Chemical & Physical Properties of Crude Oil

MODULE NO. 4

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

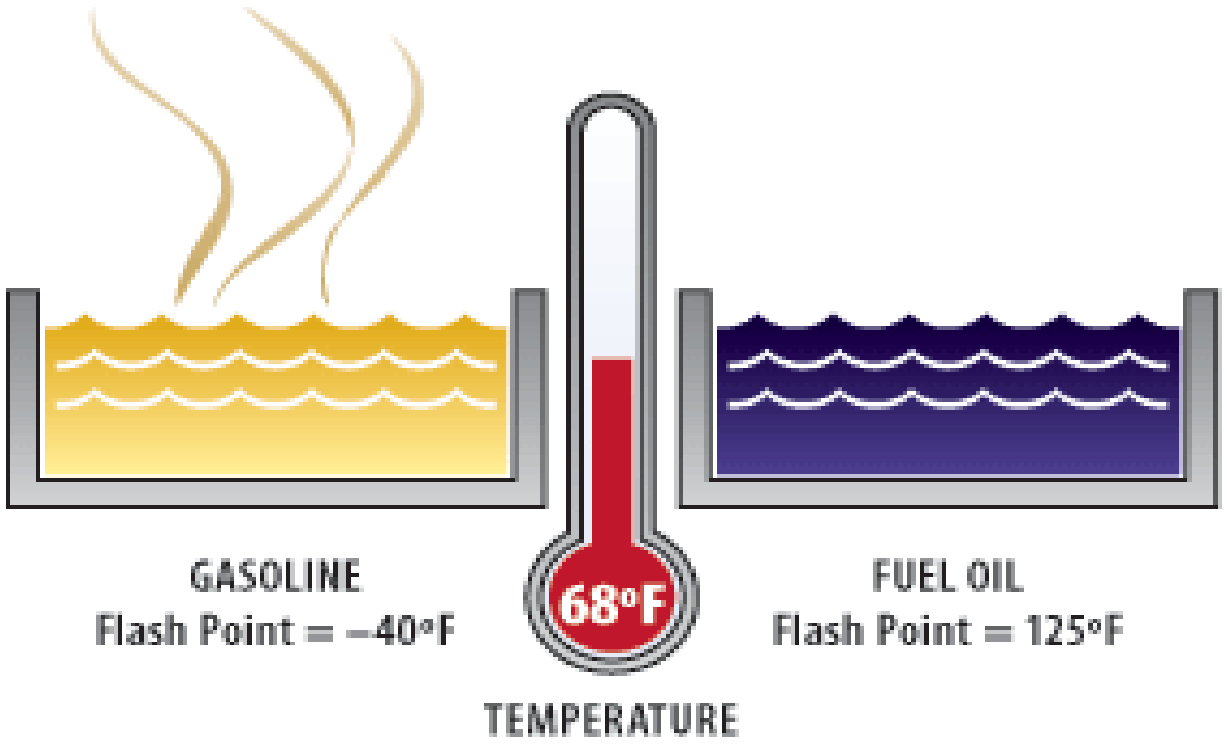
- In order to understand the Hazards of Flammability of Crude Oil, some basic concepts must be understood.
- These include the terms:
  - Flashpoint
  - Upper and Lower Explosive Limits
  - Vapor Density
  - Vapor Pressure
  - Specific Gravity

