Makin' It On The Farm: Alcohol Fuel is the Road to Independence

by Micki Nellis
Photos by Alden Nellis

Makin' It On The Farm: Alcohol Fuel is the Road to Independence
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Special thanks to the Gene, Bill and Derral Schroder families in Campo, Colorado, the Forrest Flippos in Abilene, Kansas, and Dr. Paul Middaugh in Brookings, South Dakota. They were all pioneers in alcohol fuel.

Cover Photograph

Front:

No, it's not a barn dance. The neighbors have gathered to see the beginning of a new era - farmers producing their own fuel from their own crops. Gene Schroder's barn in Campo, Colorado, houses a working alcohol plant that delivers 30 gallons an hour of 192 proof ethanol.

Dedication

To my Parents, Sam and Bessie Stout, who chose to leave the farm so their children could get an education

To my husband, Alden, who continually shows me that I can, when I know darn well I can't

To the children, Michael and Jeffrey, who adapted well to their parents' way of life, considering they had no choice

- Micki Nellis

Makin' It on the Farm: Contents

Twenty Years After Our First Book

Chapter One - Introduction

Chapter Two

Chapter Three

Chapter Four

Chapter Five

Chapter Six

Chapter Seven

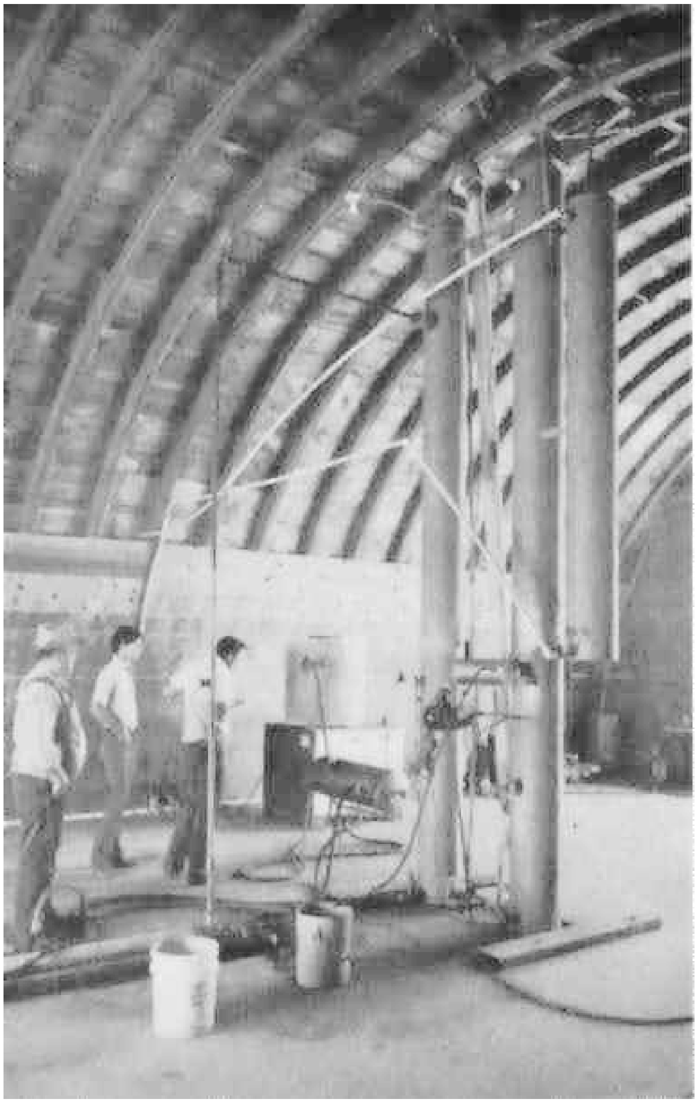
Chapter Eight

Chapter Nine

Chapter Ten

Chapter Eleven

Chapter Twelve



Derral Schroder, left, and Gene Schroder, right, fire up the alcohol plant. In the background are the steam generator and steam dryer. In the foreground are two distillation columns and a condenser.

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Alcohol Fuel
is the Road
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Electronic Edition

March, 2000

Twenty Years After Our First Book

Twenty years after *Makin' It on the Farm: Alcohol Fuel is the Road to Independence was first written in 1979, nothing much has changed. OPEC is still controlling the oil prices, and the people of the United States and the world have no recourse other than to pay the price or become self-sufficient. Y2K concerns came to the forefront in 1999, and now in 2000 the OPEC oil cartel has again raised prices to near-historical highs.*

The question was and still is who can we depend on for energy. None of us can control what will happen to the power grid or supplies of imported oil. Those who want to be prepared with low technology solutions will want to understand the process of making fuel alcohol.

