

# Renewable Energy

## The Ethanol Production Process – Dry Mill *Flow Meters and Controls*



Direct Reading Flowmeters  
For Liquids and Gases

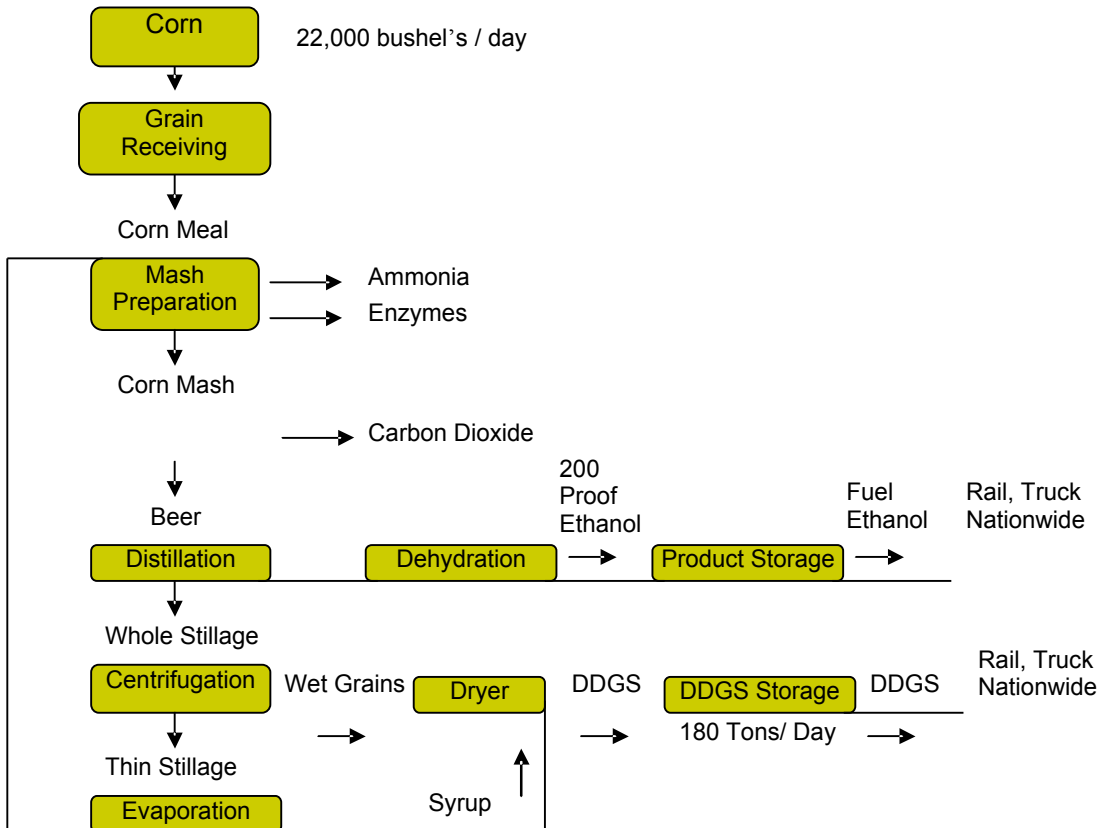
## Ethanol- How it's made....

There are three main uses for ethanol (industrial, beverage and fuel) and production varies for each industry. Ethanol production in the US is primarily used for fuel consumption using a dry mill process.

It takes 1 bushel (56 lbs.) of corn to produce an estimated 2.5 to 3.0 gallon of ethanol. Now more than ever US consumption of ethanol will increase dramatically over the next few years from 2 billion to over 7 billion gallons per year. Our goal is to eliminate our dependence on foreign oil. The following steps go into the production of ethanol.

- **Milling:** The corn will first pass through hammer mills, which grind it into fine powder called meal.
- **Liquefaction:** The meal will then be mixed with water and alpha-amylase, and will pass through cookers where the starch is liquefied. Heat will be applied at this stage to enable liquefaction. Cookers with a high temperature stage (120-150 degrees Celsius) and a lower temperature holding period (95 degrees Celsius) will be used. These high temperatures reduce bacteria levels in the mash.
- **Saccharification:** The mash from the cookers will then be cooled and the secondary enzymes (gluco-amylase) will be added to convert the liquefied starch to fermentable sugar (dextrose), a process called saccharification.
- **Fermentation:** Yeast will then be added to the mash to ferment the sugar to ethanol and carbon dioxide. Using a continuous process, the fermenting mash will be allowed to flow, or cascade, through several fermenters until the mash is fully fermented and then leaves the final tank.
- **Distillation:** The fermented mash, now called "beer", will contain about 10% alcohol, as well as all the non-fermentable solids from corn and the yeast cells. The mash will then be pumped to the continuous flow, multi-column distillation system where the alcohol will be removed from the solids and the water. The alcohol will leave the top of the final column at about 96% strength, and the residue mash, called stillage, will be transferred from the base of the column to the co-product processing area.
- **Dehydration:** The alcohol from the top column will then be passing through a dehydration system where the remaining water will be removed. Most ethanol plants use a molecular sieve to capture the last bit of water in the ethanol. The alcohol product at this stage is called anhydrous (pure, without water) ethanol and is approximately 200 proof.
- **Denaturing:** Ethanol that will be used for fuel is then denatured with a small amount (2-5%) of some product, like gasoline, to make it unfit for human consumption.
- **Co-Products:** There are two main co-products created in the production of ethanol: carbon dioxide and distillers grain. Carbon dioxide is given off in great quantities during the fermentation and many ethanol plants collect that carbon dioxide, clean it of any residual alcohol, compress it and sell it for use to carbonated beverages or in the flash freezing of meats. Distiller grains, wet and dried, are high in protein and other nutrients and are a highly valued livestock feed ingredient. Syrup is another byproduct containing some of the solids that can be sold. Ethanol production is a no-waste process that adds value to the corn by converting it into more valuable products.

