BIOFUELS – PART 2: ETHANOL ISSUES

by
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Every alternative fuel has issues that have to be addressed in order for it to be implemented. Ethanol and biodiesel are two of the easier-to-implement alternative fuels, but still face challenges. This article is the second in a series about the biofuels ethanol and biodiesel, and will cover some of the issues regarding the use of ethanol as an alternative motor vehicle fuel.

Energy Balance

One of the key reasons to use any alternative motor vehicle fuel is to increase U.S. energy security. This is accomplished by substituting fuels that are made from U.S. resources for fuels (gasoline and diesel) that are made from resources (crude oil) that are imported from nations hostile to the U.S. The ability of ethanol to increase energy security depends on its energy balance. The energy balance of ethanol production is simply the expression of the quantity of energy that is either lost or gained when converting a particular feedstock into ethanol. Virtually all of the ethanol produced in the U.S. is produced from corn, and the energy balance of corn ethanol has been a hotly debated topic since the 1970s. The calculation of the energy balance of corn ethanol includes not only the energy required in the actual conversion process, but secondary energy inputs such as corn farming and transportation, ethanol distribution, and energy credits for coproducts. Many studies have been carried out to assess the energy balance of corn ethanol with little consensus among the results, which have ranged from, approximately, -30% (energy loss) to +30% (energy gain). The wide range of results is due to wide ranging assumptions and estimates that are made for the direct energy inputs, and differences in what exactly is and is not included in secondary energy inputs; that is, where the box is drawn around the process. Several previous studies were reviewed in a 2002 study published by The U.S. Department of Agriculture (USDA)[1]. The study highlighted the differences between the studies which led to the wide range of energy balances. The debate over the energy balance of corn ethanol is not yet settled. The authors of the USDA study calculated a +34% energy balance for corn ethanol, while David Pimentel of Cornell University (his earlier study is included in USDA's 2002 study) still claims the energy balance for corn ethanol is -29% [2].

It is important to remember that, no matter what the true value of corn ethanol's energy balance is, corn ethanol cannot completely displace gasoline in the U.S. The entire corn crop in the U.S., if converted entirely to ethanol, would only replace about 12% of gasoline[3].

Cellulosic ethanol has a much greater potential to displace gasoline. The overall energy balance for cellulosic ethanol is much greater than that of corn ethanol. The USDA's calculation of a +34% energy balance for corn ethanol translates to an energy gain of, approximately, 21,000 Btu per gallon of ethanol. A 1999 study, conducted by the Argonne National Laboratory[4], found that the production of ethanol from cellulose had an energy gain of more than 60,000 Btu. Part of the gain was attributable to electricity being generated during the process. A large part of the

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[1] J. Hill, E. Nelson, D. Tilman, S. Polasky, D. Tiffany, "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels," *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 103, No. 30, July 2006. URL: http://www.pnas.org/cgi/content/ abstract/103/30/11206.

[2] D. Pimentel, "Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts are Negative," *Natural Resources Research,* Vol. 12, No. 2, June 2003.

[3] H. Shapouri, J.A. Duffield, M. Wang, "The Energy Balance of Corn Ethanol: An Update," U.S. Dept. of Agriculture, Washington D.C., July 2002. URL: http://www.transportation.anl.gov/pdfs/AF/265.pdf.

[4] M. Wang, C. Saricks, and D. Santini, "Effects of Fuel Ethanol Use on Fuel-Cycle Energy and Greenhouse Gas Emissions," Argonne National Laboratory, Center for Transportation Research, Argonne, IL, January 1999. URL: http://www.transportation.anl.gov/pdfs/TA/58.pdf.

gain is attributable to lower fossil energy used in biomass farming and cellulosic conversion.

Public Perception

When gasoline containing 10% ethanol (commonly referred to as gasohol) started being used in the 1970s, many people experienced problems. Ethanol is corrosive to some of the materials that are typically used in fuel systems. Problems caused by corrosion, such as gasket and seal failures, were not uncommon in automotive and marine/outboard engines. Since then, engine manufacturers have largely eliminated the problems by upgrading fuel system components. Most recently manufactured vehicles and marine/outboard engines are able to use gasoline with up to 10% ethanol. The general rule is that, if the owner's manual does not specifically authorize the use of gasoline that contains ethanol, it should not be used. The only way to be sure is to contact the engine manufacturer. Many people today remember the problems and are reluctant to use fuel containing ethanol.

Cost

Outside of government mandates, cost to the consumer is the overriding factor that determines whether or not a particular alternative fuel gets used. Producers of corn ethanol that is used for motor vehicle fuel currently receive state and federal subsidies. These subsidies are typically passed on to the consumer of the fuel in the form of lower prices which help ethanol to be more price competitive with gasoline. E85 pump prices in the Midwest are commonly lower than regular unleaded gasoline prices; however, pump prices are in $ per gallon. It must be remembered that what is being bought is energy, and a gallon of E85 contains about 27% less energy than a gallon of regular unleaded gasoline. Once prices are adjusted and given on an energy equivalent basis (commonly referred to as a gasoline gallon equivalent or GGE), E85 is usually more expensive than regular unleaded gasoline. The 27% decrease in energy when switching from gasoline to E85 does not necessarily mean that fuel economy will be 27% less; it is dependent on the design of the engine and vehicle, and may be substantially less than 27%. Cellulosic ethanol is even further away from being economically feasible, but research is advancing rapidly in this area.

Vehicles and Infrastructure

Vehicles that can use E85 (flex fuel vehicles or FFVs) are readily available. FFVs are the same as their gasoline only counterparts except for upgraded fuel system materials and special sensors that measure the ethanol concentration of the fuel mixture. They can operate on any ethanol/gasoline mixture up to 85% ethanol. There are currently about 25 light duty FFV models available from 8 manufacturers. They range from mid-size sedans to half-ton trucks and SUVs. FFVs cost little to nothing more than their gasoline only counterparts. Many people are currently driving FFVs and are not aware of it. An FFV can be identified by its vehicle identification number (VIN). The National Ethanol Vehicle Coalition has an FFV VIN chart on their website[5].

There are currently no E85 filling stations in Louisiana, but with the recent enactment of a renewable fuel standard (Act 313 of the 2006 legislative session mandates that 2% of the gasoline sold in Louisiana will be ethanol, once the annualized production of ethanol in Louisiana equals or exceeds 50,000,000 gallons), and the proposal of several ethanol plants in Louisiana, it is reasonable that E85 fueling capacity will be built.

[5] URL: http://www.e85fuel.com/e85101/flexfuelvehicles.php.