In 1979, when farmers began to make alcohol fuel out of low-price grain, critics did their best to convince us that alcohol would not work as a fuel. Now several large corporations have built alcohol plants and sell it as fuel and as an additive to gasoline, using the farmers' still low-priced grain. The political issue was not whether alcohol fuel would work, but who would control it.

There are several reasons to use alcohol fuel: it is clean-burning, it reduces dependence on foreign oil, and allows people to be self-sufficient. It can be cheaper than gasoline depending on the current price.

Alcohol fuel can be used alone and does not need to be added to gasoline. Now you can buy an automobile or sports utility vehicle designed to use alcohol fuel, and the Department of Energy maintains a website to help you find alternative fuel.

There are even tax incentives to convert to alternative fuel if you care to deal with the red tape. Reference websites are listed in the appendix.

This book tells you how to make alcohol fuel, gives you the basic U. S. permit requirements, and points you to sources of more information.

The American Agriculture News, which brought out the original book, no longer exists, but Alden and Micki Nellis, the editors, now own a computer service company and Buffalo Creek Press in Cleburne, Texas, which publishes traditional books, ebooks, and maintains a website to link small farmers together in their fight for parity.

Chapter One - Introduction

Why Use Alcohol Fuels?

Americans can be free of OPEC control by burning alcohol fuels instead of gasoline. Alcohol can be used in automobiles, tractors, farm machinery, and any engine that uses gasoline. Even diesel engines can use alcohol with some changes.

Alcohol can be burned straight or mixed with gasoline. Alcohol containing as much as 20% water can be used alone. If mixed with gasoline, it is called "gasohol."

There are only two types of energy - renewable and non renewable. Oil, coal, and nuclear energy are nonrenewable. Electricity is made from nonrenewable resources except when it is generated by the force of failing water at a dam.

Most of our energy sources are controlled by huge multinational corporations. Even though we may think of the oil companies as American because their names are so familiar, they are in part foreign-owned. They operate for profit, and not necessarily in the best interests of the United States.

Who is affected by America's dependence on imported oil? Everyone in the United States. The more America spends for imported oil, the worse the trade deficit becomes, and the less the dollar is worth. Every man, woman and child pays the "hidden tax" of inflation daily. The U.S. pays more for what it imports than it gets for what it exports. Why not use our own renewable raw materials for our own needs and cut down on imported oil?

The most logical raw materials for alcohol fuels are the crops grown on America's farms. Alcohol can be made from petroleum, if we want to continue importing it. It can be made from coal, but it is more expensive and coal is a nonrenewable resource. Only farm products can be grown year after year.

Led by a few pioneers, farmers began to make alcohol fuel in 1979. Op position surfaced quickly from the multinational oil companies. The reason is obvious - anyone can make alcohol fuels, but only oil companies can make gasoline. They saw their very profitable monopoly slipping through their fingers. They mounted a campaign to discredit alcohol fuels and started debate seething in bureaucratic circles, leaning heavily on moral questions. “Is it right to use resources that could be used for growing food to produce fuel?" they asked piously, at the same time that they quietly warned the Energy Department that they would have to ship more oil to Europe if the U.S. price controls were not eased.

Making alcohol is not hard to do. Moonshiners used to make their living at it. Germany fought the last two years of the war on alcohol fuel. It has been used in Italy, Czechoslovakia, Hungary, Lithuania, Latvia, France, Yugoslavia, Sweden, Poland, and Great Britain. But these countries do not have the vast agricultural capabilities of the United States, and crop shortages sooner or later forced them to cut down on alcohol use.

Brazil, a country which has no oil of its own, used up to 20% alcohol for its fuel needs in 1979. Automobile manufacturers who wanted to do business in Brazil lost no time in optimizing their engines for alcohol. Brazil’s alcohol is made from sugar cane or manioc, which is much like our sweet potatoes. An undertaking that started out as an agricultural aid program became the nation’s passport to in dependence from OPEC.

The alcohol revolution sprang up, like Bluegrass, from the common people. Alcohol stills appeared on hundreds of farms in the backwoods of America, with or without the government’s blessings, and without government grants. Government Officials were like the proverbial General, who, seeing his troops charging, scratched his head and said, “There go my troops. I must lead them.”

Farm products can fill our fuel tanks year after year, as readily as a new crop is grown each season. It takes millions of years to grow a new oil crop.

The United States has been bogged down in "burdensome surpluses" from farm products for years, the USDA will tell you, and the main "farm problem" has been how to get rid of them. These surpluses have been blamed for low crop prices, rural poverty, and for farmers leaving the land to swell the cities' welfare and unemployment ranks. With the mass exodus, Rural America is just about dead. There is no reason for Small Town America to exist after the farmers leave the land.

