

**Ethanol: The World's Future?**

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April 3<sup>rd</sup>, 2007

Mr. Morrison

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### **Ethanol?**

Ethanol is used as a clean-burning fuel. It's the form of alcohol that people usually refer to when talking about the compound in alcoholic drinks (Ethanol, 2007). It's colorless, naturally smells like perfume, low-carbon, and sports a very high octane rating, which means it's extra-flammable.

### **Ethanol: It's a Fuel? And why choose it?**

With 7.5 billion gallons of ethanol (5.75% of annual U.S fuel consumption) going into supply by 2012 (Moreira, 2005) many people can't help but wonder why Congress has decided to use that particular fuel. Global warming is slowly chipping away at our ozone layer, which protects us from harmful U.V. rays which the sun sends us. Global warming is caused by our carbon output (our **Green House Gas**, or GHG emissions), and carbon comes out the tail pipes of our cars, our buses, our planes, and every single appliance which runs on energy generated by burning fossil fuels. That's a fairly complicated domino effect! Basically, every time we burn oil and its byproducts (gasoline, kerosene, etc.), it brings us closer to our demise.

The good news is that ethanol is a green fuel, which means that it burns with less carbon output. According to Cellulosic Ethanol (2007), Renewable Fuels (2007), and Cellulosic Ethanol (n.d.) common ethanol obtained from starch makes 18-29% less GHG emissions than gasoline, not to mention cellulosic ethanol (ethanol obtained from cellulose bio-mass), which makes 85% less.

Ethanol is attractive out of the many alternative energy sources because it can be widely used as an all around motor fuel. This means it has the ability to power all motors which are now run on fossil fuels (i.e. the car, the train, the bus, etc.), not to mention that

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it can also be used for electricity generation. As ethanol ignites faster and leaves fewer waste products than standard gasoline, the authors of the article *Renewable Fuels* (2007), were able to conclude that most vehicles in circulation today can run with up to 10% ethanol inside the tank, perfectly. Dolbear said this year that some *new* vehicles can even run with 85% ethanol! Ethanol is made from bio-mass. So, the carbon it emits is just reabsorbed into plants which are going to make more ethanol (Chemical Compound, 2007). This halts the energy crisis in its tracks. Another disadvantage of fossil fuels has to do with the fact that in the West there aren't very many oil reserves. As a whole, and in the U.S. especially, there is political tension about the fact that if there was some sort of problem, and the constant stream of oil we receive from the Middle East was denied to us, exploited or interrupted, we would be in big trouble (Barta, 2007). Ethanol can be produced anywhere that certain plants or animal fats can be grown or produced. And, it makes lots of local farming jobs.

But, there are disadvantages of ethanol also. As a fuel, it can be corrosive to older engines (Ethanol, 2007). Barta (2007) says that the demand for the corn most commonly used today to make ethanol is pushing up prices for the corn in poor, rural areas. Locals in Mexico are finding it harder to buy the corn they use to make tortillas, a staple in their diet. Similarly, inflationary cost pressures are being felt in developing countries like India and China, increasing poverty. Mixing ethanol and gasoline together may cause acid rain from the nitrogen oxides which form (Renewable Fuels, 2007). And, ethanol does contain a suspected carcinogen.

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Many people are wondering: is it just to clear forests to get woodchips? Is it okay to let poverty-stricken people in third world countries burn their rainforests to grow energy grass? The coming years may define the lives of those living millennia after us.

### **How is ethanol produced?**

Ethanol comes from a variety of bio-mass. The most commonly used sources include soy, corn, wheat, sorghum, grass, potato skins, rice, barley, sugarcane, palm-oil, wood and straw. Rarely, other kinds of plant-matter may be used, but even rarer is using recycled restaurant greases and animal fat (Renewable Fuels, 2007; Ethanol, a Biofuel, n.d.; Cellulosic Ethanol, 2007). This will be focusing on the ways to make cellulosic ethanol, or ethanol obtained from cellulose.

