Guidebook for Handling, Storing, & Dispensing Fuel Ethanol

Prepared for the
U.S. Department of Energy
by the Center for Transportation Research
Energy Systems Division
Argonne National Laboratory

National Ethanol 85 Vehicle Coalition

Alternative-Fuel Vehicles Made for Tomorrow, Today

FOREWORD

This guidebook is intended as firsthand information for fuel distributors and retailers who have not had any experience or formal training with ethanol fuels. The first three chapters contain information about government regulations, ethanol-fueled vehicles, and fuel standards, which may also be useful to fleet managers and ethanol fuel users. The rest of the handbook addresses material recommendations, parts and equipment, and handling and delivery of ethanol fuel.

This guidebook has been reviewed by selected representatives of vehicle manufacturers, fuel providers, fleet operators, and Federal and state governments, as well as a technical review committee.

Argonne National Laboratory is operated by the University of Chicago as part of the
U.S. Department of Energy National Laboratory System under contract No. W-31-109-ENG-38.

Produced in cooperation with the National Ethanol Vehicle Coalition, which is jointly supported by the Governors' Ethanol Coalition and the National Corn Growers Association and its affiliated state corn associations.

Publishing support services provided by Information and Publishing Division,
Argonne National Laboratory

TABLE OF CONTENTS

WHY FUEL ETHANOL?

Concern about our country's dependence on foreign petroleum and about the environment has led to development of alternative fuels in the transportation sector. By switching to these new fuels and vehicle technologies, fleet owners are leading the way to energy security and cleaner air. Alcohol fuels* and, in particular, fuels of ethyl alcohol (also known as ethanol) blended with gasoline are well-suited for replacing gasoline in light-duty vehicles and diesel fuel in trucks and buses. The other fuel alcohol commercially available today is methanol. Although it sounds similar to ethanol, it is derived from different sources, its properties are quite different, and it cannot be used in place of ethanol.

Currently, a small amount of ethanol (10% by volume) is added to gasoline to increase the octane rating and to provide oxygen to decrease tail-pipe emissions of carbon monoxide (CO); the resulting fuel blend, called gasohol by the public and E10 by the industry in the United States, is a widely accepted vehicle fuel. New vehicle technologies have been developed that can use blends having higher concentrations of ethanol in gasoline as fuels while achieving reliable, low-emission operation. The new flexible-fuel vehicles operate on blends of up to 85% ethanol (known as E85). The gasoline in E85 makes the vehicle easier to start in cold weather and increases the vehicle's range.

Specifications, technical standards, handling procedures, and refueling equipment for fuel ethanol have been developing at a rapid pace. Because of the limited experience with ethanol blends as fuels, research and data collection from vehicles in the field will be continuing for some time. Fuel distributors and fuel producers, as well as managers responsible for operating these new fleets of ethanol-powered vehicles, need practical information to successfully use this renewable alternative fuel.

This guidebook provides accurate and up-to-date information — based on proven practices developed by experienced fuel providers, fleet managers, and vehicle manufacturers — for successfully using fuel ethanol in vehicles. Safe and environmentally responsible working procedures and simple tests to assess fuel quality in the field are presented.

In the near future, as market conditions demand, vehicles in the field may need to operate on blends having ethanol concentrations different from E85. No matter what the blend, the basic practices for handling and using fuel ethanol remain the same — you can apply the information presented in this guidebook to all expected new blends.

---

* Alcohol fuel blends are designated by E for ethanol or M for methanol, followed by a number representing the percentage of alcohol (by volume) in the blend. The ethanol used in fuel blends is denatured and can contain up to 5% hydrocarbons (gasoline or gasoline-like additives) before blending. Additional gasoline is added to the ethanol to make up the desired percentage in the blend. The fuel E10, or "gasohol," is 10% denatured ethanol blended with 90% gasoline; E85, commonly called fuel ethanol, is 70-85% denatured ethanol blended with 30-15% hydrocarbons; and E100 is 100% denatured ethanol.

ENERGY POLICY ACT OF 1992

The Energy Policy Act of 1992 (EPACT) addresses the energy challenges facing our country as we approach the next century, including lessening our dependence on foreign oil. Under this law, the Secretary of Energy is required to ". . . ensure the availability of those replacement fuels that will have the greatest impact in reducing oil imports, improving the health of our Nation's economy, and reducing greenhouse gas emissions."

According to EPACT, alternative fuels include ethanol, methanol, and other alcohols; mixtures containing 85% or more by volume of methanol, ethanol, or other alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; coal-derived liquid fuels; hydrogen; fuels (other than alcohols) derived from biological materials; electricity; and any other fuel the Secretary of Energy determines is substantially not petroleum.

EPACT established the purchase requirements for alternative-fueled vehicles (AFVs) for Federal, state government, and fuel-provider fleets. If the Secretary of Energy determines that EPACT goals will not be met with only the above requirements, municipal and private sector fleets may be required to purchase AFVs. Also established were tax incentives for purchasing AFVs, for converting gasoline vehicles to operate on alternative fuels, and for installing refueling or recharging facilities. Other state and local financial incentive programs may be available in your area. For up-to-date information on these programs or on funding, financing, and incentives, contact the U.S. Department of Energy (DOE) National Alternative Fuels Hotline at 800-423-1DOE, the DOE Alternative Fuels Data Center Internet home page at http://www.afdc.doe.gov, or your state energy office.

ALCOHOL-FUELED VEHICLES

To safely and effectively operate your alcohol-fueled fleet, the vehicles need to be compatible with alcohol use. Aftermarket conversion of gasoline-powered vehicles to alcohol-fueled vehicles, although possible, is not recommended because of the changes in component materials necessary, the high cost, and the need for extensive engine recalibration. In addition, the lack of widespread refueling facilities makes operating vehicles dedicated to alcohol fuel impractical.

To resolve refueling infrastructure problems, automakers have developed vehicles, called flexible-fuel vehicles (FFVs), that can operate on alcohol, gasoline, or any blend of these fuels up to 85% alcohol (dedicated to either methanol blends or denatured ethanol blends). These vehicles are designed to use a specific alcohol fuel, either methanol or denatured ethanol, and only the alcohol fuel the vehicle is designed for can be used. Use of methanol in an ethanol vehicle, and vice-versa, will result in improper vehicle operation and could cause failure of fuel system components. Flexible-fuel vehicles manufactured by Ford are available now in the marketplace. These vehicles are fully warranted. You may take advantage of government incentives and credits if you purchase FFVs. Contact the DOE National Alternative Fuels Hotline (800-423-1DOE), or your automobile dealer for an up-to-date list of available vehicles. More information about FFVs can be found on the DOE Alternative Fuels Data Center Internet home page at http://www.afdc.doe.gov or by calling the E85 hotline (800-E85-8895).

Ethanol FFVs are similar to gasoline vehicles. The main changes are new materials in the fuel management system and special engine calibration. In addition, FFVs require special lubricating oils and fuel filters.

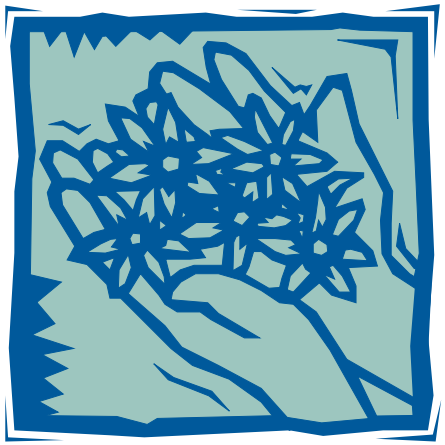
Flexible-fuel vehicles are fueled by pumping the fuel from a storage tank through a dispenser and hose, just like gasoline-powered vehicles. Differences in the fueling installations are discussed later in this guidebook (see ***Materials Recommendations, Fuel Storage & Dispensing,*** and ***Fuel Transport & Delivery***). Although the alcohol content of the blend while it is in the storage tank may be specified, the alcohol content of the fuel after it has been dispensed to the vehicle may be different because of mixing with any existing fuel in the vehicle's tank.

