

Instructor Manual

Module

2

Ethanol and Ethanol-Blended Fuels

Module Objective

Upon the completion of this module, participants should be able to describe the use and growth of ethanol and ethanol-blended fuels in the United States.

Enabling Objectives

1. Describe the differences between gasoline and ethanol-blended gasoline as fuels.
2. List the four most common ethanol-blends.
 - Denatured Fuel Ethanol, 95-98% volume/ 2-5% natural gasoline
 - Ethanol Flex-Fuel, 51-85% volume ethanol
 - E10, 10% volume ethanol/ 90% gasoline
 - E15, 15% volume ethanol/ 85% gasoline

Instructor Note:

Module Time: 30 minutes/ 40 minutes

Materials:

- *Emergency Response Considerations video – (Show the video segment from 0:00 to 4:31)*
- *Responding to Ethanol Incidents video – (Total time 19:20)*

Instructor Note:

Show the video Emergency Response Considerations (0:00 to 4:31).

Introduction

Ethanol, what is the worry?

- On May 14, 2007, a cargo tank truck carrying 8,000 gallons of ethanol overturned and burst into flames on an interstate in Baltimore, Maryland, killing the driver and sending a burning stream of ethanol into the street below, igniting a row of parked vehicles.
 - The following videos in public domain may enhance the presentation of this slide:
 - <https://www.youtube.com/watch?v=F17e1Vjgjr8&feature=youtu.be>
 - https://www.youtube.com/watch?v=LCD_rg3r518&t=41s
- On October 20, 2006, a train carrying eighty-six-cars of ethanol derailed in New Brighton, Pennsylvania, twenty-three cars derailed and approximately twenty of those cars released product. Some of the rail tank cars went into a river while others burst into flames.
- On March 3, 2004, an ethanol bulk storage tank containing approximately 1,850,000 gallons exploded and burned in Port Kembla, New South Wales (NSW), Australia. The explosion blew the roof of the tank 100 feet in the air, landing next to the tank, and damaging firefighting equipment for the whole facility.

*See DOT PHMSA Report of Incidents.

Instructor Note:

- *Ask the participants if they think those will be isolated incidents or if they think the occurrence of such incidents is likely to increase? In other words what is the urgency to learn more about ethanol?*
 - **Answer:** Domestic consumer use of ethanol is likely to increase in the coming years.
- *If you have a large ethanol or ethanol-blended fuel fire in your jurisdiction, do you know the best extinguishing agent and the most effective application techniques?*
- *That is what this course is designed to cover. We want to give you an awareness of the use, transport, storages, and extinguishment of ethanol and ethanol-blended fuel fires.*

The addition of ethanol to gasoline presents some unique firefighting challenges. Traditional methods of firefighting against hydrocarbon (gasoline) fires have been found to be ineffective against these polar solvent-type (ethanol-blended) fuels. While gasoline will tend to float on top of water, ethanol-blended fuels are water miscible and will tend to blend with the water. For this reason, the use of Alcohol-Resistant Aqueous Film-Foaming Foam (AR-AFFF) as a means of extinguishing an ethanol fire is recommended.

Instructor Note:

Show the video Responding to Ethanol Incidents (total time 19:20).

Tell participants that the video focuses on the storage of ethanol and ethanol-blended fuels and the effectiveness of foam on ethanol fires. After the video, ask and discuss the following:

- Are traditional suppression methods for gasoline emergencies effective for ethanol and ethanol-blended fuels?
 - **Answer:** No
- Based on the studies, which foam was the most effective on E10, Ethanol Flex-Fuels and denatured fuel ethanol (E95/ E98)?
 - **Answer:** Alcohol-Resistant Aqueous Film-Forming Foam (AR-AFFF)

Since the beginning of the twentieth century, the United States and the world have become a motorized society. Most families either own an automobile or rely on motorized transportation on a daily basis. For the past 100 years, the primary automotive fuel has been a byproduct of crude oil. Opposite from the European community, who focused on diesel engines for light-duty and passenger vehicles, the United States automobile industry, has predominantly produced gasoline-powered vehicles. The heavy-duty or off-road larger vehicles and equipment are generally being powered by diesel. Both gasoline and diesel are hydrocarbons (composed of hydrogen and carbon) derived from crude oil.