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

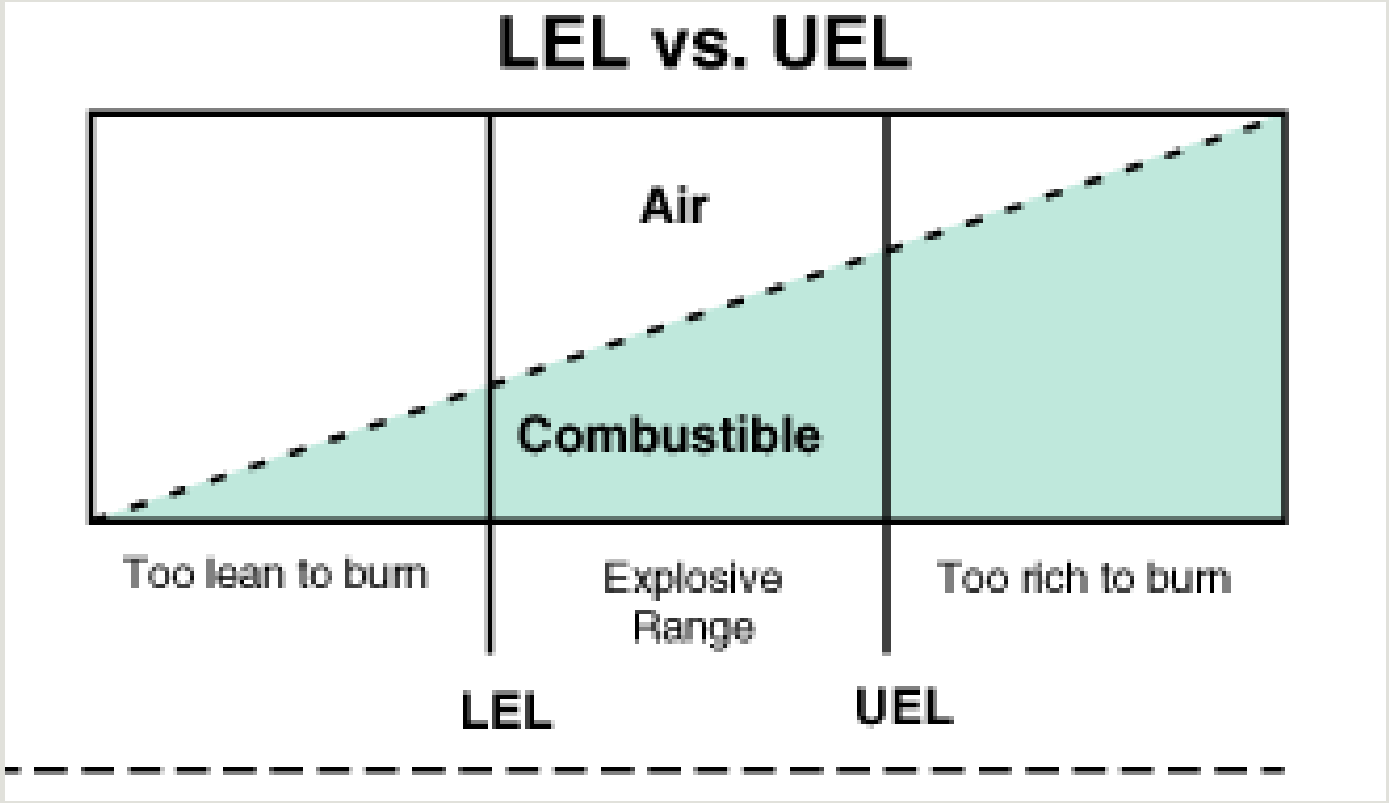
FLASH POINT — Lowest temperature at which a liquid gives off enough vapors to form an ignitable mixture with air



