



Module 2: Chemical and Physical Characteristics of Ethanol and Hydrocarbon Fuels

Objective

Upon the successful completion of this module, participants will be able to describe the chemical and physical differences between pure gasoline and gasoline-ethanol blends.

Introduction

This Module will address:

- The characteristics of polar solvents & hydrocarbons, their differences, and how they interact;
- Conditions under which ethanol-blended fuels will retain certain characteristics of conventional types of fuel;
- Facility responsibilities to help emergency responders mitigate various incidents according to conditions found on-site.

Characteristics of Gasoline (Hydrocarbon)

- Similar characteristics whether flammable / combustible liquids
- Produced from crude oil by fractional distillation

Characteristics of Gasoline (Hydrocarbon)

Gasoline's Greatest hazard is flammability:
Fairly narrow range of flammability.

Characteristics of Gasoline (Hydrocarbon)

- Not considered poisonous:
 - Harmful effects after long-term & high-level exposure
 - Can lead to respiratory failure
- Smoke from burning gasoline is thick, black & has toxic components



Characteristics of Ethanol (Polar Solvent)

- Ethanol is a renewable fuel source produced by fermentation & distillation process
- The most common feedstock for this fuel in the U.S. during 2008 was corn
- Ethanol is commonly used as a high-octane racing fuel, e.g.
 - Indy Racing League



Characteristics of Ethanol (Polar Solvent)

- Pure ethanol at ethanol production facilities exhibits the same physical and chemical properties as ethanol intended for use in motor fuels that has been denatured with up to 5% gasoline / similar hydrocarbon for transport
- Denaturant has minimal effects on product handling and performance characteristics.

Characteristics of Ethanol (Polar Solvent)

**Ethanol's Greatest hazard as
motor fuel component is
flammability:**

**Wider flammable range than
gasoline.**

Characteristics of Ethanol (Polar Solvent)

- Ethanol is less toxic than gasoline or methanol
- Carcinogenic compounds are not present in pure ethanol



Characteristics of Ethanol (Polar Solvent)

- In pure form, burning ethanol has no visible smoke & a hard-to-see blue flame
- In denatured (E95) form, a slight orange flame and some smoke may be visible
- Ethanol & some ethanol blends can conduct electricity

Water Solubility

- Gasoline is insoluble in water.
- Ethanol is completely water soluble at any concentration.
 - Large amounts of water are required to dilute ethanol to the point where it no longer support combustion

Chemical Properties Comparison

Gasoline

- Flammable Material
- Motor Fuel
- Hydrocarbon
- Flash Point
 - -55°F
- Boiling Point
 - 100°F & 400°F

Ethanol

- Flammable Material
- Motor Fuel
- Polar Solvent
- Flash Point
 - -5°F
- Boiling Point
 - 173°F

More Important Properties

Gasoline

- Vapor Density 3 & 4:
 - Gasoline vapors seek low levels / remain close to ground level
- Specific Gravity 0.72–0.76:
 - Will float on top of water
- Auto Ignition Temp. 536°F- 853°F

Ethanol

- Vapor Density 1.59:
 - Heavier than air
 - Vapors do not rise
- Specific Gravity 0.79:
 - Lighter than water
 - Thoroughly mix with water
- Auto Ignition Temperature 793°F

Activity 2.1 — Comparison of Gasoline and Ethanol

- Purpose:
 - To allow participants to discuss the differences & similarities in the chemical & physical properties of ethanol & gasoline.

Characteristics of Ethanol-Blended Fuels

- Ethanol increases the heat output of unleaded gasoline:
 - Lower emissions from unburned hydrocarbons
- Minimal amounts of water will draw ethanol out of the gasoline:
 - Ethanol blended fuel is more a suspension than a solution

Characteristics of Ethanol-Blended Fuels

- Gasoline will float on a layer of an ethanol-water solution
 - Resulting ethanol-water solution still flammable



Fuel Blends: Physical & Chemical Changes compared to conventional Fuels

- When foam / water flowed on burning product, gasoline tends to burn off first:
 - May have no visible flame or smoke
- Visually, burning fuel blends with higher ethanol concentrations show:
 - less visible black smoke, and
 - An increasingly faint orange flame

Activity 2.2 — Definitions

- Purpose:
 - To allow participants to demonstrate understanding of definitions applicable to ethanol.

Summary

- Polar solvents are both water-soluble & flammable
- When gasoline is blended with ethanol, the mixture produces a slightly cleaner burn than gasoline alone
- Blend of gasoline & ethanol can easily go unnoticed by emergency responders:
 - Ethanol will be last fuel to burn
 - Ethanol will burn without visible smoke / flame