Always follow the recommendations of the manufacturer for maintenance, lubricants, and replacement parts for the vehicle. Training on alcohol-fueled vehicles is helpful for a fleet's mechanics, but if the specified parts and lubricants are used, routine maintenance can easily be performed.

PRODUCTION, PROPERTIES, & ENVIRONMENTAL IMPACTS

Production

Ethanol is also known as ethyl alcohol or grain alcohol. Like gasoline, ethanol contains hydrogen and carbon, but ethanol also contains oxygen in its chemical structure. The oxygen makes ethanol a cleaner burning fuel than gasoline. It can be produced chemically from ethylene or biologically from grains, agricultural wastes, or any material containing starch or sugar. Because ethanol can be produced from crops, it is classified as a renewable fuel. Today's ethanol is produced in the United States mainly from corn grown in the Midwest. One bushel of corn (approximately 56 pounds) produces 2.5 gallons of ethanol.* Because the gasoline or additives in an ethanol blend make the ethanol "denatured" (unfit to drink), blends are exempt from Federal liquor taxes.



It is a common misconception that ethanol production consumes as much energy as the ethanol may offer. Recent research has shown that producing ethanol from corn creates 24% more energy than the production process uses. Due to the abundance of natural gas, propane, and coal, ethanol produced from these feedstocks has the potential to replace a significant amount of petroleum imports.

Physical Properties

Properties of E85 are listed in *Table 1*. Ethanol is a flammable, colorless liquid (E100 is clear like water) with a faint alcohol odor, but ethanol fuel blends have a color that depends on the color of the gasoline in the blend and have a gasoline-like odor. One gallon of E85 provides as much energy as 0.72 gallon of gasoline. A comparison of the properties of E85 to those of methanol, ethanol, and gasoline is found in ***Appendix A*** of this guidebook.

Emissions

One of the benefits of using AFVs is a reduction in the emission of pollutants into the air we breathe. In general, the type of emissions from vehicles using E85 will be similar to that from gasoline-powered vehicles, but the amount of emissions will be less. The quantity of pollutants released depends on how well the vehicle's emissions control system captures and burns emissions and how well the engine is designed and "tuned" for using fuel ethanol. The emissions control systems found on ethanol-powered vehicles manufactured today have been engineered to meet or exceed all Federal and state emissions control regulations.

MORE

* In addition to the ethanol, one bushel of corn produces 12.4 lb of 21% protein feed, 3 lb of 60% gluten meal, 1.5 lb of corn oil, and 17.0 lb of carbon dioxide (for carbonated soft drinks).

Two types of emissions are released by AFVs: exhaust and evaporative. Although compliance with Federal and state regulations has already resulted in a decrease in exhaust emissions from gasoline-powered vehicles, ethanol-fueled vehicles can further reduce pollution from emissions by a modest, but meaningful, amount. Compared with gasoline-fueled vehicles, most ethanol-fueled vehicles produce lower carbon monoxide (CO) and carbon dioxide (CO_2) emissions and the same or lower levels of hydrocarbon (HC) and nonmethane hydrocarbon (NMHC) emissions; nitrogen oxides (NO_X) emissions are about the same or even less. In recent tests, 1996 model Ford Taurus FFVs emitted 50% less NMHC and 35% less CO when running with E85 than when running with reformulated gasoline (RFG). No change was reported for NO_X. In addition, once at operating temperature, the catalytic converter in an ethanol-fueled vehicle is very efficient at breaking down aldehydes into less harmful chemicals. (Aldehydes are chemical compounds associated with incomplete combustion of alcohol that are suspected of being carcinogenic).

Emissions resulting from fuel evaporation are a potential problem for any vehicle, regardless of the fuel. More emissions can leak from a vehicle when it is sitting than when it is operating! The built-up heat in the engine compartment, and sometimes even the heat reflected from the pavement onto the fuel tank, can cause the most volatile parts of the fuel to boil off and leak into the air, causing pollution. E85 has fewer highly volatile components than gasoline and so has fewer emissions resulting from evaporation. Ethanol's low volatility means that it needs help in igniting at low temperatures — that's why gasoline and other hydrocarbons are added to the fuel. Without hydrocarbons in the blend, an ethanol-fueled vehicle may be hard to start when the engine is cold, especially in wintertime.

