

Module

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# Ethanol and Ethanol-Blended Fuels

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## Terminal Objective

Upon the successful completion of this module, participants will be able to describe the use and growth of ethanol in the United States.

## Enabling Objectives

1. Describe the differences between pure gasoline and ethanol-blended gasoline as fuels.
2. List the three most common ethanol blends.

### Instructor Note:

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**Module Time:** 40 minutes

**Materials:** Responding to Ethanol Incidents *video*

# Introduction

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Ethanol, what is the worry?

- On May 14, 2007, a tanker 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.
- On October 22, 2006, an eighty-six-car train carrying ethanol derailed, sending some of the tank cars into a river while others burst into flames.
- On June 19, 2006, five tank cars derailed and leaked approximately 12,000 gallons of ethanol before emergency crews were able to stop the leaks.

## Instructor Note:

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- *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. Federal mandates for renewable fuel consumption, including ethanol, have increased from 4.3 billion gallons in 2007, to 9 billion in 2008, and up to 36 billion gallons in the year 2022.*
- *If you have a large ethanol-fuel blend 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, storage, and extinguishment of ethanol and ethanol-fuel blend fires.*

Ethanol and ethanol-blended fuels are in use in growing quantities in the United States, and volumes have become substantial. Consumers in the United States use more than 140 billion gallons of gasoline per year. Today, there are more than 8 billion gallons of fuel ethanol produced in the United States.

The addition of ethanol to gasoline presents some unique fire fighting challenges. Traditional methods of fire fighting 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 fuels are water soluble and will tend to blend with the water. For this reason, the use of Alcohol-Resistant (AR) foam as a means of extinguishing an ethanol fire is recommended.

**Instructor Note:**

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Show the video *Responding to Ethanol Incidents (total time 19:20)*. This video was produced by the *Ethanol Emergency Response Coalition (EERC)*.

**Source:** EERC. (2007). *Responding to Ethanol Incidents [Video]*.

Tell participants that the video focuses on the storage of ethanol and ethanol-fuel blends 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 blends?  
— **Answer:** No
- Based on the studies, which foam was the most effective on both E-10 and E-85/95?  
— **Answer:** Alcohol-Resistant Aqueous Film-Forming Foam (AR-AFFF)

Since the beginning of the twentieth century, the United States and the world has 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, a limited natural resource. 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 power plants. 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. However, as a result of public policy toward foreign oil supplies and other mandates, ethanol-blended fuels are becoming a substantial component of the U.S. motor fuel market. Today, ethanol is blended into nearly 50 percent of the nation's fuel and is sold virtually from coast-to-coast and border-to-border.

As of the beginning of 2007, the domestic U.S. ethanol industry consisted of over 100 bio-refineries, located in 21 different states, with the capacity to produce more than 6 billion gallons of this motor fuel. Fuel ethanol inherently burns with less visible smoke than gasoline. The bio-fuels industry, in general, is expected to significantly contribute to the nation's motor fuel supply.

The ethanol industry has been growing rapidly. According to the American Petroleum Institute (API), in 2006 the growth of the

transportation fuels marketplace was equivalent to the capacity expansion realized in the ethanol industry. In early 2008, there are reportedly seventy-eight bio-refineries under construction. With seven existing bio-refineries expanding, the industry projected more than 6 billion gallons of new production capacity to be in operation by the end of 2009, more than doubling production capacity in under three years. Some predict that similar growth will continue into future years.

Consumers in the United States use more than 140 billion gallons of gasoline per year, and already most of that is blended with ethanol. This course will address the needs of emergency responders when faced with incidents involving ethanol and ethanol-blended fuels.

## History of Ethanol-Blended Fuels

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Ethanol has been a gasoline additive since the late 1970s. As of 2007, the United States fuel-grade ethanol production capacity has grown to over 6 billion gallons. Until the late 1980s ethanol's primary role in the fuels market was that of an octane enhancer, and it was viewed as an environmentally sound alternative to the use of lead in gasoline. With its 112.5 blending octane value, ethanol remains an effective octane enhancer for the refiner or fuel blender.

In the late 1980s some states began to use ethanol and other oxygenates in mandatory oxygenated fuel programs to reduce automobile tailpipe emissions of carbon monoxide (CO). 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 used to meet the oxygen requirement for Reformulated Gasoline (RFG). This is largely due to the fact that use of the other oxygenate in the program, methyl tertiary butyl ether (MTBE), has been banned in nearly all states.

## Common Ethanol-Blended Fuel Mixtures

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Ethanol-blended fuels may include blends of gasoline and ethanol in any ratio, but at present there are three common ethanol-blended fuels. Most common is E-10, a 90 percent gasoline/10 percent ethanol blend, which may be labeled as RFG or oxygenated gasoline. Also common is E-95 ethanol that has been denatured with 5 percent unleaded gasoline, the volume of which during 2007 was over 6 billion gallons. Finally, E-85 (85 percent fuel ethanol and 15 percent gasoline) is sold into a developing market as a retail blend for Flexible-Fuel Vehicles (FFV) only.

While ethanol has been consistently blended at the 5.7 percent and 7.7 percent level in California, it is more frequently blended at the 10 percent level by volume across the United States. With a requirement to replace the octane improvement lost by state bans on MTBE, the demand for ethanol has increased dramatically.

## Summary

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### Instructor Note:

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*Ask the participants:*

- *With mixed blended fuel use increasing, you can expect to encounter them just about anywhere. What aspect of the use of 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 additional alternative fuels besides ethanol and other bio-fuels are being considered to supply energy to the United States consumer (e.g., hydroelectric, wind, solar, nuclear, etc.)?*

Ethanol has been in use since the early 1970s. However, it has been since the year 2000 that we have seen its use expand dramatically in the United States, largely due to demands for cleaner air combined with state bans on MTBE since March of 1999 in California. The increase in transportation fuel consumption since 2006 has been fully met through growth in ethanol production.