Government policies to cut down on these "burdensome surpluses" include idling productive land, buying up crops and storing them at taxpayer expense, giving away food to other countries, often over objections of the foreign government that the giveaways destroy their own farmers, and by extending credit at low interest rates to other countries so they can buy U.S. farm products, and by setting low crop loan rates so that the few who are still farming will soon quit.

Farm activists in the 1970s and 80s warned that if the trend was not turned around soon, agriculture was destined to fall into the hands of 250,000 "Superfarms," according to the respected U.S. News and World Report marketing letter. The same huge corporations will raise your food, process it, transport it, and sell it to you in their own supermarkets, they warned. Several of the large corporations who sold oil and gasoline also got into farming. They could afford to lose money until the 2 million small, independent farmers were gone.

Today most of the small farmers are gone. The government has shown no concern for their welfare. An independent farmer is pitted against supercorporations who sell him his bio-engineered hybrid patented seed, fertilizer designed for the altered seed, buy his crops from him at their prices, process the food and sell it to consumers in vertically integrated business structures. Those same companies go into the farmers' fields and snoop for stray plants that may have sprung up from last year's patented seed (for he is forbidden to save seed and replant from it) and take him to court. At the smallest rise in farm prices, they make a public hue and cry that food prices will rise, even though studies show that food prices have no relation to farm prices. These are the super-corporations we now depend on to feed us.

Large corporations do not buy from local, hometown merchants. They buy from their own subsidiaries. Corporate takeover of agriculture has sounded the death-knell for independent businesses, independent farmers, and small towns at the same time.

America grew to be the strongest nation in the world in less than 200 years. While the rest of the world wallowed in feudalism, royal favoritism, dictatorships, socialism and communism, America forged ahead. Millions of strong-willed Americans used their ingenuity to go after a better way of life, spurred on by the opportunity to make a profit in return for their work, sweat and tears.

This has changed now. Small businesses, including farmers, just aren't making it any more. Powerful lobbies in Washington influence congress (by buying votes, if necessary) to pass laws favoring the corporations, giving them huge federal subsidies, and further choking independent business.

Americans find themselves captive. They depend on the multinational corporations for their salaries, and then in turn buy back their food, clothing, shelter and energy from these same corporations. America, the Land of the Free and the Home of the Brave, with a government of the people, by the people, and for the people, has turned into the home of the totally dependent.

Alcohol from farm products could play a big part in changing this. Community size alcohol plants using locally grown farm products could make towns independent of Big Oil almost over-night. Alcohol fuel plants would breathe new life into America, provide fuel, use up those “burdensome surpluses” that are blamed for depressing farm prices, and provide a high-protein feed byproduct for local use that is oftentimes as valuable as the raw commodity that went into the alcohol. Alcohol fuel nationally would cut down inflation by reducing the trade deficit and strengthening the dollar.

Countering The Critics

We will touch on the most common criticisms of alcohol fuels quickly, then get on with the information you need to make your own fuel.

Ethanol has a lower heating value than gasoline - 84,400 BTUs per gallon, compared with 115,400 BTUs average per gallon of gasoline. But the heat value of a volatile liquid has no relationship to the power output obtainable from that fuel. The important thing is the extent to which the energy is used. Automobile engines convert only about 25% of the energy in gasoline into useful work. Alcohol is more completely used. The wasted energy of gasoline caused by in complete combustion is left behind in the form of residues, gummy lubricating oils, and polluted air. Alcohol causes none of these.

If alcohol fuels are run in a motor that has been running on gasoline, the alcohol will dissolve the built-up residue in the system and loosen rust deposits inside the tanks and fuel lines. The fuel system should be cleaned out before using alcohol to avoid clogged filters and carburetor jets.

Dr. William Scheller of the University of Nebraska conducted a 2 million mile road test on gasohol-powered vehicles. His study showed that the gasohol cars got up to 5.3% more miles per gallon than those using unleaded gas. There was less engine wear, and gasohol caused less pollution. There were no adverse effects on the automobiles or the environment.

We Do Not Have a Food Shortage

What about food shortages? The United States has a history of surpluses, not shortages. Farmers can continue to produce heavily as long as they can afford to keep farming. A market for their products and the opportunity to make a profit are two things that will insure that the farmers will keep producing.

Hunger is caused by people not having enough money to buy food, not by a shortage of food. This has nothing to do with the productivity of agriculture. It has to do with the policy of public aid and the question of who should foot the bill for it.

