

# ETHANOL

## Alternative Fuel Fact Sheet on E85 Motor Fuel

### FUEL OVERVIEW

*Ethanol*, or ethyl alcohol (C<sub>2</sub>H<sub>5</sub>OH), is produced by fermenting corn or other high starch or sugar sources; producing ethanol from plentiful, low-cost biomass is under intensive research and development. For several years, 10% ethanol/90% unleaded gasoline blends have been used in millions of vehicles to increase the octane level and oxygen content of straight gasoline.

E85 is a motor fuel blend of 85% denatured ethanol and 15% gasoline. E85 fuel is normally used in *flexible fuel vehicles* (FFVs) capable of burning any combination of E85 and straight gasoline. E85 is explicitly recognized by the U.S. Department of Energy and the U.S. Environmental Protection Agency as an important alternative fuel in the nation's energy future.

### ADVANTAGES

- ethanol is a renewable fuel component of E85, nontoxic, and "greenhouse neutral"
- no special orientation is needed to drive or refuel alternative fuel vehicles using E85
- no special precautions or facility changes are needed for vehicle maintenance
- E85 is cheapest alternative fuel option for some vehicle classes, using life cycle analysis
- higher octane and unique fuel properties of E85 vs. gasoline increase engine power
- E85 produces lower evaporative and tailpipe emissions than straight gasoline

### DISADVANTAGES

- vehicle mileage using E85 is approximately 25% less than that for straight gasoline
- occasional starting problems in sub-zero weather with E85 fuel
- flexible fuel vehicles manufactured to use E85 are not widely available yet
- E85 fuel is currently not available through retail outlets in Colorado
- higher aldehyde emissions will require improved catalytic converters for control

### FUEL COST ANALYSIS AND EXAMPLES

The cost of using E85, or any other alternative fuel, is most accurately determined by using *life cycle cost* (LCC) analysis. LCC analysis measures the total dollar cost of operating a vehicle using a given fuel during the vehicle's useful life. For example, based upon the assumptions listed on page 2, simplified LCC costs using gasoline vs. four alternative fuels to drive 75,000 miles in a mid-size vehicle, such as the Chevrolet Lumina, are given in the following two tables:

#### **Simplified Life Cycle Cost Example: Private Fleet (non tax-exempt status)**

Fuel Type	Cost of Operation (25,000 miles/year)	Cost of Operation (75,000 miles/3 yrs)	Conversion Costs	Life Cycle Cost Compared to Gasoline
Gasoline	\$1,239	\$3,717	\$0	\$0
Propane	\$1,084	\$3,252	\$1,450	+\$ 985
Ethanol (E85)	\$1,735	\$5,205	\$0	+\$1,488
Compressed Natural Gas	\$ 905	\$2,715	\$3,400	+\$2,398
Methanol (M85)	\$2,418	\$7,254	\$0	+\$3,537

## FUEL COST ANALYSIS AND EXAMPLES (continued)

### Simplified Life Cycle Cost Example: Public Fleet (tax-exempt status)

Fuel Type	Cost of Operation (25,000 miles/year)	Cost of Operation (75,000 miles/3 yrs)	Conversion Costs	Life Cycle Cost Compared to Gasoline
Gasoline	\$ 835	\$2,505	\$0	\$0
Ethanol (E85)	\$1,168	\$3,504	\$0	+\$ 999
Propane	\$ 787	\$2,361	\$1,450	+\$1,306
Methanol (M85)	\$1,750	\$5,250	\$0	+\$2,745
Compressed Natural Gas	\$ 774	\$2,322	\$3,400	+\$3,217

### Assumptions Used in Simplified Life Cycle Cost Examples

1. All vehicles are mid-size vehicles, such as Chevrolet Lumina or Ford Taurus.
2. Vehicles are driven under identical conditions.
3. Salvage values for all vehicles are identical.
4. Maintenance and repair costs--other than conversion costs--for all vehicles are identical.
5. Fuel economy is directly proportional to the Btu content of the fuels involved. Thus, mileage values used: gasoline (25 mpg), E85 (18 mpg), M85 (12.5 mpg), propane (20.2 mpg), and CNG (21.25 mile per therm = 24.225 miles per gallon gasoline equivalent).  
NOTE: 1.14 therms = 1 gallon of gasoline in Btu content = 114,000 Btus.
6. Impacts of conversion requirements upon mileage ignored: e.g., weight of fuel and tanks.
7. Impacts upon duty cycle of variability in driving range for various fuels are ignored.

