Chemical & Physical Properties of Crude Oil
Lesson Objectives

• Upon completion of this Module, Students will be able to:
  • Identify the characteristics of crude oil
  • Understand the difference between sweet and sour crude oil
  • Identify the adverse health effects of crude oil
Characteristics of Crude Oil

• What is Crude Oil?
  • “a complex combination of hydrocarbons consisting predominantly of aliphatic, alicyclic and aromatic hydrocarbons. It may also contain small amounts of nitrogen, oxygen, and sulfur compounds.”

• Mixed crude oils have varying amounts of each type of hydrocarbon.
Characteristics of Crude Oil

• The hydrocarbons in crude oil can generally be divided into four categories:
  • **Paraffins**: These can make up 15 to 60% of crude.
    • Paraffins are the desired content in crude and what are used to make fuels.
    • The shorter the paraffins are, the lighter the crude is.
  • **Napthenes**: These can make up 30 to 60% of crude.
    • They are higher in density than equivalent paraffins and are more viscous.
Characteristics of Crude Oil

- The hydrocarbons in crude oil can generally be divided into four categories:
  - **Aromatics**: These can constitute anywhere from 3 to 30% of crude.
    - They are undesirable because burning results in soot.
    - They are also more viscous. They are often solid or semi-solid.
  - **Asphaltics**: These average about 6% in most crude.
    - They are generally undesirable in crude, but their 'stickiness' makes them excellent for use in road construction.
Characteristics of Crude Oil

- Based upon the many recent rail car incidents involving crude oil and Bakken Crude oil specifically, two important characteristics have become evident
  - Flammability
  - Toxicity
Understanding the Flammability Issue

• In order to understand the Hazards of Flammability of Crude Oil, some basic concepts must be understood.

• These include the terms:
  • Flashpoint
  • Upper and Lower Explosive Limits
  • Vapor Density
  • Vapor Pressure
  • Specific Gravity
Flashpoint

• Flashpoint is defined as: “the lowest temperature that a liquid emits vapors that may be ignited”.
• The lower the flashpoint the more flammable the material.
• Bakken Crude Oil has a flashpoint of: -31° F
FLASH POINT — Lowest temperature at which a liquid gives off enough vapors to form an ignitable mixture with air.

- **GASOLINE**
  - Flash Point: $-40^\circ F$

- **FUEL OIL**
  - Flash Point: $125^\circ F$
LEL, UEL and Flammable Range

• Lower Explosive Limit (LEL)
  • The lowest concentration of vapors in the air capable of producing a flash fire in the presence of an ignition source

• Upper Explosive Limit (UEL)
  • The highest concentration of vapors in the air capable of producing a flash fire in the presence of an ignition source
LEL, UEL and Flammable Range
## LEL – UEL Comparisons

<table>
<thead>
<tr>
<th>Hazardous Substance</th>
<th>Flammable Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>1.4% - 7.6%</td>
</tr>
<tr>
<td>Methane</td>
<td>5% - 14%</td>
</tr>
<tr>
<td>Bakken Crude Oil</td>
<td>0.8% - 8.0%</td>
</tr>
</tbody>
</table>
Vapor Density

• Weight of a unit volume of gas or vapor compared to the weight of an equal volume of air

• Bakken Crude Oil has a Vapor Density of:
  • 2.5 – 5.0

• As such vapors can accumulate in low or depressed areas

• These vapors can be both flammable and toxic
Vapor Pressure

- Vapor Pressure is the pressure exerted by a vapor at a given temperature in a closed system.
- A liquid with a high vapor pressure is called a volatile liquid.
- Vapor Pressure is directly related to temperature.
  - Increasing Temperature = Increased Vapor Pressure.
- Bakken Crude Oil has a Vapor Pressure of 280 – 360 at 68° F.
Specific Gravity

• Specific Gravity is the weight of a volume of liquid compared to an equal volume of water

• Bakken Crude Oil has a Specific Gravity of: 0.7 – 0.8
Toxicity of Bakken Crude Oil

- Toxicity is the degree to which a substance can damage an organism.

- Toxicity can refer to the effect on a whole organism, such as a human,
  - It can also be the effect on a substructure of the organism, such as a cell (cytotoxicity) or an organ such as the liver (hepatotoxicity).

- The degree of toxicity is dependent upon the components of the crude oil.
Components of Crude Oil

The following products may be found in Bakken Crude Oil:

- Hydrogen Sulfide
- Benzene
- Ethyl Benzene
- Xylene
- Naphthalene
- Toluene
Hazards of Crude Oil Components

• All of these components are inhalation hazards
• Some also pose a dermal exposure hazard
  • Exposures may result in either acute or chronic effects
• Remember the Routes of Entry
  • Inhalation
  • Absorption
  • Ingestion
  • Injection
Safety Data Sheet Review

- Using the Safety Data Sheet provided, complete the Exercise Worksheet
- Work in Groups
- Let’s discuss your findings
Adverse Health effects of Crude Oil

- Effects of Inhalation
  - Headache
  - Dizziness
  - Nausea
  - Vomiting
  - Confusion
  - Victim may appear “intoxicated”
Adverse Health Effects of Crude Oil

- Effects of Skin Absorption
  - Skin erythema (reddenning)
  - Edema (swelling)
  - Burning Sensation
  - Dermatitis
  - Defatting of the skin
Adverse Health Effects of Crude Oil

• Effects of Ingestion
  • Nausea
  • Vomiting
  • Gastrointestinal distress
  • Diarrhea