



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

Question Time

- ◆ 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 oils vapors will ignite
- ◆ Must know for safety
- ◆ Lighter, volatile oils, once spilled, will gradually loose 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