KAM Controls

*Karl Fischer* for Crude Oil Custody Transfer

COQM Meeting
February 1, 2001
New Orleans, LA
World Oil Economics Quiz

• World’s Daily Oil Consumption
  – 75 M bbls

• US Daily Oil Consumption
  – 18 M bbls

• Top Oil Producer in the World (top 3)
  – US (8.2 M), Saudi (7.9), Former USSR (7.7)

• US Daily Oil Imports
  – DUH !!! 10 M

• Average Water Content of Each Oil Transaction
  – Depends on which device used for analysis!!
Karl Fischer
for Crude Oil Custody Transfer

Unique Application Challenges

• Simplicity - because measurement technicians wear many hats; device must be easy to use

• Accuracy - because $ are involved with each analysis, accuracy is critical

• Repeatability - to satisfy buyer & seller all results must be repeatable
Unique Application Challenges

• Crude Oil - crude’s complex chemistry presents a challenge for traditional Karl Fischer moisture analysis

• Non Laboratory Environment - water content determination has traditionally been a non-laboratory procedure

• Buyers & Sellers - Test Results determine Large $ Transactions, both parties must accept data with minimal challenges!
Karl Fischer
SIMPLICITY

• Crude Oil analysis is typically performed in a non-laboratory environment
• Crude oil techs are typically not “white-coat” chemists (unaccustomed to lab procedure)
• Employee cross training requires Karl Fischer to be easy to operate & easy to understand
Karl Fischer - ACCURACY

• US crude market is $540 M per day
• World crude market is $2.2 B per day
• $$$ Every crude oil water analysis determines a monetary transaction $$$
• Because money is involved, Karl Fischer for crude oil must be extremely accurate!!!
Karl Fischer
REPEATABILITY

• Every KF transaction involves a buyer & seller
• Each analysis result must repeat to avoid conflict
• To keep both parties happy Crude Oil Karl Fischer analysis must be repeatable.
Reagent
Requirements for Crude Custody Transfer

• Standard KF Reagent
  – Pre-bottled or by recipe
  – **Methanol**: solvent for petrochemical & hydrocarbons
  – **Pyridine**: PH optimizer, reagent stabilizer, prolongs reagent degradation
  – **SO₂**: accepts free O molecules generated in KF reaction
  – **Iodine**: bonds with free H₂ ions from KF reaction

• Crude Reagent
  – **Xylene**: specifically attacks oil-asphalt-water bond in crude,
  – **Methanol**:
  – **Chloroform**: PH optimizer, catalyst for KF reaction
  – **Imidizol**: enhanced PH optimizer & reagent stabilizer
  – **SO₂**:
  – **Iodine**:
## Crude Oil Moisture Determination

### Traditional Methods Analysis

**REPRODUCIBILITY OF ASTM & API STANDARD TEST METHODS FOR WATER DETERMINATION IN CRUDE OIL**

<table>
<thead>
<tr>
<th>TEST METHOD</th>
<th>TEST TIME (minutes)</th>
<th>WATER VOL %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.1%</td>
</tr>
<tr>
<td>Centrifuge (D-4007)</td>
<td>20</td>
<td>0.20</td>
</tr>
<tr>
<td>Water by Distillation (D-4006)</td>
<td>120</td>
<td>0.11</td>
</tr>
<tr>
<td>Karl Fischer Titration Weight Injection (D-4928)</td>
<td>5</td>
<td>0.02</td>
</tr>
<tr>
<td>Karl Fischer Titration Volume Injection (D-4928)</td>
<td>5</td>
<td>0.02</td>
</tr>
</tbody>
</table>
### Crude Oil Moisture Determination

**Traditional Methods Analysis**

**Economic Comparison on 1 M bbl transaction at $30 per bbl**

<table>
<thead>
<tr>
<th>Device</th>
<th>Accuracy</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifuge</td>
<td>0.20%</td>
<td>+/- $ 60K</td>
</tr>
<tr>
<td>Distillation</td>
<td>0.11%</td>
<td>+/- $ 30K</td>
</tr>
<tr>
<td>Karl Fischer</td>
<td>0.02%</td>
<td>+/- $ 6K</td>
</tr>
</tbody>
</table>
Karl Fischer for Crude Oil

RECAP

• **Simplicity** for ease of use

• **Accuracy** Best Solution for Monetary settlements

• **Repeatability** eliminate conflict for Buyers & Sellers