Why cellulose? Well, for one, Cellulosic ethanol (not dated) says that it happens to be the most common bio-mass on the planet! The sources for making *it* include all cellulose-based bio-mass. Today, the sources tend to be mainly the urban, agricultural and forestry varieties of waste (Cellulosic Ethanol, 2007). This form of ethanol is naturally much greener than the starch and sugarcane kinds. SunOpta and Iogen, two Canadian firms, are at the forefront of the fight for cellulosic ethanol with innovative and ground-breaking new technology. There are two ways to produce it: Either using hydrolis, or with gasification. Finally, within hydrolis there are two additional subdivisions: chemical and enzymic.

#### **Hydrolis:**

The article Cellulosic ethanol (2007) and Cellulosic ethanol (n.d.) describes hydrolis (or hydrolysis) as being, in this case, the ways to break up the long strings of glucose molecules that make up cellulose to convert into another form of energy. Starch ethanol

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is the same basic principle, but the strings of sugar are much shorter in that form of biomass. The new stable mixture can then be fermented to get ethanol.

### **Chemical:**

According some articles, chemical hydrolysis uses acids that hit the cellulose to break it down. Then, water is added to separate the new sugar from the acid additives. The flammable lignin obtained during this stage can power the whole process, making it incredibly green.

### **Enzymic:**

Enzymic hydrolysis is similar to the chemical form; however, the cellulose isn't broken down using acids. It's done using enzymes, like cellulase (Cellulosic ethanol, 2007). These enzymes are found in nature, not to mention in the Canadian biotechnology firm Iogen. Iogen has changed the way cellulose ethanol is made by using new enzymes and a steam-oriented pre-treatment to maximize exposure of the plant fiber to the enzymes. These enzymes are generally excreted (pooped-out) by specific microorganisms, some of which are found in our gut (Company delivers waste straw to refinery, 2004). Other companies are taking a different approach: fungi (Cellulosic ethanol, 2007). They genetically modify them to produce large amounts of cellulase.

### **Gasification:**

Gasification is very different from the other method. It uses the carbon in the plant to produce ethanol. So, plants with higher carbon levels, like wood chips, are preferable (Ethanol fuel, 2007). The carbon is gasified, and then eaten

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by a bacterium named *Clostridium ljungdahlii* and its variants. As a waste product it produces ethanol and water.

### **Cellulosic ethanol in the market:**

Iogen, SunOpta and Greenfield Ethanol, two of which have been mentioned before, are the people making ethanol *today*. Iogen was the first to sell cellulosic ethanol in April, 2004 (Cellulosic Ethanol, 2007), while SunOpta is the largest cellulose ethanol producing entity in Canada.

The article SunOpta (2007) reported that on Dec. 21st, 2006, SunOpta — announced a partnership with Greenfield Ethanol. Each company has 50% ownership (Cellulosic ethanol, 2007). SunOpta stated that the deal will include the construction of large scale plants that make ethanol from wood chips. The first of these plants will make 10 million gallons cellulosic ethanol per year, which is most certainly about as commercial as you can get when it comes to ethanol (Cellulosic ethanol, 2007; Company delivers waste straw to refinery, 2007).

Iogen is a small compared to SunOpta. But, it was the first to sell just over a million gallons of this new form of fuel, so we can give it credit for a lot (Cellulosic ethanol, n.d.). The same article notes that it produces ethanol from wheat, oat, and barley straw. A quick review of the PTO website reveals that these companies, and their competitors, will fight to gain rights to exploit their collective technologies. A group of investors, including the Canadian Government (its primary customer) have invested in it, to bring in about 110 million USD. Even Petro Canada has hopped on the bandwagon as a consumer!

Greenfield Ethanol has an interesting history: it began in 1989 as 'Commercial

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Alcohols,' but, after becoming more and more estranged with ethanol, it changed its name (Cellulosic ethanol, n.d.) Since then, it has opened numerous plants, in Ontario, and has another one coming soon.

### So what have I learned?

In conclusion, ethanol and the cellulosic ethanol hold promise for replacing a significant portion of petroleum and its byproducts in transportation and power-generation over the course of the coming decade. This renewable energy resource has a sunny future ahead of it on many the Iowa farm.

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