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Corn-Based Ethanol – Is it Viable?

By: Thomas D. Mull, PE, PEM, CEM

Unless you are a major producer of corn, sugarcane, seller automotive fuels, or political pundit your awareness of ethanol may have been limited to noticing the stickers on gasoline pumps; “May contain up to 10% ethanol”, “E85”, or an E15 notification on your car’s gas cap.

The use of ethanol as a biofuel has been a much-debated topic for over a decade. Advocate have said it would reduce our dependency on foreign oil and reduce automobile emissions. Opponents have pointed out ethanol has had an adverse impact on the price of corn-based food products, while providing notably less BTU content that gasoline. So, what exactly is ethanol? How is it produced? What are the benefits and drawbacks of using ethanol vs. unleaded gasoline?

Ethanol is a simple alcohol with the formula C2H6O. It’s naturally produced by the fermentation of sugars by yeast or petrochemical processes. In addition to being used as a clean-burning fuel, ethanol is used to boost the octane rating of gasoline and as drinking alcohol (i.e., grain alcohol).

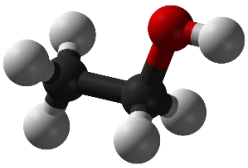

Figure 1 – Ethanol Molecule

Ethanol, with limited exceptions, is not an acceptable fuel for automobiles. It can, however, offset a portion of our petroleum-based gasoline requirement.

Background

Ethanol became a major factor in automotive fuels with Brazil’s development of what is considered the first *sustainable* biofuels economy (2006-2008). With an emphasis on eliminating dependency on foreign energy, Brazil’s program focused on the utilization of sugarcane in the production of ethanol. Their success was viewed as a potential model for other countries. However, the climate, land available for cultivation and agricultural technology that made Brazil’s program so successful was not directly transferrable to other countries.

During this same general timeframe (2005), the US became the world’s largest producer of ethanol. In lieu of using sugarcane, producers utilized corn. Major considerations in employing corn were; 1) the climate was not viable for large-scale production of sugarcane and 2) there was adequate land, technology, and climatic conditions for the large-scale production of corn.

Corn-Based Ethanol – Is it Viable? *(continued)*

The downside to using corn for ethanol production is the energy required to produce ethanol is seven (7) times greater than required for sugarcane. This is due to the fact the starch (corn) must first be converted into sugar, which takes energy, before the ethanol can be produced. Consequently, sugarcane-based ethanol is less expensive to produce (~15%) than corn-based ethanol.

Data for 2018 indicates that 28.7 billion gallons of ethanol were produced worldwide, with more than 80% coming from the US and Brazil. The following table details production by country.

Ethanol Production 2018 ($\times 10^6$ Gallons)	
USA	16,100
Brazil	7,950
EU	1,430
China	1,180
Canada	480
Thailand	390
India	330
Argentina	290
Others	550

Table 1 – 2018 World Ethanol Production

Importer or Exporter?

In 2018 the USA exported over 31 times more ethanol than it imported. According to the US Energy Information Administration (EIA) data, approximately 54.3 million gallons were imported, with 97.7% coming from Brazil. This was a decline of 29% over the previous year. Exports for 2018 were 1,710 million gallons, up over 20% from 2017. Brazil was the largest recipient with 29.2% and Canada second with 20.3%.

The Viability of Ethanol

Generally viewed positively because of its environmental benefits, ethanol still has its critics.

Fuel Efficiency – Among the most often cited issues is the lower mileage associated with ethanol enhanced fuels. According to Wikipedia, one gallon of ethanol contains approximately 76,100 BTUs, while a gallon of unleaded gasoline contains about 114,100 BTUs. Due to ethanol's lower energy content, vehicles operating on an E85 blend get roughly 15% to 27% fewer miles per gallon than when operating on regular unleaded gasoline.

Older Automotive/Smaller Engines – Ethanol blends can have an adverse impact on older automotive and smaller engines. Initially, only a small percentage of ethanol was mixed and with most engines there were no problems. Today, gasoline is commonly 10% to 15% (E10 and E15) ethanol. Most newer vehicles tolerate E10 well. Some manufacturers specifically prohibit the use E15, even though the EPA approved E15 for vehicles 2001 and newer.

There are politicians that want to expand blending to as much as 20%. It should be mentioned that there is an E85 blend (85% ethanol and 15% gasoline). This is only acceptable to vehicles especially engineered for it and marked as “Flex Fuel”.