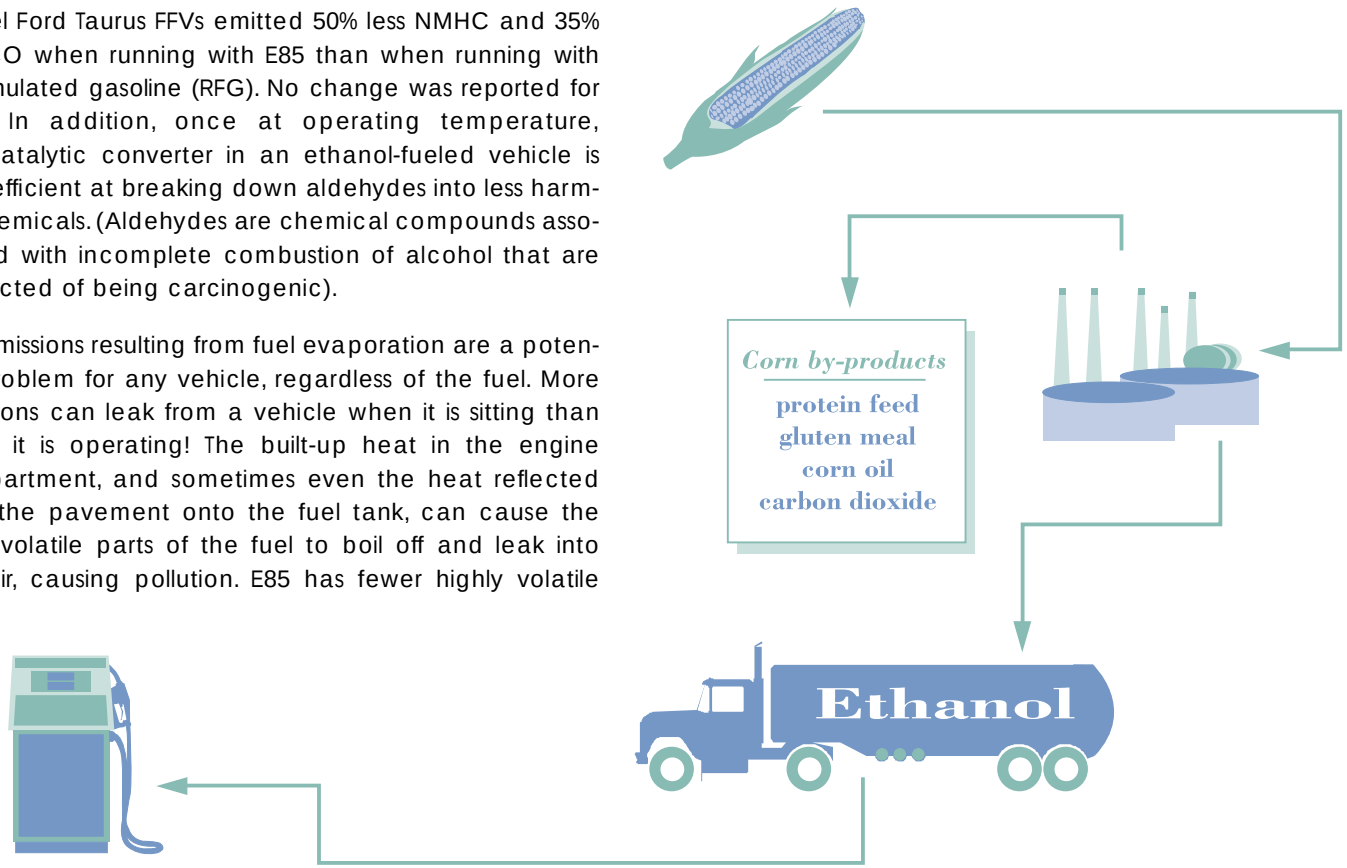


TABLE 1 PROPERTIES OF FUEL ETHANOL

Property	*Comment*
Vapor density	Ethanol vapor, like gasoline vapor, is denser than air and tends to settle in low areas. However, ethanol vapor disperses rapidly.
Solubility in water	Fuel ethanol will mix with water, but at high enough concentrations of water, the ethanol will separate from the gasoline.
Energy content	For identical volumes, ethanol contains less energy than gasoline. On an energy basis, 1.0 gallon of E85 is equivalent to 0.72 gallon of gasoline.
Flame visibility	A fuel ethanol flame is less bright than a gasoline flame but is easily visible in daylight.
Specific gravity	Pure ethanol and ethanol blends are heavier than gasoline.
Conductivity	Ethanol and ethanol blends conduct electricity. Gasoline, by contrast, is an electrical insulator.
Stoichiometric fuel-to-air ratio	E85 needs more fuel per pound of air than gasoline; therefore, E85 cannot be used in a conventional vehicle.
Toxicity	Ethanol is less toxic than gasoline or methanol. Carcinogenic compounds are not present in pure ethanol; however, because gasoline is used in the blend, E85 is considered to be potentially carcinogenic.
Flammability	At low temperature (32˚F), E85 vapor is more flammable than gasoline vapor. However at normal temperatures, E85 vapor is less flammable than gasoline, because of the higher autoignition temperature of E85.

E85 FUEL SPECIFICATIONS & STANDARDS

Alcohols are more corrosive than gasoline because they are electrically conductive and may contain corrosive impurities. Alcohols may degrade materials that are commonly used with gasoline or diesel fuel. You can reduce the chance for failure or contamination of alcohol equipment and systems by selecting proper materials and by controlling fuel composition. The American Society for Testing and Materials (ASTM) and the American Automobile Manufacturers Association (AAMA) have established standards for E85. While the two standards are similar, only the ASTM standard (*Table 2*) is discussed in this section. For your information, a copy of the AAMA specification appears in ***Appendix B***.

ASTM Fuel Standard Specification (ASTM D 5798)

The ASTM standard specification for fuel ethanol, designated ASTM E_d75-E_d85 (where d stands for denatured), covers fuel blends for different seasons and geographical areas. These specifications, shown in *Table 2,* represent the minimum commercial standards and reflect the consensus of many stakeholders. The ethanol and hydrocarbon denaturant used in making fuel ethanol must meet the requirements of ASTM D 4806.

Seasonally Adjusted Blend

The amount of alcohol in the fuel ethanol blend depends on the geographical fuel-marketing region and the season. (A complete breakdown by volatility class for the geographical fuel regions can be found in ***Appendix C***.) In cold weather, more gasoline is added to the blend to avoid starting problems. A minimum of 70% by volume of alcohol is permitted in the winter blend by the ASTM fuel standard.

Hydrocarbons

The hydrocarbon(s) blended into the fuel ethanol must comply with several of the same standards as gasoline. The hydrocarbon may contain ethyl tertiary butylether (ETBE), methyl tertiary butyl ether (MTBE), or other aliphatic ethers as blending components, as is customary for automobile spark-ignition-engine fuel. Natural gasoline, commonly used as the denaturant of fuel ethanol, is an excellent blend stock for the hydrocarbon portion of E85.

Fuel Additives

Commercial gasoline contains additives, detergents, and inhibitors, as well as hydrocarbons. Federal law requires that the hydrocarbon portion of E85 contain detergent additives. After blending the gasoline with denatured alcohol to make E85, any additives that were in the gasoline are now in the E85 (although at reduced levels). In some states in the United States, certain detergents used in commercial gasoline, such as

polyisobutylene amine, have performed poorly in FFV operation. If these additives get into the fuel ethanol, precipitation and deposition in the FFV's fuel system may result. The best way to avoid this problem is to use natural gasoline in the E85 blend, if it is available in your area.

TABLE 2 ASTM D 5798 STANDARD SPECIFICATION FOR FUEL ETHANOL (E_d75-E_d85) FOR AUTOMOTIVE SPARK-IGNITION ENGINES

Property	Value for Class			Test Method
ASTM volatility class	1	2	3	N/A
Ethanol, plus higher alcohols (minimum, volume %)	79	74	70	ASTM D 5501
Hydrocarbons (including denaturant)/(volume %)	17-21	17-26	17-30	ASTM D 4815
Vapor pressure at 37.8°C				
kPa	38-59	48-65	66-83	ASTM D 4953, D 5190, D 5191
psi	5.5-8.5	7.0-9.5	9.5-12.0	
Lead (maximum, mg/L)	2.6	2.6	3.9	ASTM D 5059
Phosphorus (maximum, mg/L)	0.3	0.3	0.4	ASTM D 3231
Sulfur (maximum, mg/kg)	210	260	300	ASTM D 3120, D 1266, D 2622
Methanol (maximum, volume %)	0.5			N/A
Higher aliphatic alcohols, C3-C8 (maximum, volume %)	2			N/A
Water (maximum, mass %)	1.0			ASTM E 203
Acidity as acetic acid (maximum, mg/kg)	50			ASTM D 1613
Inorganic chloride (maximum, mg/kg)	1			ASTM D 512, D7988
Total chlorine as chlorides (maximum, mg/kg)	2			ASTM D 4929
Gum, unwashed (maximum, mg/100 mL)	20			ASTM D 381
Gum, solvent-washed (maximum, mg/100 mL)	5.0			ASTM D 381
Copper (maximum, mg/L)	0.07			ASTM D 1688
Appearance	Product shall be visibly free of suspended or precipitated contaminants (shall be clear and bright).			Appearance determined at ambient temperature or 21°C (70°F), whichever is higher.

N/A = Not applicable.

E85 QUALITY ASSURANCE

Once your E85 refueling station has been installed, taking simple operational precautions can assure fuel quality. A periodic check of fuel properties will avoid costly damage to vehicles operating with E85. Some of these checks may be performed in the field, but others may require the services of a specialized laboratory. A list of some of these laboratories may be obtained by calling the U.S DOE National Alternative Fuels Hotline (800-423-1DOE).

For a new fuel station, the following properties of E85, at a minimum, should be checked within a few days of the start of operation:

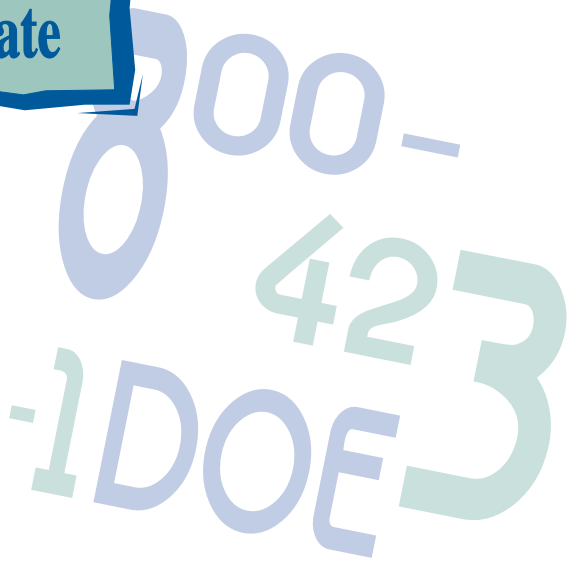
- ✓ Conductivity (see ***Electrical Conductivity*** on page 16),
- ✓ Unwashed gum content,
- ✓ Water content, and
- ✓ Particulate content.

After the refueling station has reached normal operation, test the fuel periodically. At a minimum, the following items should be checked every 1-2 months, depending on how frequently the station is used. Also, any time you suspect your fuel is contaminated, check these properties:

- ✓ Hydrocarbon content (see ***Hydrocarbon Content of the Fuel Ethanol*** on page 16),
- ✓ Reid vapor pressure,
- ✓ Water content, and
- ✓ Acidity.

Because it is possible to perform the conductivity test and the test for hydrocarbon content in the field, these tests should be performed more often. More details about these tests may be found in ***Handling Fuel Ethanol*** (page 15).

If you need to send a fuel sample to a laboratory, you will find information on shipping procedures in ***Appendix D***; always remember to follow the shipper's requirements for packaging hazardous materials.