### Representative Colorado Fuel Prices (8/23/94)

Fuel Type	Tax Exempt Prices	Federal Motor Fuel Tax	Colorado Motor Fuel Tax	Retail Fuel Prices
Gasoline	\$0.835	\$0.184	\$0.22	\$1.239
Ethanol (E85)	\$0.895	\$0.130	\$0.22	\$1.245
Propane	\$0.636	\$0.183	\$0.057	\$0.876
Methanol (M85)	\$0.875	\$0.114	\$0.22	\$1.209
Compressed Natural Gas	\$0.750	\$0.059	\$0.068	\$0.877

Except for E85, Retail Fuel Prices are representative "on the street" Colorado prices for 8/23/94.

Except for E85, Tax Exempt Prices are derived from retail fuel prices, minus state and federal taxes. Tax exempt prices include "rack price" of fuel, plus freight, distribution, and profit.

Retail prices for propane and CNG include additional imputed state motor fuel tax, imputed from annual \$70 decal fee for mid-size vehicles (GVW < 10,000 lb), assuming 25,000 miles/year and mpg in #5 above.

Tax Exempt Price calculations for E85: rack prices for E100 (\$1.28/gal) and gasoline (\$0.75/gal) on 8/23/94 yield rack price of \$1.20/gal for E85. Federal tax credit of \$0.54/gal for E100 is equivalent to \$0.459/gal for E85. For sales to private sector, blender's tax credit is reduced by \$0.054/gal of E85 to offset reduced federal taxes collected at the pump. \$0.10/gal added for freight, distribution, and profit. Tax-exempt price for public sector: \$0.841/gal.

Prices and federal taxes for CNG are calculated on gasoline gallon equivalent basis.

Federal and state motor fuel tax figures are rounded to nearest \$0.001.

## **AIR QUALITY IMPACTS**

Currently, federal emission standards for most alternative fuels, including E85, have not yet been issued. However, preliminary tests demonstrate that existing FFVs using E85 fuel easily meet current federal emission standards for gasoline. Moreover, these results indicate that E85 vehicles are at or are approaching the proposed 1998 Clean Fuel Fleet emission standards for low emission (LEV) and ultra low emission (ULEV) vehicles. E85 vehicles meet the California Transitional Low Emission Vehicle (TLEV) standard.

E85 fuel has a significantly lower Reid vapor pressure than straight gasoline; hence, evaporative emissions from E85 vehicles are less than that for straight gasoline. However, E85 produces greater levels of aldehydes, which are irritants and highly photoreactive compounds.

The relationship between standards and technology is dynamic. Vehicles are designed to meet specific standards, set by the federal government. As lower emissions levels are required over time, auto designers will seek to incorporate technology to meet the new standards. Suffice it to say that ethanol fuel has demonstrated its ability to compete in this dynamic technical arena.

## **FUEL PERFORMANCE AND ECONOMY**

On an equivalent Btu basis, E85 has 71% percent as much energy as straight gasoline (73% of reformulated gasoline). However, when octane levels and different combustion properties of ethanol vs. gasoline as taken into account, E85-powered vehicles have theoretical mileage rates of 75-77% that of comparable gasoline-powered vehicles. For mid-size passenger cars in Illinois using E85 fuel, 20-22 mpg has been reported. These figures are consistent with data from selected vehicle fleets reporting to the Alternative Fuels Data Center of the National Renewable Energy Laboratory.

Ethanol has an octane rating of 113, using the (R+M)/2 method; E85 fuel with 85 or 87 octane gasoline has an octane rating of 109. The higher octane number for ethanol means that engines optimized for E85 could use higher compression ratios and deliver more power. But because FFVs must accommodate the lowest octane fuel used (i.e., gasoline), current FFVs are not optimized for ethanol and operate at a lower compression ratio suitable for gasoline.

