources
- Data was obtained at four different laboratories (Three were slated in the project)
- Data development continues
Preliminary Observations

- API Gravity levels have trended up since the previous study
- Sulfur levels continue to exceed the NYMEX maximum on many samples and have increased slightly since the previous study
- TAN values are consistent with the previous study
  - There appears to be some between laboratory bias
- MCRT values are consistent with the previous study
- Ni & V data significantly lower than previous study and less variable
- Simulated distillation data is still suspect
Preliminary API Data

API - Cushing Domestic Sweet
Outliers removed

API data  Average  2 Sigma limits  NYMEX Limits
Preliminary Sulfur Data

Sulfur - Cushing Domestic Sweet
Outliers eliminated

Wt%
Preliminary TAN Data

TAN - Cushing Domestic Sweet
Outliers eliminated

Data
Average
2 Sigma Limit
Preliminary MCRT Data

MCRT - Cushing Domestic Sweet
Outliers Removed

mg/kg

MCRT Data  Average  2 Sigma limits
Preliminary Nickel Data

Nickel - Cushing Domestic Sweet
Outliers eliminated

Data
Average
2 Sigma limits
Preliminary Vanadium Data

Vanadium - Cushing Domestic Sweet
Outliers eliminated
Simulated Distillation (1)

- Reported total recovery data has varied from 92 to 100% recovery
- Reported 1020°F recovery has varied from 78.8 to 91.9% recovery
- Reported 20% recovery temperatures have varied from 206 to 286°F
- Reported 50% recovery temperatures have varied from 494 to 599°F
Simulated Distillation (2)

- Preliminary data indicates possible between laboratory biases
  - Always ~100% recovery
  - Never 100% recovery
- Complete review of data will follow when all labs are equally represented
Where do we go from here

- Continue to compile data
- Compare data from different sources
- Compare data from different labs
- Agree on control limits for the various components
The results obtained to date are encouraging!
Better definition of the sampling and analytical testing requirements has resulted in better precision.
Our data, from multiple terminals at Cushing, over several months, will provide a basis for the development of meaningful specifications for WTI/Domestic Sweet.
What Next?
Future Plans - Development of Specifications

- Complete current testing survey. This should be finished by the end of the year. Clifford Mills will evaluate and distribute data without sample submitters or laboratories.
- Review this data, the CO0903 crosscheck data, previous COQG results and own individual in-house information.
- Agree on specifications for Domestic Sweet
  - API >37 and <42
  - Sulfur <0.42 weight percent
  - Nickel and Vanadium (ppm)
  - MCRT
  - TAN
  - 20%, 50% and recovery @1020F by HTSD
Future Plans - Implementation

- COQA representatives should contact their individual anti-trust attorneys and be sure legal is aware of COQA’s efforts and to provide appropriate counsel.

- By January 1, be prepared to discuss how best to implement the specifications.
Final Thoughts

- NYMEX currently has published WTI specifications for: API Gravity, Sulfur, Viscosity, RVP, Basic Sediment, and Pour Point. There are no requirements on how these properties should be monitored.

- Current LLS specifications include: API, Sulfur, MCRT, Light Ends, HTSD, Metals and TAN. The Capline owners and operator have determined the monitoring and enforcement programs.

- Our current efforts to develop and implement more meaningful WTI/Domestic Sweet specs are an extension of programs that have run successfully for years!