noaa

NOAA Fact Sheets on Oil Properties

ED Levine
Response Operations Supervisor – East
Emergency Response Division

noaa

10 New Fact Sheets:

- Biodiesel
- Denatured Ethanol
- Dielectric Fluids (non-PCB fluids)
- Diesel
- Dilbit
- Heavy Fuel Oil
- Kerosene & Jet Fuel
- Non-Petroleum Oils
- Light Shale (Tight) Oil
- Synthetic Based Drilling Muds

noaa

Basic Outline:

- Definition
- Properties
- Environmental Behavior
- Environmental Effects
- ADIOS2 Weathering Graphs

FACT SHEET: Kerosene and Jet Fuel Spills

Definition

- Kerosene is a light refined product (C_6-C_{16}) that has a lower boiling point range than diesel/No. 2 fuel oils. Jet-A (freeze point of -40°C) and Jet-A1 (freeze point of -47°C) are highly refined kerosene-type fuels used in commercial and general aviation turbine engines. JP-8 is military fuel that similar to Jet-A1 but contains additional additives (de-icing, antibacterial, anti-corrosive and anti-static agents), that are added in amounts equal to a few 100 ppm. These are the most commonly used jet fuels today.

Properties

- All of these light refined fuels are composed light hydrocarbons with a relatively narrow boiling range and have low viscosities, meaning that, when spilled on open water, most of the oil will evaporate or naturally disperse within a day or less (see ADIOS2 oil weathering plots on the next page). Thus, seldom is there any oil on the surface for responders to recover from open water.
- These oils are much lighter than water (specific gravity is 0.77-0.85, compared to 1.00 for freshwater and 1.03 for seawater). The API gravity is >40.
- Water solubility at 70°F ranges from 50-80 ppm and is linear with temperature. The water-soluble fraction contains about 6-7 ppm aromatics, which are mostly the mono-aromatic compounds, with xylenes, ethylbenzene, and trimethylbenzenes being the dominant compounds in solution.
- Kerosene and jet fuels are virtually clear and extremely difficult to see on the water.

Environmental Behavior

- When spilled on water, kerosene-type oils spread very quickly to a thin film. Even when the oil is described as a heavy sheen, its thickness may be less than 0.0004 inches (0.01 millimeters) and there will be about 1,000 gallons per square nautical mile of continuous coverage. The volume of oil in areas covered by streamers would be much less. Silver sheen only contains about 75 gallons per square nautical mile.
- Jet fuel or kerosene that is dispersed in the water column can adhere to fine-grained suspended sediments, which then settle out and get deposited on the bottom of a waterbody. This process is more likely to occur in streams and rivers with significant suspended sediment loads. It is less likely to occur in open marine settings. This process is not likely to result in measurable sediment contamination for small spills.
- Kerosene-type fuels are not very sticky or viscous, compared to black oils. When small spills do strand on the shoreline, the oil tends to penetrate porous sediments quickly, but also to be washed off quickly by waves and tidal flushing. Thus, shoreline cleanup may not be needed.
- Where larger amounts of oil soak into wetland soils, expect high mortality of animals and plants.
- Kerosene-type fuels are completely degraded by naturally occurring microbes, under time frames of 1-2 months when there is sufficient oxygen. Fuel that has penetrated to 1 ft. in sandy soils can take more than 18 months to degrade. Nutrient addition and vegetation may speed this process in soils.

Environmental Effects

- The rapid loss by evaporation for spills to open water reduces the exposure to aquatic organisms, thus fish kills are seldom reported.