MATERIALS RECOMMENDATIONS

Fuel ethanol, like other liquid fuels, is very easy to contaminate. Certain materials commonly used with gasoline are totally incompatible with alcohols. When these materials come in contact with ethanol, they may dissolve in the fuel and damage engine parts, possibly causing breakdown of the vehicle. Even if parts do not fail, running an ethanol-fueled vehicle with contaminated fuel may cause deposits that could eventually harm the engine. The materials and parts presented in this guidebook have been shown to perform well with E85.

The supplier providing your equipment and the contractor installing it are responsible for using components compatible with E85 in your system, but you should be aware of materials-compatibility issues in case of problems with your customers' vehicles.

The AAMA has identified materials and equipment that are compatible with E85. Compatibility with E85 means not only that equipment made from a material will not deteriorate, but also that the quality of the E85 in contact with that material will not degrade. The AAMA recommends that the integrity of all components coming into contact with the fuel be verified by soak testing. Before and after soak testing the equipment, you should determine the electrical conductivity, chemical stability, and filter-plugging tendencies (presence of particulates and unwashed gum) of the soak test fuel. In addition, the AAMA recommends that, when constructing the dispensing site, dissimilar metals that come in contact with the fuel should not be coupled. (Dissimilar metals are those that are separated widely in the galvanic series.)

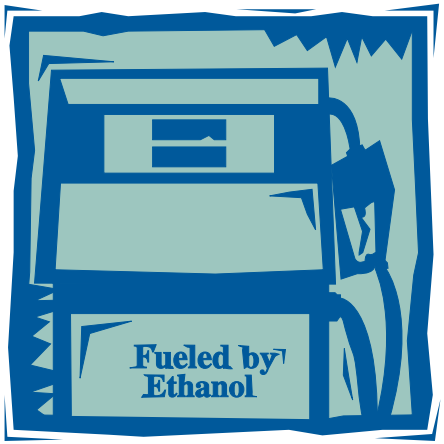
The following sections describe parts and equipment that are compatible with fuel ethanol. They should be available from your usual supplier. (Reference to specific products is for your convenience and does not constitute endorsement by the U.S. Government.)

Some materials are known to become degraded by contact with fuel ethanol blends having high alcohol concentrations. Zinc, brass, lead, and aluminum are some of these sensitive metals. Terne (lead-tin-alloy)-plated steel, which is commonly used for gasoline fuel tanks, and lead-based solder are also incompatible with fuel ethanol. Avoid using these metals because of the possibility of vehicle failure or fuel contamination. Unplated steel, stainless steel, black iron, and bronze have shown acceptable resistance to corrosion by ethanol.

Nonmetallic materials that degrade when in contact with fuel ethanol include natural rubber, polyurethane, cork gasket material, leather, polyester-bonded fiberglass laminate, polyvinyl chloride (PVC), polyamides, and methyl-methacrylate plastics. Nonmetallic materials that have been successfully used with fuel ethanol include Buna-N, Neoprene rubber, polyethylene, nylon, polypropylene, nitrile, Viton, and Teflon.

FUEL STORAGE & DISPENSING

The technology for storing and dispensing gasoline can be applied to alcohol fuels because alcohols and alcohol blends, like gasoline, are liquid under the pressures and temperatures usually encountered. However, only E85-compatible materials should be used. Most operating problems with ethanol-fueled vehicles have been traced to contaminated fuel. Consequently, choosing the right materials for fuel storage and dispensing systems and following proper fuel-handling procedures are crucial for successful operation of ethanol-fueled vehicles. Although research and testing of materials is expected to continue, the parts and materials discussed here have performed well with E85. They can be obtained from your usual supplier. (Reference to specific products is for your convenience and does not constitute endorsement by the U.S. Government.)



E85 can be stored in aboveground or underground installations. Both systems are safe and practical. Factors like the size of the tank, the space available, requirements for stationary evaporative emissions, and local safety codes will determine which type of installation is best for your fleet.

Important! Before planning any fuel-storage system, check your local building and fire codes. Fuel ethanol falls under the same handling and storage requirements as gasoline within the provisions of National Fire Protection Agency (NFPA) Standards 30 and 30A (see ***Safety Codes*** on page 18).

General Dispensing Equipment

Dispenser hoses, nozzles, and fitting connectors are the same for aboveground and underground fuel-storage systems. The items common to both systems are discussed in this section. Parts that differ for aboveground and underground installations are discussed in the specific sections that follow. Again, your supplier can help you obtain E85-compatible parts and equipment.

Avoid any components made from zinc, brass, lead, aluminum, or other soft metals; the ethanol fuel may cause leaching from such soft metals, contaminating the vehicle's fuel system and potentially resulting in poor vehicle performance.

In-Line Filters. A one-micron, in-line filter is recommended for fuel ethanol dispensing equipment. This size filter will trap most of the debris and impurities that might be present in the storage tank and prevent them from being transferred to the vehicle during refueling. The CUNO model 1B2 filter or the Cim-Tek filter have performed well in fuel ethanol installations.

Dispenser Hoses. The type of hose used for dispensing E85 depends on the type of vapor recovery in your system. For a Stage II vapor-recovery system, a Goodyear Maxxim coaxial hose with stainless steel fittings has performed well. For a system without Stage II vapor recovery, the Goodall Kem Flexpart No. N2494 with stainless steel end fittings has been successfully used.

New research has shown that hoses with nylon inner liners, especially the Goodyear Nylon Veneer 11, perform better than Maxxim coaxial hose. However, at the time of publication of this guidebook, hoses made from Nylon Veneer 11 are still considered experimental.

When you are specifying materials for your refueling facility, contact equipment vendors for the latest information and use the components with the highest resistance to deterioration from continuous contact with fuel alcohols. In some cases, equipment specified for use with fuel methanol will be available. ***Because fuel methanol is even more corrosive than fuel ethanol, components and materials certified for fuel methanol use will almost always be acceptable for fuel ethanol use.*** If you have a choice of materials, select the ones certified by the manufacturer for fuel methanol to provide an extra measure of insurance against materials compatibility problems.

Nozzles. Aluminum nozzles should not be used with E85, and nozzles made from any aluminum alloy must be used with caution. A nickel-plated nozzle is the best choice; OPW No. 11AP-0492 or Emco Wheathon No. A2000-451 models will work well.

Fittings and Connectors. All fittings, connectors, and adapters that will be in contact with the fuel blend should be made of materials like stainless steel (best choice), black iron, or bronze to avoid degradation. If aluminum or brass fittings are used, they must be nickel-plated to avoid any contact of the bare metal with fuel ethanol.

Piping. The best choice for piping is inexpensive schedule 40 black iron pipe. If secondary piping is needed, polyethylene pipe (such as the Total Containment brand) should be used. Do not use conventional zinc-plated steel piping for fuel ethanol. Galvanized pipe may be used. Pipe thread sealant, when needed, must be Teflon tape or Teflon-based pipe-thread compound.

Aboveground Fuel-Storage Systems

Tanks. Several companies manufacture tanks for E85 storage. ConVault, U-Fuel, and Hallmark are the most commonly mentioned manufacturers. Typical capacities are 1000 or 2000 gallons. Tanks should be constructed of cold-finished steel and butt-welded. Do not use any plated metal tanks.

Dispensers. The Tokheim dispenser model No. 785 RC or No. 7552 (with a No. 898 piston-type meter) and two different-sized dispensers produced by Gasboy, model numbers 9152 (1/3 hp) and 9153 (3/4 hp), are some of the dispensers that have been successfully used. The dispenser must use iron unplated steel or stainless steel in the fuel path. In the case of vane-type pumps, avoid impellers made from soft metals (zinc, brass, lead, aluminum, etc.). Steel or an engineering polymer having high chemical resistance (like Torlon) will give excellent results.

Underground Fuel-Storage Systems

Tanks. Double-walled, low-carbon, cold-finished steel tanks will be serviceable, but butt-welded tanks are preferable. Do not use plated-metal tanks. Fiberglass tanks can be used, but they should be lined with chemical-grade rubber to prevent the fuel from contacting the fiberglass.