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

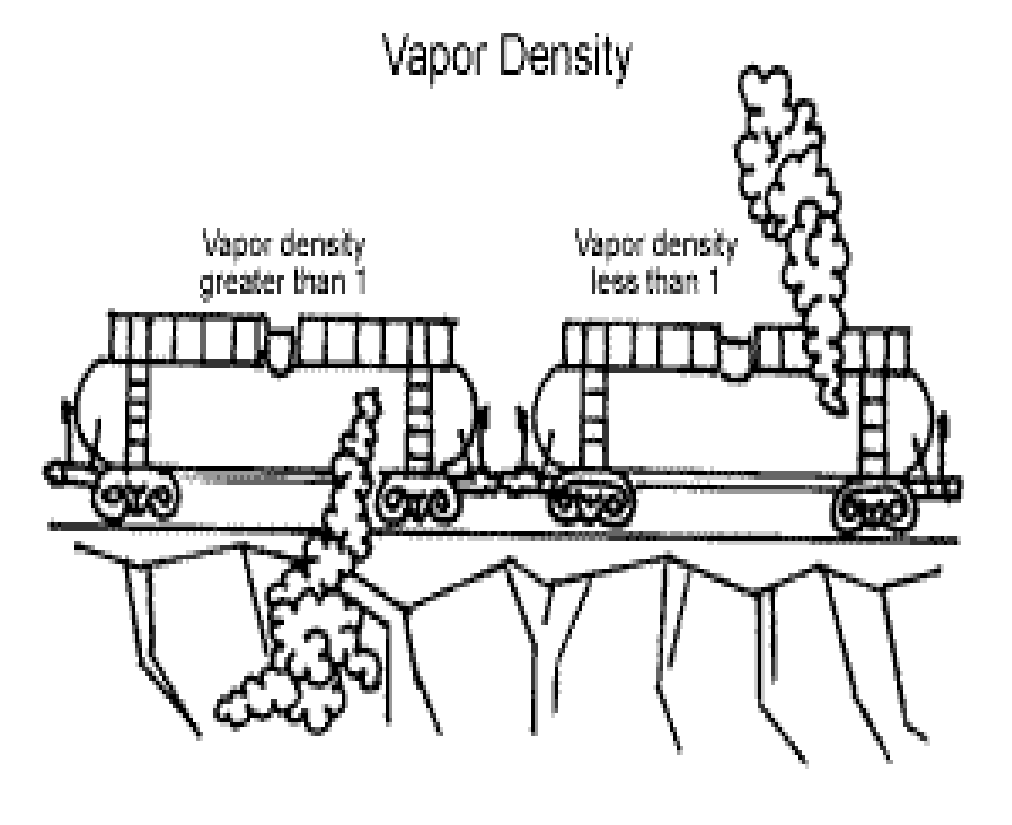
LEL, UEL and Flammable Range



LEL – UEL Comparisons

HAZARDOUS SUBSTANCE	FLAMMABLE RANGE
Gasoline	1.4% - 7.6%
Methane	5% - 14%
Bakken Crude Oil	0.8% - 8.0%

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

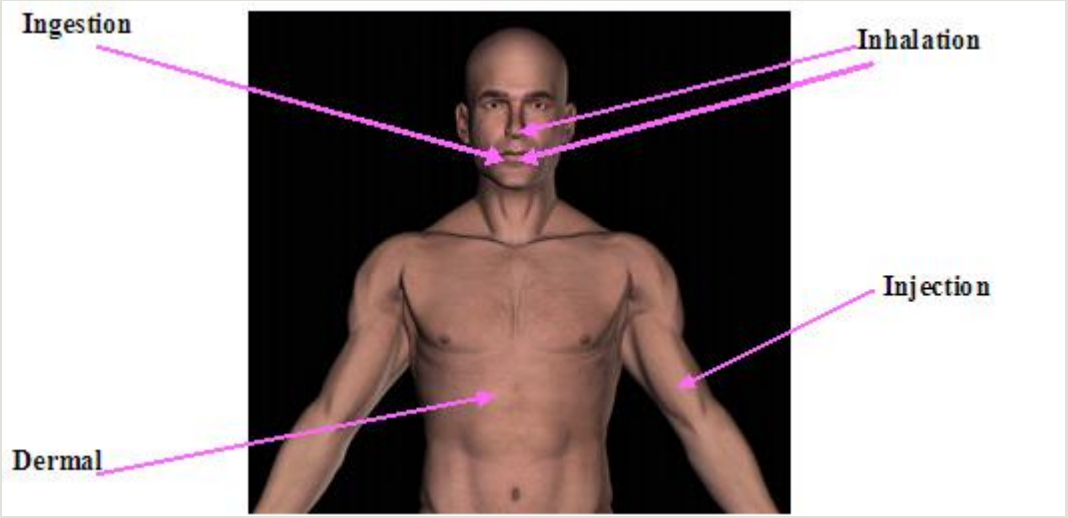
- Toxicity is the degree to which a substance can damage an organism.
- Toxicity can refer to the effect on a whole organism, such as a human,
  - It can also be the effect on a substructure of the organism, such as a cell (cytotoxicity) or an organ such as the liver (hepatotoxicity).
- The degree of 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 (reddening)
  - Edema (swelling)
  - Burning Sensation
  - Dermatitis
  - Defatting of the skin

Adverse Health Effects of Crude Oil

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