## **FUEL STORAGE AND INFRASTRUCTURE**

Refueling stations for gasoline can be used to store and dispense E85 with minor modifications. The installation of alcohol resistant impellers and nickel-plated pump nozzles is required. Existing refueling systems which already meet EPA standards for gasoline can be cleaned and converted for under \$5,000 if dedicated for E85. Estimated costs for installing a new refueling system range from \$35,000 to \$70,000.

At this time, Colorado has no commercial outlets dispensing E85 fuel. However, skid-mounted tanks with 1000 gallon capacity can be installed relatively easily for public and private fleets.

## **FUEL SAFETY**

By federal law, all fuel grade ethanol is denatured with toxic additives, such as gasoline. Work areas for refueling and maintenance work involving gasoline or alcohol fuels should be well-ventilated. Vapors and direct skin contact with such fuels should be avoided. The environmental risk in the event of leakage of ethanol-gasoline mixtures from storage tanks is less than that for 100% gasoline. The flammability range and volatility of E85 approach those for gasoline.

## **FUEL PERMITS, TAXES, AND LICENSES REQUIRED**

The federal government allows a 54 cent per gallon income tax credit for ethanol used as a fuel. The income tax credit is available to taxpayers who: (a) produce or blend a fuel alcohol mixture, or (2) sell or use for business 100% straight alcohol placed in the vehicle's fuel tank by the taxpayer. The credit is claimed by using IRS Form 6478: "Credit for Alcohol Used as Fuel".

To benefit from this federal tax credit, a governmental unit using E85 fuel must use an alcohol mixture purchased from a fuel blender. Further, the blender must be subject to income taxes, have sufficient income tax liabilities to use the credit, and be willing to pass through the value of the credit by selling the fuel at a reduced price.

Distributors of gasoline and special fuels in Colorado must be licensed by the Colorado Dept. of Revenue. For state excise tax purposes, E85 (and M85) are treated in Colorado like gasoline. Distributors of E85 must post a bond equal to twice the monthly tax liability; bonds range between \$3,000 and \$100,000. No annual license fee is charged for E85 distributors.

The Colorado tax rate for straight gasoline and E85 is 22 cents per gallon. The first receiver in Colorado is liable for the tax; the tax is paid monthly on all fuel received that month whether or not the entire amount is sold that month. Government agencies, school districts, and political subdivisions are exempt from Colorado fuel taxes. For additional information about tax filing, request publication DRP 1815 from the Colorado Dept. of Revenue's Hotline at (303) 534-1408.

## **FLEXIBLE FUEL VEHICLE AVAILABILITY AND CONVERSIONS**

Hundreds of flexible fuel vehicles capable of using E85 fuel have been manufactured by Chevrolet and Ford. Ford plans to produce thousands of Taurus FFVs, optimized for E85 fuel, during January and February of 1996. These FFVs will be made available to the general public at no additional cost above comparable gasoline-fueled models. Conversions are not widely practiced at this time. Not all conversions improve air quality. In addition, few conversions are factory certified and few of them do not void the warranty.

## **FLEXIBLE FUEL VEHICLE MODIFICATIONS**

Alcohol fuels are generally more corrosive than gasoline; ethanol is less corrosive than methanol. Corrosiveness can be adjusted for by using alternative fuel system materials. Additional FFV components include: a flame arrester to prevent sparks from entering the fuel tank during refueling, a fuel sensor to determine the amount of alcohol in the fuel, high capacity fuel injectors, and a cold-start system. Computer control devices are configured differently in FFVs. FFV manufacturers recommend a different type of engine oil than is used in gasoline engines; oil change and spark plug replacement schedules for FFVs using E85 may also differ slightly.

## **REFERENCES**

Alternative Fuels Data Center, National Renewable Energy Laboratory, 1617 Cole Blvd., Golden, CO 80401-3393. Phone: (303) 275-4491 or 1-800-423-1363 (Washington, D.C.).

Current and Potential Future Performance of Ethanol Fuels (SAE Technical Paper 930376), Jerry Sinor (J. E. Sinor Consultants, Inc.) and Brent Bailey (National Renewable Energy Lab) (1993). Copies are available for \$4.00 from SAE: phone (412) 776-4841, fax (412) 776-5760.

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