Dispensers. The Tokheim dispenser model No. 785 RC or No. 7552 (with a No. 898 piston-type meter) and two different-sized dispensers produced by Gasboy, model numbers 9152 (1/3 hp) and 9153 (3/4 hp), are some of the dispensers that have been successfully used. The dispenser must use iron, unplated steel, or stainless steel in the fuel path.

FUEL TRANSPORT & DELIVERY

Today fuel ethanol is transported by truck from the producer or distributor to the refueling facility. Ethanol/gasoline blends cannot use existing petroleum pipeline systems because of possible contamination by water and residues from other petroleum products or incompatibility with the system due to the corrosive properties of alcohols.

The fuel provider should blend the fuel ethanol as E85 before distribution, either in the terminal tank or on the transport truck. Sometimes the fuel is transported as E100 and "splash" blended with local gasoline after delivery. This method is not recommended; however, if you must splash blend in your area, pour the ethanol into the gasoline for more uniform blending of the two components.

Although transport and delivery of fuel are responsibilities of the fuel provider, fuel retailers need to be aware of normal operating procedures to avoid fuel contamination or unsafe performance by the fuel provider.

To avoid contamination during transport, the fuel provider should use a dedicated ethanol container, tank, or truck constructed only of E85-compatible materials. If a dedicated ethanol tank is not available, a tank that has been used only for gasoline transport may be used. Avoid using tanks that have contained other types of fuels. If you must use a tank that was not dedicated to ethanol or gasoline transport, before loading the fuel ethanol, wash the tank with solvent and allow it to air dry. If the solvent-washed tank is steam-dried, condensate will contaminate the fuel ethanol. Since transport trucks deliver from the bottom of the tanker compartment, any accumulated water or contaminants will be dispensed into the storage tank.

HANDLING FUEL ETHANOL

Up to this point, you have been told what your equipment supplier should do to make your installation compatible with alcohol fuels and what your fuel provider should do to deliver uncontaminated fuel ethanol. Now it's time to explain how you should handle E85 to keep your customers' vehicles operating properly and safely.

As with any other fuel, common sense should govern handling of fuel ethanol. The procedures are similar to those for handling gasoline. Following the recommendations below at your installation should keep your employees and customers safe, prevent contamination of the fuel, and protect your equipment from degradation.

✓ Avoid skin or vapor contact with E85. If you are handling E85, always wear ethanol-resistant gloves (such as nitrile gloves). In the event of contact, seek medical help (also see ***Safety Procedures*** on page 17).

✓ Use only equipment that is recommended for use with ethanol. Do not use parts or equipment for handling and dispensing E85 fuel that are designed for use with other fuels (see pages 11-13).

✓ Be sure that the fuel ethanol is transported and delivered to you in an ethanol-compatible, dedicated tank; in a gasoline tank; or, if necessary, in a tank that has been cleaned by following the recommendations on page 14.

✓ Do not reuse cans or barrels that have contained other fuels to store or transport fuel ethanol. Other fuels can leave residues that may contaminate E85. New containers are always preferable. Dedicate them to fuel ethanol use!

✓ If your refueling station is used less often than once a week, recycle the fuel contained in the hose between the nozzle and the filter. If E85 is in contact with the hose material for a long period of time, the hose may degrade and become a source for contamination that cannot be trapped by the filter. At least weekly, fill a one-gallon E85-compatible container with fuel from the nozzle and return the fuel to the storage tank. (Although a quart would probably be enough to drain the hose, draw a gallon to be on the safe side.)

✓ E85 from your storage tank should be tested on a regular basis for appearance, hydrocarbon content, and electrical conductivity (see the following sections for directions on how to perform these tests). Put samples to be tested into alcohol-compatible containers. Stainless steel containers, steel containers with epoxy liners, or glass containers are recommended for use in sampling and testing.

Visual Inspection

Visual inspection may be the least expensive and most efficient way to check for possible contamination of alcohol fuel. Fuels must be completely clear and free from

MORE

visible particulates. Particulates indicate contamination; if they are found, immediately begin an investigation into the source of the contamination.

At least two samples should be visually examined. Pour one sample of fuel from the dispenser hose into a quart-sized clear glass container and inspect the liquid. Remember that this first quart is the fuel that was stored in the dispenser hose between the nozzle and the filter. If particulates are found in the first sample, the hose has begun to degrade. Draw more fuel through the hose into a compatible container until you are sure you have emptied the hose and are dispensing fuel from the tank. (This fuel can be returned to the tank later if no particulates are found in the test sample to be drawn next.) Then draw another quart sample of fuel into a separate glass container and observe the liquid. If particulates are found in the second sample, fuel in the tank has become contaminated. If particulates are found in either sample, do not dispense any fuel until the problem has been identified and corrected. Contact your fuel provider for assistance.

Hydrocarbon Content of the Fuel Ethanol

If you are experiencing poor vehicle performance, the hydrocarbon content in the fuel blend may be too low. The FFVs produced in the United States today have alcohol sensors as standard equipment, but storage tanks rarely are equipped with this kind of sensor. Checking the hydrocarbon content of the fuel in the tank is inexpensive and fast — use the procedure described in ***Appendix E***. Check the hydrocarbon content as a standard procedure once every month, after each fuel delivery, or when drivers report a change in vehicle performance. If the hydrocarbon content is too high or too low, contact your fuel provider for assistance.

Remember that the blend you are dispensing from the storage tank may be different from the blend inside the vehicle because of mixing with fuel already in the vehicle tank. If vehicles are experiencing performance problems, you may need to check the hydrocarbon content of the fuel in the vehicle's tank as well as in the storage tank.

Electrical Conductivity

The electrical conductivity of the fuel ethanol is a measure of the fuel's quality. High conductivity is a sign of corrosivity of the fuel and may indicate the presence of metal in the fuel, which could be the result of material or equipment degradation. If you use fuel whose conductivity is higher than specification, your vehicles will not operate properly. A conductivity value of no more than 500 micro-mhos/meter is recommended (mho is sometimes abbreviated as S). If the conductivity reading is outside specification, contact your fuel provider for assistance.

Measuring the electrical conductivity of the fuel sample with a conductivity meter is easy. Follow the manufacturer's instructions.

Check the AAMA specification for fuel ethanol to obtain more details about recommended conductivity meters. Check the fuel's conductivity every time one-quarter of the storage tank has been dispensed or every two weeks, whichever occurs sooner.

SAFETY PROCEDURES

Health Considerations

Treat fuel ethanol with a high degree of respect, just as you would any fuel. Minimize exposure to the fuel. Just like gasoline, fuel ethanol is flammable and poisonous, and may contain additives that are harmful, even in casual contact. And, do not confuse fuel ethanol with alcohol intended for human consumption — fuel ethanol can poison and kill you. ***Never drink fuel ethanol!***

Exposure to fuel ethanol can occur by breathing its vapors (inhalation), getting it on the skin or in the eyes (skin absorption), or accidentally swallowing it (ingestion). The following symptoms of exposure to fuel ethanol may appear immediately:

- ✓ Dullness of memory and concentration;
- ✓ Impaired motor coordination; and
- ✓ Drowsiness, stupor, and finally coma.

Contact medical personnel immediately in cases of exposure.

The first-aid treatment needed will depend on the type of exposure:

For inhalation,

- ✓ Move away from the vapors to fresh air and
- ✓ Contact medical personnel.

For skin absorption,

- ✓ Wash the skin with soap and rinse with large quantities of water,
- ✓ Remove contaminated clothing, and
- ✓ Contact medical personnel.

For eye absorption,

- ✓ Flush the eyes with water for at least 15 minutes and
- ✓ Contact medical personnel.

For ingestion,

- ✓ Have the person lie down and keep him/her warm,
- ✓ Do not induce vomiting, and
- ✓ Contact medical personnel immediately.