The nature and characteristics of hydrocarbon fuels are familiar to virtually everyone involved in fire protection today since gasoline and diesel are so widely used and incidents are common occurrences. Ethanol-blended fuels are a substantial component of the U.S. motor fuel market. Today, ethanol is blended into nearly all unleaded gasoline and is sold virtually from coast-to-coast and border-to-border. The bio-fuels industry, in general, is expected to significantly contribute to the nation's motor fuel supply. Consumers in the United States use billions of gallons of gasoline per year, and nearly all of that is blended with ethanol.

Ethanol production facilities can be found across the country and commonly use rail to bring their product to market. The transport of ethanol via rail tank cars has increased significantly and is expected to continue to grow.

History of Ethanol-Blended Fuels

Ethanol for use as a transportation fuel has been steadily growing since the 1980s. As production grew, ethanol was added to gasoline supplies to replace the octane enhancer's lead, benzene, toluene, and xylene as they were being removed from the gasoline supply due to toxicity concerns. The Clean Air Act of 1990 further increased the market share for ethanol-blended fuel due to mandated usage of oxygenated fuels in reformulated gasoline (RFG) in certain areas of the United States to help reduce carbon monoxide emissions. RFG refers to extensive changes in gasoline properties that reduce emissions of volatile and toxic organic compounds in ozone non-attainment areas. Fuel oxygenates, such as ethanol, add chemical oxygen to the fuel, which promotes more complete combustion thereby lowering CO emissions. Hydrocarbon exhaust emissions are also often reduced. Today, ethanol is the most widely used oxygenate for RFG.

Ethanol has a blending octane of 113 and is widely used in creating regular octane gasoline from sub-octane base stocks or raising regular octane fuels to the mid-octane level. This addition of ethanol to gasoline to boost octane is an alternative to more severe refining operations making ethanol one of the most cost-effective octane enhancers available to the refiner and blender today.

EPA approved an increased concentration of ethanol, E15, for use in conventional gasoline powered vehicles in 2011. E15 can be used in light duty cars, trucks and SUVs model year 2001 and newer and for use in all flexible fuel vehicles (FFVs). Vehicles older than 2001, small engines, boats and motorcycles were not approved to use E15. Higher ethanol-blended fuels are growing in use. An example of this type of fuel is Ethanol Flex-Fuels (51-85% ethanol by volume).

Common Ethanol Blends and Ethanol-Blended Fuels

“Exx” is commonly used to indicate the ethanol concentration. The “xx” is the percentage by volume of the ethanol in the fuel. Ethanol - 100% volume is produced and marketed as undenatured/ neat, beverage alcohol. Denatured fuel ethanol is ethanol that has been denatured with 2-5% of approved hydrocarbon, typically natural gasoline. This blend is also known as E95-E98 or fuel alcohol. Denatured fuel ethanol is one of the top hazardous materials shipped by rail in the United States.

Ethanol-blended fuels may include blends of gasoline and ethanol in any ratio, presently there are three common ethanol-blended fuels. The most common is E10, which is a blend of 90% gasoline/ 10% ethanol. This is the most common at all retail fueling stations. Currently E15, a blend of 85% gasoline/ 15% ethanol is being marketed and is growing in the marketplace. You will also find Ethanol Flex-Fuels in the marketplace which range from E51-E85, this fuel is sold for use in flexible-fuel vehicles (FFVs) only.

Summary

Ethanol has been a gasoline additive since the 1980s. However, it has been since the mid-2000s that we have seen its use expand dramatically in the United States.

Instructor Note:

Ask the participants:

- *With ethanol-blended fuel use increasing, you can expect to encounter them just about anywhere. What aspect of the use of ethanol-blended fuels might have the most impact on your private life or professional career (i.e., increased production, spill and fire risk, price at the pump, vehicle efficiency, etc.)?*
- *What impacts does increasing ethanol production & use have on transportation?*