noaa

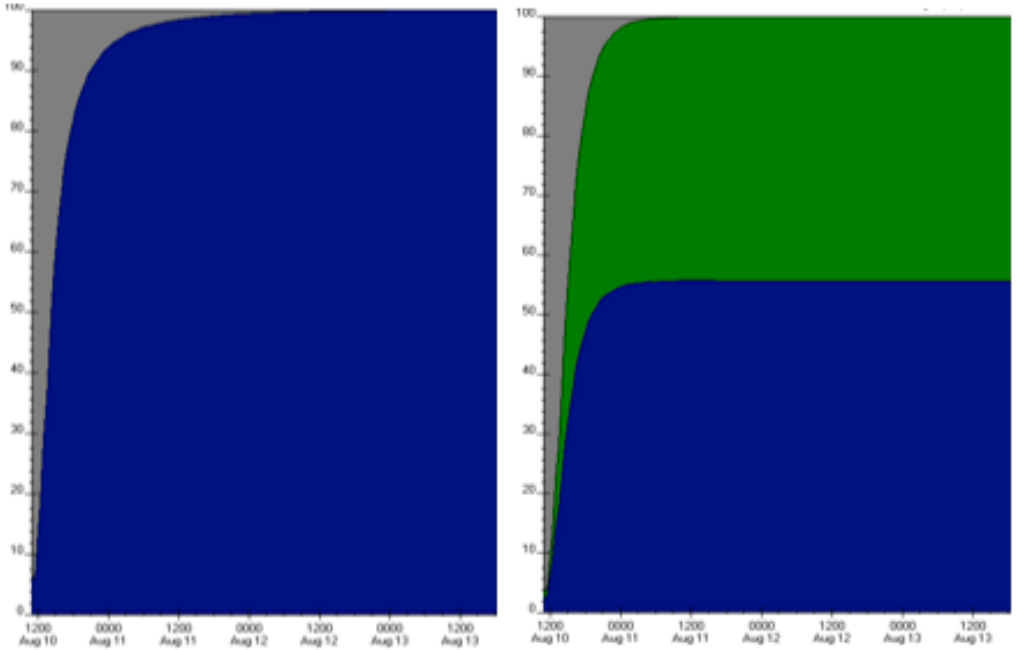
Definition

Properties

Environmental Behavior

Environmental Effects

- Spills to small streams with dense vegetation cover will evaporate much slower, allowing the fuel to persist and impact both animals and vegetation. For example, the release of 112,000 gallons of JP-5 into a mangrove creek in Puerto Rico in October 1999 resulted in impacts to 50 acres of mangrove forest and mortality of 30 acres. There was extensive mortality of fish, shellfish, and birds. A culvert was plugged to prevent the fuel from spreading further downstream, which raised the water level by 3 ft. The mangrove canopy slowed evaporation, allowing recovery of 15-20% of the spilled fuel.
- Jet fuels are relatively less acutely toxic than diesel. Aquatic organisms that come in direct contact with naturally dispersed and entrained jet fuel in the water column may be killed. However, small spills in open water may not result in fish kills. Fish kills may occur for small spills in confined, shallow water and in streams, where weathering and mixing are reduced. Fish and invertebrates in small streams can be affected for miles downstream of a jet fuel release into the water.



ADIOS2 model output for a jet fuel spill of 100 bbl; winds of 5 knots (left) and 7 knots (right). **Blue = evaporated**; **green = dispersed**; grey = remaining. Jet fuel and kerosene are lighter than diesel/No. 2 fuel oil, with higher rates of evaporation under similar conditions.

noaa

ADIOS 2
Weathering Graphs

FACT SHEET: Denatured Ethanol Spills

Definition

- Denatured ethanol is a mixture of ethanol (grain alcohol) that is blended with 2-7% unleaded gasoline to make it undrinkable. Other additives often present in denatured ethanol include: methanol (4%), methyl isobutyl ketone (2%), and ethyl acetate (1%).
- The most common ethanol product shipped by rail is called E98 (2% gasoline).

Properties

- Ethanol has a specific gravity of 0.79 (compared to 1.0 for fresh water and 1.03 for salt water), thus it will float on water. However, the ethanol component completely mixes with water, thus the gasoline component will separate and float on the surface (e.g., a release from a 30,000-gallon railroad tank car may result in 28,500 gallons of ethanol entering the water and 1,500 gallons of gasoline floating on the water surface).

Fire-Fighting

- Denatured ethanol is highly flammable. However, under fire conditions where foam or water have been applied to the burning fuel, the gasoline tends to burn off first, leaving the less volatile ethanol/water solution, **which might have no visible flame or smoke**.
- Only alcohol-resistant foams are effective in fighting ethanol fires, and foam must be applied gently and often at higher flow rates to successfully extinguish a fire.
- Often, the decision is made to allow the fire to burn and attempt to prevent the fire from spreading to adjacent rail cars, tanks, barges, or structures by application of cooling water.
- Runoff firefighting water should be contained and recovered, because ethanol mixes into the water.
- Ethanol can conduct electricity, so it may present an electrocution or ignition hazard if spilled.

Environmental Behavior

- The behavior of spills to water will vary, depending upon the mixing energy and dilution potential of the receiving water. In fast-flowing and deep waterbodies, expect rapid mixing and dilution, and hence low concentrations; in slow, shallow waterbodies, expect elevated concentrations to persist for days.
- Ethanol does not adsorb to soils very well. If spilled onto soil it will seep into the ground and will be transported with groundwater. It does not sorb well onto carbon, so treatment of contaminated water by filtering with granulated activated carbon is not very effective.
- Ethanol biodegradation rates in soil, groundwater, and surface water have predicted half-lives ranging from 0.1 to 10 days at temperatures >50°F. In colder temperatures, ethanol can persist for several months. Gasoline constituents tend to be more persistent.
- The presence of ethanol in blended fuels can slow the rate of degradation of benzene, toluene, ethyl benzene, and xylenes (BTEX) compounds in the gasoline fraction (the ethanol is preferentially degraded first), which can extend the transport of BTEX in groundwater plumes.