Fire Safety Considerations

Fuel ethanol fires generally release less heat than gasoline fires, but any fires should be taken seriously. Use a CO_2, halon, or dry chemical extinguisher that is marked B, C, BC, or ABC. An alcohol-type or alcohol-resistant (ARF) foam may be used to effectively combat fuel ethanol fires. ***Never use water*** to control a fire involving high-concentration fuel ethanol such as E85.

Before constructing any refueling installations, consult your local Fire Marshall. Regulations governing the safe

MORE

handling of fuel ethanol vary from area to area. Only your local officials will know the regulations in force in your locale.

Safety Codes

The safety standards for handling and storing E85 are the same as those for gasoline. The National Fire Protection Agency (NFPA) has two standards that apply to fuel ethanol blends: NFPA 30, "Flammable and Combustible Liquids Code," and NFPA 30A, "Automotive and Marine Service Station Code." These codes contain information on refueling facilities, storage, and handling requirements for all flammable and combustible liquids. NFPA assigns both ethanol and methanol fuels (including E100 and M100) to the same class as gasoline. Contact your local Fire Marshall or the NFPA for copies of these standards.

A Material Safety Data Sheet (MSDS) for E85 is shown in ***Appendix F***.

TABLE 3 FIRST AID TREATMENTS FOR EXPOSURE TO FUEL ETHANOL

Symptoms of Exposure

Dullness of memory and concentration
Impaired motor coordination
Drowsiness, stupor, and finally coma

Exposure	*First Aid Treatment*	*Treatment Compared to Gasoline Exposure*
Inhalation	Move away from the vapors to fresh air and contact medical personnel.	Same
Skin absorption	Wash the skin with soap and rinse with large quantities of water; remove contaminated clothing; and contact medical personnel.	Same
Eye absorption	Flush the eyes with water for at least 15 minutes and contact medical personnel.	Same
Ingestion	Have the person lie down and keep him/her warm; do not induce vomiting; and contact medical personnel immediately.	Different

APPENDIX A: Comparison of Fuel Properties

Property	*Methanol*	*Ethanol*	*Gasoline (87 Octane)*	*E85*
Chemical formula	CH_3OH	C_2H_5OH	C_4 to C_{12} chains	*
Main constituents (% by weight)	38C, 12H, 50O	52C, 13H, 35O	85-88C, 12-15H	57C, 13H, 30O
Octane (R+M)/2	100	98-100	86-94	96
Lower heating value (Btu/lb)	8,570	11,500	18,000-19,000	12,500
Gallon equivalent	1.8	1.5	1	1.4
Miles per gallon as compared to gasoline	55%	70%	–	72%
Relative tank size to yield driving range equivalent to gasoline	Tank is 1.8 times larger	Tank is 1.5 times larger	1	Tank is 1.4 times larger
Reid vapor pressure (psi)	4.6	2.3	8-15	6-12
Ignition point				
Fuel in air (%)	7-36	3-19	1-8	*
Temperature (approx.) (°F)	800	850	495	*
Specific gravity (60/60°F)	0.796	0.794	0.72-0.78	0.78
Cold weather starting	Poor	Poor	Good	Good
Vehicle power	4% power increase	5% power increase	Standard	3-5% power increase
Stoichiometric air/fuel ratio (by weight)	6.45	9	14.7	10

* Depends on percentage and type of the hydrocarbon fraction.

APPENDIX B: AAMA Specifications for Fuel Ethanol (E_d75-E_d85) as Dispensed to Vehicles (Purged or Unpurged Dispenser)

Property	*Value for Class*			*Test Method*
ASTM volatility class (applications per ASTM D 4814)	1	2	3	_
Ethanol, plus higher alcohols (minimum, volume %)	79	74	70	ASTM D 5501
Hydrocarbons (including denaturant)/(volume %)	17-21	17-26	17-30	N/A
Vapor pressure at 37.8°C				
kPa	38-59	48-65	66-83	ASTM D 4953, D 5190,
psi	5.5-8.5	7.0-9.5	9.5-12.0	D 5191, D5482
Octane		TBD		N/A
Higher aliphatic alcohols, C3-C8 (maximum, volume %)		2		ASTM D 5501
Acidity as acetic acid (maximum, mg/kg)		50		ASTM D 1613
Chloride ion (maximum, mg/kg)		1		Ion chromatography
Total chlorine as chlorides (maximum, mg/kg)		2		ASTM D 4929, Method B
Electrical Conductivity (maximum, micro S/m)		500		ASTM D 1125
Gum, unwashed (maximum, mg/100 mL)		20		ASTM D 381
Gum, washed (maximum, mg/100 mL)		5.0		ASTM D 381
Particulates (maximum, mg/L)		0.1		ASTM D 2276
Aluminum (maximum, mg/L)		0.03		ICP-Atomic emission spectroscopy
Iron (maximum, mg/L)		0.1		
Filter plugging		TBD		N/A
Lead (maximum, mg/L)		2.6		ASTM D 3229
Phosphorus (maximum, mg/L)		0.2		ASTM D 3231
Sulfur (maximum, mg/kg)		50.0		ASTM D 3120, D 1266, D 2622
Water (maximum, mass %)		1.0		ASTM E 203
Denaturant (maximum, %)		5.0		ASTM D 4806
Appearance	Product shall be visibly free of suspended or precipitated contaminants (shall be clear and bright).			Use a strong beam of light aimed diagonally toward the eye and view through a clear glass 250 mL beaker.

N/A = Not applicable.
TBD = To be determined.

APPENDIX C: Geographical Fuel-Marketing Regions

State and Fuel-Marketing Region	Volatility Class by Month											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Alabama	2	2	2	2	2/1	1	1	1	1	1/2	2	2
Alaska												
Southern Region	3	3	3	3	3/2	2/1	1	1/2	2/3	3	3	3
South Mainland	3	3	3	3	3/2	2/1	1/2	2	2/3	3	3	3
Arizona												
North of 34 lat. & E of 111° long.	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Remainder south of 34°	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Arkansas	3	3	3/2	2/1	1	1	1	1	1/2	2	2/3	3
California												
North Coast	2	2	2	2	2	2/1	1	1	1	1/2	2	2
South Coast	2	2	2	2	2/1	1	1	1	1	1/2	2	2
Southeast	3	3/2	2	2	2/1	1	1	1	1/2	2	2/3	3
Interior	2	2	2	2	2	2/1	1	1	1	1/2	2	2
Colorado												
East of 105° longitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
West of 105° longitude	3	3	3	3	3/2	2	2/1	1/2	2/3	3	3	3
Connecticut	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Delaware	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
District of Columbia	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Florida												
North of 29° latitude	2	2	2	2/1	1	1	1	1	1	1/2	2	2
South of 29° latitude	2	2/1	1	1	1	1	1	1	1	1	1/2	2
Georgia	3	3/2	2	2/1	1	1	1	1	1	1/2	2	2/3
Hawaii	1	1	1	1	1	1	1	1	1	1	1	1
Idaho	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
Illinois												
North of 40° latitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
South of 40° latitude	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Indiana	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Iowa	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Kansas	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Kentucky	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Louisiana	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Maine	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Maryland	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Massachusetts	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Michigan												
Lower Peninsula	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Upper Peninsula	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3

MORE >

APPENDIX C: Geographical Fuel-Marketing Regions (cont.)

