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.

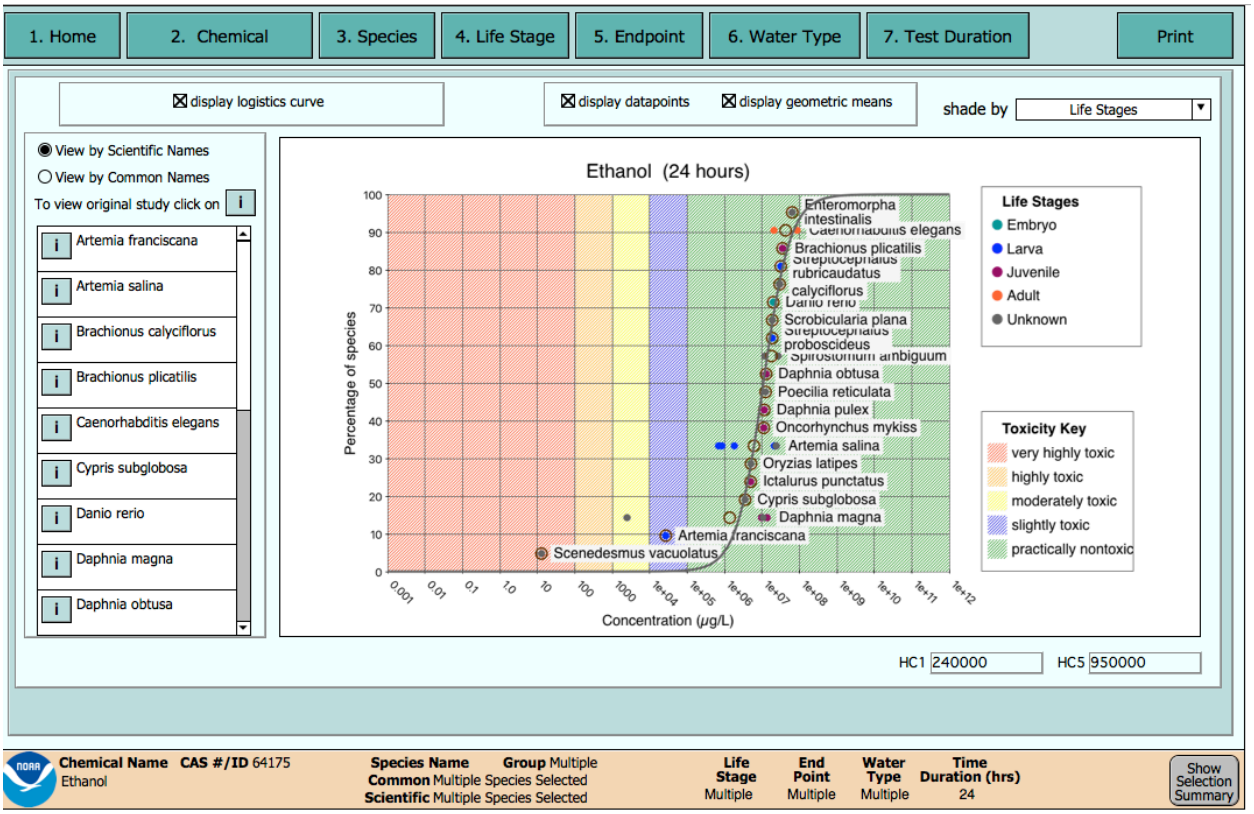
Environmental Behavior

- 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 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 following plot shows 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.



CAFE (Chemical Aquatic Fate and Effects) Database 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

Shaw. 2011. Large volume ethanol spills - environmental impacts and response options. 72 pp + app. https://www.mass.gov/files/documents/2016/09/us/ethanol-spill-impacts-and-response-7-11_44776_56452.pdf