Environmental Effects

- Ethanol is considered to be practically nontoxic, based on acute toxicity tests with aquatic species (most 24-hr LC_{50} >100 mg/L; LC_{50} = concentration that kills 50% of the test animals). However, releases to water can cause fish kills as a result of the high biochemical oxygen demand (BOD), which can lower

noaa

Definition

Properties

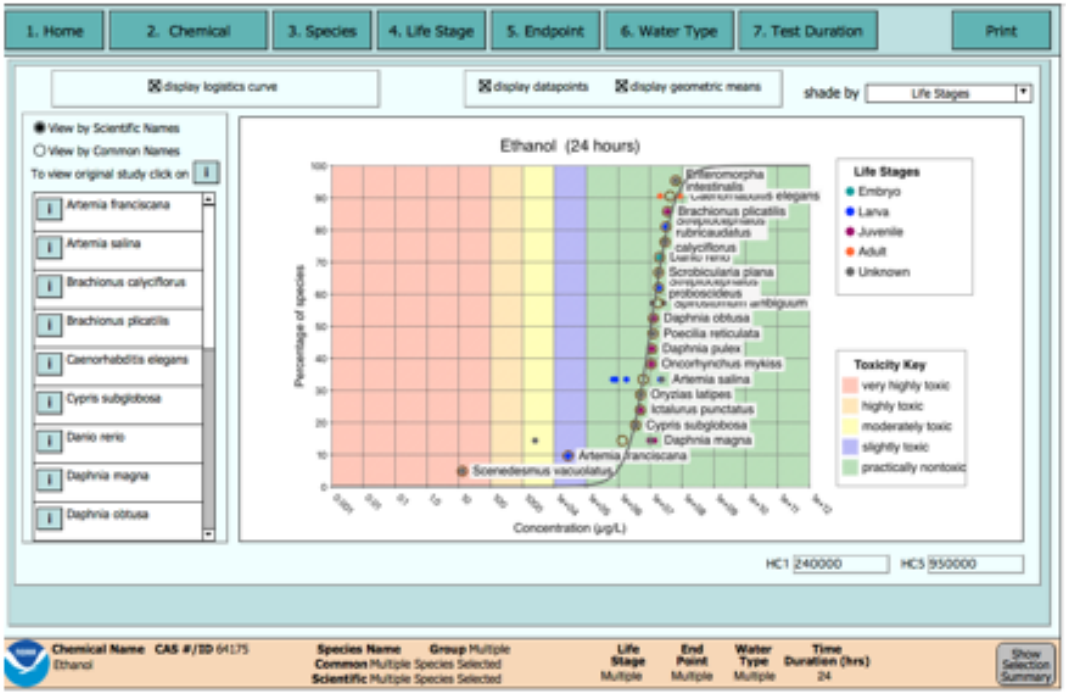
Fire-Fighting

Environmental Behavior

Environmental Effects

dissolved oxygen levels leading to hypoxia. For large spills, the hypoxic plume can travel downstream and kill fish for tens of miles and days after the release.

The figure below shows a plot of the toxicity test results for a wide range of species, indicating that ethanol is practically nontoxic to most aquatic species for exposures of 24 hours. Thus, most effects to aquatic resources are a result of low dissolved oxygen caused by the rapid biodegradation of ethanol.



CAFÉ web link: https://response.restoration.noaa.gov/cafe

Helpful References

Commonwealth of Massachusetts. 2016. Large Volume/High Concentration Ethanol Incident Response Appendix to the Hazardous Material Annex to the Comprehensive Emergency Management Plan. https://www.mass.gov/files/2017-07/statewide-ethanol-appendix.pdf

National Response Team. 2010. National Response Center Quick Reference Guide: Fuel Grade Ethanol Spills (including E85). 2010. 2 pp. https://www.nrt.org/sites/2/files/ETOH-85-Final_Rev00_2010_halfpt%20increase_022610.pdf%20

Shaw. 2011. Large volume ethanol spills - environmental impacts and response options. 72 pp + app. http://www.mass.gov/eopss/docs/dfs/emergencyresponse/special-ops/ethanol-spill-impacts-and-response-7-11.pdf

noaa

CAFÉ - Chemical Aquatic Fate and Effects


EMERGENCY