State and Fuel-Marketing Region	Volatility Class by Month											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Minnesota	**3**	**3**	**3**	**3**	**3/2**	2/1	1	1/2	2	2/3	3	3
Mississippi	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Missouri	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Montana	3	3	3	3	3/2	2	2/1	1/2	2/3	3	3	3
Nebraska	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Nevada												
North of 38° latitude	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
South of 38° latitude	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
New Hampshire	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
New Jersey	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
New Mexico												
North of 34° latitude	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
South of 34° latitude	3	3	3/2	2/1	1	1	1	1	1	1/2	2/3	3
New York												
North of 42° latitude	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
South of 42° latitude	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
North Carolina	3	3	3/2	2	2/1	1	1	1	1/2	2/3	3	3
North Dakota	3	3	3	3	3/2	2/1	1	1/2	2	2/3	3	3
Ohio	3	3	3	3/2	2/1	1	1	1	1/2	2/3	3	3
Oklahoma	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
Oregon												
East of 122° longitude	3	3	3	3/2	2	2	2/1	1/2	2	2/3	3	3
West of 122° longitude	3	3/2	2	2	2	2/1	1	1	1/2	2	2	2/3
Pennsylvania												
North of 41° latitude	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
South of 41° latitude	3	3	3	3/2	2	2/1	1	1	1/2	2	2/3	3
Rhode Island	3	3	3	3/2	2/1	1	1	1	1/2	2	2/3	3
South Carolina	2	2	2	2/1	1	1	1	1	1	1/2	2	2
South Dakota	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Tennessee	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Texas												
North of 31° latitude	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
South of 31° latitude	2	2	2	2/1	1	1	1	1	1	1/2	2	2
Utah	3	3	3	3/2	2	2/1	1	1	1/2	2/3	3	3
Vermont	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Virginia	3	3	3/2	2	2/1	1	1	1	1/2	2	2/3	3
Washington												
East of 122° longitude	3	3	3/2	2	2	2/1	1	1	1/2	2/3	3	3
West of 122° longitude	3	3/2	2	2	2	2/1	1	1	1/2	2	2	2/3
West Virginia	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Wisconsin	3	3	3	3/2	2	2/1	1	1/2	2	2/3	3	3
Wyoming	3	3	3	3	3/2	2	2/1	1/2	2	2/3	3	3

APPENDIX D: E85 Shipping Procedures

To ensure the high quality of your fuel, it may be wise to send a sample of your fuel ethanol to a laboratory for analysis. Your fuel provider may be able to recommend a laboratory in your area that can perform this type of test, or for a list of laboratories that perform E85 tests, call the U.S. DOE Alternative Fuels Hotline (800-423-1DOE). To safely ship a sample of the fuel, follow all of your shipper's requirements for hazardous materials. Be sure that the following information appears on the outside of the package —

DOT Shipping Name:
"Denatured Ethanol (Ethanol and Gasoline)"
Identification Number:
"NA1987"
Diamond Labels:
Health 2, Flammability 3, Reactivity 0
Label:
"Flammable Liquid"
Arrow Label:
"This End Up"

A one-gallon container compatible with ethanol is recommended. The SturdeeSeal UN 4G gasoline combination package is one product on the market that has been successfully used for this purpose. The combination package contains a UN-marked one-gallon metal can with an epoxy phenolic lining, fiberboard, polyethylene bag, and closing tape. For information on where to obtain this package, see the section, ***For More Information, Call . . .***, found at the back of this guidebook.

APPENDIX E: Method to Determine the Total Hydrocarbon Content of Alcohol Fuel

This procedure is based on a similar procedure for methanol developed by General Motors.* Errors in ethanol content of up to 5 percentage points may occur for E85 blended with gasoline containing detergent additives.

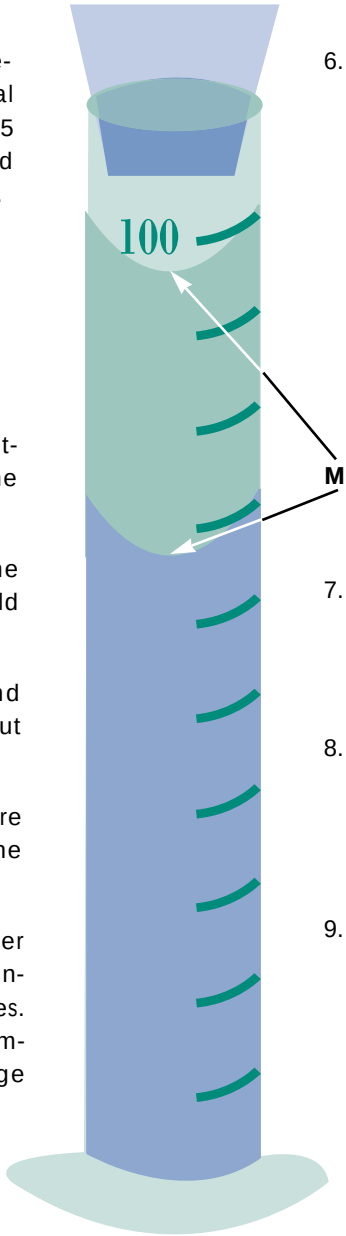
Essential Equipment

50-mL volumetric pipette

100-mL graduated cylinder with stopper

Procedure

1. Use the volumetric pipette to extract exactly 50 mL of fuel and place the fuel in the graduated cylinder.
2. Add approximately 50 mL of water to the fuel in the cylinder. (The total volume should not exceed 100 mL.)
3. Place the stopper in the cylinder, and shake the contents vigorously for about 15 seconds.
4. Loosen the stopper to release the pressure in the cylinder but do not remove the stopper.
5. Tighten the stopper. Place the cylinder upright on a level surface away from sunlight and heat sources. Wait 15 minutes. If separation of the two layers is not complete, lightly tap the cylinder to encourage complete separation.



6. Record the level of the top and bottom of the hydrocarbon layer (upper layer). Do this by reading the measurement at the lowest part of the meniscus at both the top and bottom of the upper layer. (The meniscus is the curved border [the interface] between the air and the top of the liquid or between the hydrocarbon layer and the water layer. See the accompanying illustration.)
7. Find the volume (in milliliters) of the upper layer by subtracting the value at the lower meniscus from the value at the upper meniscus.
8. Calculate the ethanol concentration (percent by volume) by this equation:

   % ethanol = 98.69 - [1.97 x volume of the upper layer in milliliters].

9. Calculate the hydrocarbon concentration (percent by volume) by this equation:

   % hydrocarbon = 1.31 + [1.97 x volume of the upper layer in milliliters].

* "A Simple Method to Determine the Methanol Content of Methanol Fuels," Society of Automotive Engineers paper number 912421 by Scott W. Jorgensen, Robert L. Furey, and Kevin L. Perry.

APPENDIX F: Material Safety Data Sheet for E85

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)*
Fuel Ethanol Ed85

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name Archer Daniels Midland Company	Emergency Telephone Number 800/424-9300 or 217/424-5200
Address *(Number, Street, City, State, and ZIP Code)* 4666 Fairies Parkway	Telephone Number for Information 217/362-3980
Decatur, Illinois 62526	Date Prepared 7/5/95
	Signature of Preparer *(optional)*

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity: Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Ethyl Alcohol (200 proof) CAS 0064-17-5				80%
Natural Gasoline CAS 008-006-619				20%
*Benzene CAS-0071-43-2	1ppm	10ppm		< 1100ppm
*"A chemical known to the State of California to cause cancer"				

Section III — Physical/Chemical Characteristics

Boiling Point	96°-170°F	Specific Gravity (H_2O = 1)	0.76-0.78
Vapor Pressure (mm Hg.)	340-560	Melting Point	NA
Vapor Density (AIR - 1)	2.0-4.0	Evaporation Rate (Butyl Acetate = 1)	Not Estimated

Solubility in Water
60-70 gm./100ml.

Appearance and Odor
Clear, colorless volatile liquid with an ethereal odor.

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
–20°F to –4°F TCC	Not estimated	1.4	19.0

Extinguishing Media
Carbon dioxide dry chemical, water for small fires. Polar solvent foam for large fires.

Special Fire Fighting Procedures
Use necessary protective equipment and breathing apparatus as would normally be used when fighting fires where there may be danger of breathing hazardous products of combustion.

Unusual Fire and Explosion Hazards
Flammable liquid.

(Reproduce locally) OSHA 174, Sept. 1985

MORE

Section V — Reactivity Data

Stability			Conditions to Avoid
	Unstable		None in normal use.
	Stable	X	

Incompatibility *(Materials to Avoid)*
May react vigorously with oxidizing materials.

Hazardous Decomposition or Byproducts
Combustion may produce CO_x, NO_x and reactive hydrocarbons.

