PETE 310

Lecture # 4

Aromatics & non-hydrocarbon compounds
Aromatic Compounds

- Benzene building block – examples
- Nomenclature
- Properties
- Importance
Kekule & Benzene Structure
Aromatic Compounds

- BTX’s ?
Non-Hydrocarbon Elements and Compounds

- Most common: CO$_2$, N$_2$, H$_2$S
- They lower the heating value of oil (Btu/lbm)
- Nitrogen, Oxygen and Sulfur form part of heavy molecules present in the oil (asphaltenes & resins)
- Sulfur compounds poison catalysts used in refinery operations
Sulfur Compounds

- Oils may have up to 10% of S on a weight basis
- Very sour oils may be denser than water
- $\text{H}_2\text{S}$ removal done with ethanolamines. The process is known as ‘gas sweetening’
Sulfur Compounds

- Mercaptanes (stink !)
- Use as gas odorant (safety)
- General formula $\text{RSH} \rightarrow \text{thiol}$

$\text{HS-C}_3\text{H}_7 \rightarrow$
Sulfur Compounds

Name the following compounds

HS-C₄H₉ →

- Alkyl Sulfides \textbf{RSR}
- Disulfides \textbf{R-S-S-R}
Oxygen Compounds

- **Typical Groups**

  - Phenol
  - Carboxyl
Oxygen Compounds

- **Carboxyl**
- **Acetyl**

\[ \text{O}_2 \]

\[ \text{H}_2\text{C} = \text{O} \]

\[ \text{H}_3\text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \]

\[ \text{CH} - \text{C} \]

\[ \text{H}_3\text{C} - \text{OH} \]
Importance of Acidic Compounds

- Acid # of Oils used for caustic oil recovery
- Carboxylic compounds react with NaOH to form in-situ surfactant which enhances oil recovery
Asphaltenes


Molecular structure of asphaltene proposed for Maya crude (Mexico) by Altamirano, et al. [IMP Bulletin, 1986]

http://tigger.uic.edu/~mansoori/HOD_html
Organo-metallic Compounds

- Very small amounts but heavily regulated by the EPA
- Heavy metals of concern: Ni, Va, Pb, Cd
Classification of Crude Oils

**Chemical**
- PNA and combinations (Paraffinic-Naphthenic-Aromatics)
- Resin and asphaltene content

**Physical**
- Specific gravity
- Pour and cloud points
- Gasoline and kerosene content
- S and asphalt content
Why do we care about the properties of individual components of oil and gas?
Why do we care?
# Properties of Interest

## Crude Oil Refining

<table>
<thead>
<tr>
<th>Distillate Fraction</th>
<th>Boiling Point (°C)</th>
<th>Carbon Atoms per Molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gases</td>
<td>below 30</td>
<td>1-4</td>
</tr>
<tr>
<td>Gasoline</td>
<td>30-210</td>
<td>5-12</td>
</tr>
<tr>
<td>Naphtha</td>
<td>100-200</td>
<td>8-12</td>
</tr>
<tr>
<td>Kerosene &amp; Jet Fuel</td>
<td>150-250</td>
<td>11-13</td>
</tr>
<tr>
<td>Diesel &amp; Fuel Oil</td>
<td>160-400</td>
<td>13-17</td>
</tr>
<tr>
<td>Atmospheric Gas Oil</td>
<td>220-345</td>
<td></td>
</tr>
<tr>
<td>Heavy Fuel Oil</td>
<td>315-540</td>
<td>20-45</td>
</tr>
<tr>
<td>Atmospheric Residue</td>
<td>over 450</td>
<td>over 30</td>
</tr>
<tr>
<td>Vacuum Residue</td>
<td>over 615</td>
<td>over 60</td>
</tr>
</tbody>
</table>
Beyond Distillation – Other Processes

Fractions

Before

- Gasoline
- Naptha
- Kerosene
- Diesel

After

- Gas Oil
- Heavy Fuel Oil
- Atm Residual
- Vacuum Residual

Oil Processing

- Catalytic Reforming
- Alkylation
- Fluidized Catalytic Cracking
- Hydro-Processing

- High Octane Gasoline
- Aviation Fuel
- Naptha
- Naptha
A more technical diagram...
End of Chapter One
Refining Processes
Your Duties...

- Homework Due Friday
- Next Class we will start Chapter 2
  - Read pages 46-61