Corn-Based Ethanol – Is it Viable? *(continued)*

A study conducted in 2012 by the Auto Alliance showed that cars between 2001 and 2009 showed internal engine damage as a result of using ethanol fuels blends. There was damage to the valves and valve seats. The study also showed that cars utilizing E15 had lower mileage (mpg).

Figure 2 – Older Automotive Engine

In smaller engines, such as lawn mowers, a 2013 US Department of Energy study found that E15 caused hotter operating temperatures, erratic running, and engine-part failure. The study went on to say the use of E10 "... could help destroy small engines." It should be mentioned that there are additives that can be combined to offset the adverse impact of ethanol-based fuels for smaller engines.

Figure 3 – Small Engine

Mandated Compliance – Another point from critics is refiners have spent billions of dollars complying with blending requirements from the Environmental Protection Agency. The utilization of ethanol in the US has been based upon government mandate (Renewable Fuel Standard – EPACT 2005) and subsidies. As a business model this approach not sustainable. It should be noted this year the EPA mandate for ethanol in gasoline is nearly 20 billion gallons.

Corn-Based Ethanol's Future

A July 2019 Reuters article reported US "... ethanol plants are expected to sharply curtail production..." as Midwest corn prices rise, and US-China negotiations drag on. This has resulted in weak margins and oversupply. According to an industry source margins to produce ethanol in the Midwest (where most of the corn in produced) have fallen to a four-year low. This has resulted in the highest seasonal inventories in nine (9) years, thereby "…making future cuts inevitable." If this occurs, as the price of corn increases production costs and with mandated blending, the cost of fuel would go up. In the article a marketer and distributor of ethanol stated that most producers are losing money on every gallon produced when the margins are weak.

As of October 30th, corn futures on the Chicago Board of trade were $3.87, down from the $4.49 a bushel quoted in the article. While the cost of corn has gone down weather conditions have adversely impacted planting for farmers, leading to uncertainty around the supply of corn for processing, thereby increasing price volatility.

Corn-Based Ethanol – Is it Viable? *(continued)*

A Better Way

Regardless of your position on the use of ethanol in automotive fuels it is here to stay, even as the US increases domestic oil production to new levels. The current system for ethanol production from corn in the US does not appear to be sustainable. Without government mandates and subsidies, the current system would collapse. That does not mean that ethanol should be abandoned as a fuel blend, only there must be a better way of producing and utilizing corn-based ethanol. We need to apply ourselves to develop a more self-sufficient and sustainable model for production and distribution.

Energy Management Case Studies

Submitted By: JLL Personnel

JLL (Jones, Lang LaSalle, Incorporated) is a global professional services and management company specializing in real estate. They are headquartered in Chicago, IL, but have offices in London, Singapore and Moscow.

JLL has management responsibility for the primary government facilities for the State of Tennessee. In 2017 IEP conducted the three-week PEM Training Program for the State of Tennessee in Nashville. Local JLL personnel participated in the program. Following are two (2) project case studies submitted by JLL participants highlighting achieved and projected savings. – Staff Writer

Case Study - Tennessee Tower Static Pressure Reduction

- Situation
  - High static pressure consumes more energy by increasing fan speed to maintain duct pressure.
  - 8 large Air handling units maintained 2.5” of static pressure at 1460 horsepower.
- Approach
  - Ryan Staggs - JLL Sr Op Engineer - proposed he could maintain building temperatures and save the state money by lowering duct static pressures.
  - Slowly drop static pressures incrementally over time and track the buildings performance vs weather data.
  - 5 months in & static has been lowered 1” to 1.5”.
- Results
  - No cost initiative – BAS keystroke changes.
  - Extending equipment life.
  - $4,232 per month savings
  - $50,788 per year (pending)

Energy Management Case Studies

Case Study 2 – Cleveland State Community College, Exterior LED Lighting Retrofit

- Situation
  - The exterior lighting at the Cleveland State Campus contained many old, inefficient, metal halide light fixtures.
  - Repair and maintenance cost as well as energy cost were very high.
  - Lighting outages were common.
- Approach
  - The JLL team contracted with a local electrical contractor to supply and install new LED Light fixtures in the place of the existing fixtures.
  - The work was performed on the weekend so parking for classes was not interrupted.
- Results
  - Parking lot lighting is more dependable. Well-lit for student safety.
  - $12,000 project cost labor + materials
  - $4,847 annual cost savings. $2,347 energy + $2,500 M&R savings.
  - 2.47 year payback for Cleveland State