Hazardous Polymerization			Conditions to Avoid
	May Occur		None in normal use.
	Will Not Occur	X	

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? (A) Skin? (B) Ingestion? (C)

Health Hazards *(Acute and Chronic)*
(A) May cause mucous membrane irritation; unconsciousness; coma; respiratory failure and death.
(B) May cause skin irritation as a result of defatting. (C) Moderately toxic (LD50 0.5 to 5 G/Kg), gastrointestinal irritation, vomiting, CNX depression, coma.

Carcinogenicity:	NTP?	IARC Monographs??	OSHA Regulated?
	Not determined	Not determined	Yes

Signs and Symptoms of Exposure
May cause dizziness, loss of balance and coordination.

Medical Conditions
Generally Aggravated by Exposure Not determined.

Emergency and First Aid Procedures
If swallowed, do not induce vomiting. If inhaled, remove person to fresh air. Give artificial respiration if breathing has stopped. Call a physician. If splashed in eyes or on skin, flush immediately with copious amounts of water.

Section VII — Precautions for Safe Handling and Use

Steps to be Taken in Case Material is Released or Spilled
Eliminate all sources of ignition. Small spills should be flushed with large quantities of water. Large spills should be collected for waste disposal.

Waste Disposal Method
Do not allow to enter sewers where vapors may become ignited. Incinerate in furnace where permitted under appropriate federal, state & local regulations or dispose of in a site stipulated for hazardous materials.

Precautions to Be Taken in Handling and Storage
Keep away from heat, sparks, & open flames. Keep container closed. Use with adequate ventilation.

Other Precautions
Use explosion proof electrical equipment and non-sparking tools. Ground electrical equipment.

Section VIII — Control Measures

Respiratory Protection *(Specify Type)*
Air supplied mask for high concentrations.

Ventilation			Special
	Local Exhaust	Preferred	None
	Mechanical *(General)*	Acceptable	Other: None

Protective Gloves	Eye Protection
Rubber	Goggles

Outer Protective Clothing or Equipment
Eye bath and safety shower.

Work/Hygienic Practices
NA

* U.S.G.P.O.: 1986-491-529/45775

FOR MORE INFORMATION, CALL . . .

General

U.S. Department of Energy
Alternative Fuels Data Center
National Alternative Fuels Hotline
P.O. Box 12316
Arlington, VA 22209
703-528-3500 (User Support Services)
800-423-1DOE (Toll-Free)
e-mail: hotline@afdc.nrel.gov

Governors' Ethanol Coalition
Nebraska Energy Office
The Atrium, First Floor, 1200 N Street
P.O. Box 95085
Lincoln, NE 68509
402-471-2867
Contact: Robert Harris

National Corn Growers Association
1000 Executive Parkway, Suite 105
St. Louis, MO 63141
314-275-9915

National Ethanol Vehicle Coalition*
1648 Highway 179
Jefferson City, MO 65109
573-635-8445
800-E85-8895
Contact: Phillip Lampert

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, CO 80401-3393
303-275-4481
Contact: Norm Hinman, Biofuels Program Manager

Renewable Fuels Association
One Massachusetts Avenue, N.W., Suite 820
Washington, DC 20001
202-289-3855

U.S. Environmental Protection Agency
Division of Regulatory Programs & Technology
2565 Plymouth Road
Ann Arbor, MI 48105
313-668-4296

Ethanol Fuel Codes and Safety

National Fire Protection Association
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
617-984-7407
Contact: Ted Lemoff

Standards

American Automobile Manufacturers Association
1401 H Street, N.W., Suite 900
Washington, DC 20005-2110
202-326-5500

American Society for Testing and Materials
100 Bar Harbor Drive
West Conshohocken, PA 19428-2959
Publication and Customer Service
610-832-9585

Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096-0001
412-776-5760

Materials

Convault
4109 Zeering Road
Denair, CA 95316
209-632-7571

* For the name of a contact nearest your area, call the National Ethanol Vehicle Coalition at 800-E85-8895.

MORE

FOR MORE INFORMATION, CALL . . . (cont.)

Cuno Separations Systems
50 Kerry Place
Norwood, MA 02062
800-367-6805

EMCO Wheaton
4001 Weston Parkway
Cary, NC 27513
800-285-3626

Gasboy of Canada Ltd.
430-T Industrial Road
London, Ontario, Canada N5V 1T5
519-453-5340

Goodall Rubber Co.
Grover Mill Road, Suite 203
Lawrenceville, NJ 08648
609-799-2000

Goodyear
331 McCarter Hwy
Newark, NJ 07114
201-242-5550

OPW Fueling Components
9393 Princeton-Glendale Road
P.O. Box 405003
Cincinnati, OH 45240-5003
800-947-6976

Tokheim Co.
1123 C Avenue NW
P.O. Box 74062-T
Cedar Rapids, IA 52407
319-362-4847

U-Fuel, Inc.
306 Barstow Street
P.O. Drawer 1511
Eau Claire, WI 54702
715-836-0905

Alternative Fuel Vehicles

Chrysler Corp.
Alternative Fuel Vehicle Sales and Marketing
27777 Franklin Road
Southfield, MI 48034
810-984-3644
Contact: Mike Clement

Ford Motor Co.
Alternative Fuels Program
The American Road
Dearborn, MI 48121
800-ALT-FUEL

General Motors Corp.
Automotive Emissions Control
3044 West Grand Boulevard
Detroit, MI 48202
313-556-7723
Contact: Gerald Barnes, Manager

DOE Alternative Fuels Data Center
National Alternative Fuels Hotline
P.O. Box 12316
Arlington, VA 22209
703-528-3500 (User Support Services)
800-423-1DOE (Toll-Free)
e-mail: hotline@afdc.nrel.gov

Alcohol-Fueled Vehicle Technician Training

Central Community College, Platte Campus
P.O. Box 1027
Columbus, NE 68602-1027
402-562-1280
Contact: Doug Pauley

Containers

Labelmaster
5724 N. Pulaski Road
Chicago, IL 60646-6797
800-621-5808

TROUBLESHOOTER'S GUIDE

Remember that a vehicle is a complex machine, so most of the vehicle's problems are not related to its fuel. Always follow the directions and recommendations from the owner's manual supplied with the vehicle by the manufacturer.

Problem: Vehicle does not start, idle is irregular, lack of power — and you suspect that fuel is a contributing factor

Solution:

• Check the hydrocarbon content of the fuel. If your vehicle is equipped with an alcohol sensor, read the number from your onboard display; if you do not have an alcohol sensor, refer to Appendix E for directions on how to measure the hydrocarbon content. Contact your fuel provider to see how to modify the fuel to get the correct hydrocarbon content.

• If you have an electrical conductivity meter, check the conductivity of the fuel. Check all equipment and material in contact with the fuel for incompatibility and possible degradation. Contact your fuel provider and equipment supplier for assistance.

• Check the fuel filter in the vehicle. If deposits are present, call your fuel provider or the vehicle manufacturer for assistance.

Problem: Fuel sample is not clear and/or particles are present in the fuel

Solution:

• The fuel has become contaminated. Check the refueling facility for materials compatibility problems. Check for excessive wear or degradation of nozzle, hoses, filters, etc. Check for possible external sources of contamination (for example, dirt around the nozzle or refueling valve) and remedy them. Contact your fuel provider and equipment supplier for assistance.

Problem: Fuel sample electrical conductivity reading is too high (over 500 micro S/m)

Solution:

• The fuel has become contaminated. Check the refueling facility for materials compatibility problems. Check for excessive wear or degradation of nozzle, hoses, filters, etc. Check for possible external sources of contamination (for example, dirt around the nozzle or refueling valve) and remedy them. Contact your fuel provider and equipment supplier for assistance.

Problem: White powdery deposits on the nozzle

Solution:

• Check the nozzle material for compatibility with ethanol. Contact your equipment supplier or the nozzle manufacturer for assistance.

Problem: Delivery of the fuel to the vehicle is slow or no fuel is coming through the nozzle

Solution:

• Check the electrical connection to the fuel pump. Check the filter to see if it is plugged. Look for possible causes of material degradation before the filter. Look for possible external sources of contamination. Contact your fuel provider or equipment supplier for assistance.

Printed with soy ink on recycled paper