## Ethanol Flow Chart – Dry Milling



## Production

- 1 Bushel = 56 lbs. of Corn
- 3 Gallons of Ethanol / Bushel
- Capacity – 42,000,000.00 Bushels / Year = 126,000,000.00 Gallons / Year

## Byproducts

- DDGS (Dry Distiller Grain Storage) Feed Stock
- Fertilizer
- Syrup
- Dry Ice

## **Ethanol- Metering and Flow Control**

**Ethanol** - Automobile manufacturers approve and even recommend the use of ethanol, E10 (10% ethanol and 90% gasoline) and E85 (85% ethanol and 15% gasoline) which is the cleanest burning renewable fuel used today. The U.S. ethanol industry has created new jobs in all sectors of the economy.

RCM Industries, Inc. provides flow measuring products for the manufacturing process of ethanol. Selecting the right elastomer and materials of construction are important factors when monitoring ethanol production processes, Bronze or 316 Stainless Steel with Viton™ seals (Option A) and a gasket case NEMA 4X rated (Option D) are the primary choice for this application. Typical piping connections are 8000 series (wafer) style for easy installation and removal. Since the flow meters are self contained and require no power they are the right choice during plant shut down which can hamper the production process ultimately affecting the bottom line.

The RCM flow meters monitor the flow of water into the cooker as well as the denaturing process where the remaining water is removed from the alcohol. Seal water is also metered using the RCM flow meter to ensure proper pump operation by protecting face seals and shaft seal on critical process equipment.

With the demand for cleaner burning fuels the need to produce a higher concentrations of ethanol blended gasoline or “flex fuel” (E85) will also drive the production of ethanol up. Ethanol production is expected to increase from 2.3 billion gallons per years to as much as 7.5 gallons per year in 2012. Brazil is currently using E85 and E95 which has eliminated their dependence on foreign oil. Brazil uses sugar cane in the production of ethanol which takes less overall energy to produce. In the U.S. 15% of the 2005 corn harvest was used for ethanol production.

The RCM flow meter has an accuracy of  $\pm 3\%$  of full scale which is suited for most industrial processes and is particularly suited for applications where compactness, low cost, minimal maintenance and resistance to accidental damage are important factors. The technology of flow meters has evolved using traditional DP methods and incorporating new technologies such as DP transmitters to monitor the production process. Differential pressure technology makes up a large percentage of the flow meter market and will continue to do so due to low cost and minimal maintenance.

One of the most controversial issues in the production of ethanol is the total net energy required to produce ethanol. Over the years significant improvements have been made such as state of the art technology and equipment from the farmers to the plant. Cellulosic ethanol technology is in its infancy but can provide alternative feedstock in the production of ethanol which can also reduce energy cost. Cellulosic ethanol is a process that uses a wide variety of feedstock and waste matter. Two methods are used to process fermentable sugars from cellulose biomass. One method utilizes acid hydrolysis to break down the complex carbohydrates into sugar and the other method is enzymatic hydrolysis, utilizes pretreatment processes to first reduce the size of the material to make it more cellulose biomass to fermentable sugar. The final step involves microbial fermentation yielding ethanol and carbon dioxide. Municipal solid waste is also being looked into to produce ethanol.

As long as the farmers and the industry continue to use the best technologies and practices available, using corn to produce ethanol will be a positive net energy generator. Working together to continually improve corn yields will significantly reduce the cost of production.

## Midwest Ethanol Plant – Arial View



These plants continue to crop up throughout the Midwest and as long as the demand for renewable fuel grows, the farmers and industry will also grow at a rapid rate. We need to continue to provide new technologies to support this effort along with new farming practices we will all benefit. Many experts believe consolidated bioprocess can dramatically reduce the conversion cost.