Physical and Chemical Properties of Oil
Physical and Chemical Properties of Oil

- Several physical and chemical properties useful to OSCs
- Determine what response technology works
- Terminology of the oil industry (jargon)
  - example: 1 Barrel of Oil is 42 gal
  - example: API Gravity
Physical and Chemical Properties which affect cleanup and behavior on water

- Specific gravity
- Surface tension
- Viscosity
- Pour point
- Flash point
- Solubility in water
- And how these parameters change with time
- These parameters are measured at “standard temperature and atmospheric pressure”
- Oil Spills are not at “standard temperatures and pressure”
Physical properties of Oil

- Specific Gravity-The specific gravity of a substance is a comparison of its density to that of water.
  - Less than SG 1.0 floats on water
  - Greater than SG 1.0 sinks in water
  - Majority of oils “float”
  - Great spill cleanup significance
  - In general, specific gravity of spilled oil will increase over time, as volatiles evaporate
Physical properties of Oil

- API Gravity (American Petroleum Institute)
- Pure Water has arbitrary API Gravity of 10
- Light crudes are generally those with an API gravity over 40. Gasoline ~ 60.
- Those with an API gravity below 40 are regarded as heavy
- There is an inverse relationship between API gravity and density; the higher the density the lower the API gravity.
Low Specific Gravity
High API Gravity

- Low Viscosity
- Low Adhesion properties
- High Emulsion Tendencies
- Crude oil with High API Gravity, generally has a higher monetary value
High Specific Gravity
Low API Gravity

◆ High Viscosities
◆ High Adhesion Properties
◆ Low Emulsification Tendencies
◆ Lower monetary value for low API Gravity Crudes
A spill of **very** high API Gravity crude is reported
No other info

What is the significance to an OSC?
Some Answers

Physical properties of Oil

- Flash hazard
- Evaporation of light ends (LEL)
- PPE for the cleanup crew
- Equipment to cleanup can be matched to spill
- Recovery rate is expected to be low
- Light ends are the more toxic fractions of crude
- Citizen & elected official complaints likely
Physical properties of Oil

- Surface Tension—the force of attraction between the surface molecules of a liquid
- Surface Tension together with viscosity affects the rate of spread over water or ground
- The lower the surface tension, the greater its potential spreading rate
- Low surface tensions characteristic of low specific gravity oils
- As temperature increases, surface tension decreases, and the rate of spread increases
Physical properties of Oil

◆ Viscosity- the viscosity of an oil is a measure of the oil’s resistance to shear. Viscosity is more commonly known as resistance to flow.

◆ High viscosity implies a high resistance to flow while a low viscosity indicates a low resistance to flow.

◆ Changes with temperature, decreasing temperature increases viscosity

◆ Viscosity is determined by the amount of light ends
Viscosity effects on oil spill clean ups

- Influences the spreading rate of the slick
- The stickiness of the oil
- Its penetration into soil or beaches
- The ability of pumps to remove/move the oil
Question Time

- An oil which has a low surface tension, low specific gravity and low viscosity has been spilled...implications?
Some Answers

- Spill will spread rapidly
- Spread of slick will increase with increasing temperature
- Same concerns as previous question on High API crude oil
Pour Point

- Temperature at which the oil becomes “plastic” and will not flow.
- Overrides the effects of viscosity and surface tension
- Lighter oils with low viscosities have lower pour points
- Heavy oils may become solid on cold water, and may become fluid while sitting in the sun on the shoreline, penetrating into the shoreline
Flash Point

- Temperature at which an oil's vapors will ignite
- Must know for safety
- Lighter, volatile oils, once spilled, will gradually lose their lighter components to evaporation and dispersion...don't let it disperse into your lungs
Solubility

- Solubility of oil in water is generally very low ~ 5 ppm or one grain of sugar, out of a teaspoon of sugar, in a cup of water

- Despite the low solubility, can have important consequences for the potential toxicity of hydrocarbons to aquatic organisms
Physical and Chemical Properties Affect

- Impact the physical and biological effects of an oil spill
- The behavior of the oil slick
- The efficiency of various clean up methods
- The physical and chemical properties of the oil largely determine the thickness and spreading rate of the slick, the formation of emulsions
Physical and Chemical Properties Affect

- Spreading of the oil slick
- Subsequent break up of the oil slick
- Rates and extent of emulsification, evaporation and biodegradation

- We are not trying to make you experts, just aware of the many factors affecting oil spill behavior and your response options