Fuel Alcohol Can Increase Protein Supply

Moreover, the distillers dried grain solids (DDGS) byproduct of alcohol production can be made into human food and shipped to protein-starved countries without the high protective tariffs charged on U.S. grain, and at 1/3 the shipping cost because of less bulk. Only the starch is stripped out of the grain. There is no world shortage of starch. Higher starch content grains can be planted which yield more bushels per acre. The total protein yield would be about the same, but with the added bonus of the extra starch. If the U.S. really wants to feed the world, let’s ship poor countries the protein they need and leave the starch at home in the form of alcohol fuel.

The DDGS byproduct is also a high-protein livestock feed. It has been marketed by the brewing industry for years. According to Dr. William Isgrigg of the Distillers Research Council, a unit of DDGS has 30% more value per unit than soybean meal when fed to cattle. It acts as a “bypass protein,” bypassing the first three stomachs of ruminants and going directly to the fourth stomach where it is used more efficiently. It also contains growth promotants that give poultry extra growth.

The DDGS contains vitamins from the yeast - vitamin A and B vitamins. Yeast is a well-known human food fortifier. No other feeds are as rich in vitamins as distillers feeds. Milk production of cows is even increased with stillage feeding.

Fuel Alcohol Conserves Energy

There has been a thrust for more solar energy usage. Plants are the most efficient users of solar energy. The chlorophyll in the leaves uses sunlight to help manufacture organic matter. Huge solar energy collectors could be used for energy in the cities where the ground is covered with concrete anyway, but on the farms the collectors are less efficient than the plants the farmers already grow. Collection of solar energy in the country would take the energy away from the plants, deadening the soil under the collectors.

We should point out to those who argue that a fuel alcohol program would deplete the soil that alcohol is made only from carbohydrates, which are made up of carbon, hydrogen, and oxygen from the air and water. None of the nitrogen, phosphates, lime or other minerals are used up, but remain in the residue. When this residue is fed to livestock, the minerals return to the soil as manure.

Fuel Alcohol Does Not Pollute

To those who worry that the carbon dioxide gas byproduct will change the air quality, we point out that all the carbon dioxide given off was first taken from the air by the plants that were used to make the alcohol. Thus, there is no net gain or loss.

Fuel Alcohol Is Efficient

Fuel alcohol production requires fewer BTUs per gallon than gasoline production, despite propaganda to the contrary. It takes 135,000 BTUs to make one gallon of gasoline, but only about 40,000 BTUs or less per gallon to make alcohol. Even in 1979, two engineering firms guaranteed their plant designs to produce 200 proof alcohol with an energy consumption of less than 36,000 BTUs per gallon. One of these designs included drying the byproduct.

Since a gallon of alcohol has a net energy content of 84,400 BTUs per gallon, there is a net gain of at least 47,000 BTUs even if fossil fuel is used to power the still! When crop residues or wood fire the still, all of the energy used is new energy from renewable resources. William Hedrick, Denver engineer, estimated that only about 1/4 the crop residues produced with the grain will be needed to fire the still, leaving plenty of residue to return to the land.

The oil companies argue that it takes more fossil fuels to raise the crops to make alcohol than is gained in energy by the alcohol. Even if farmers continue to use fossil fuels to raise their crops, Hedrick says it takes 63,000 BTU per bushel to raise non-irrigated corn, or about 25,300 BTU per gallon of alcohol. Subtracting this from the energy value of the alcohol leaves a net gain of 58,000 BTU of new energy in each gallon of alcohol. (Drying of grain to be used for alcohol production is not needed.)

When more alcohol fuel is available, farmers can use it instead of fossil fuels to do their far ming. Dr. William Scheller, in a paper presented to the American Chemical Society in 1976, said his research showed that when the total farming operation and fermentation process were considered, for every three gallons of grain alcohol produced, at least one gallon is new energy entering the economy. Producing beverage grade alcohol does require more energy than producing gasoline, but beverage grade alcohol requires about 4 times more energy than making fuel grade alcohol.

Many will say that alcohol fuel is not economical - but the economics change with each rollup of the price meter at the gasoline pump. Besides, what monetary value do we place on more independence and less inflation?

Farm Alcohol Means Farm Independence

An alcohol plant on every farm would make the farmer once again self-sufficient, independent. The farmer raised his own energy crops when he used horses and mules. Now he can raise his own fuel for his modern tractors and farm machinery. The farmer has the advantage over large alcohol plants because he can put up a small plant in a few weeks, compared to a two-year lead time on large plants. The farmer can use his own wastes when they are available. Large plants will have to contract months ahead of time for feedstocks.

The farmer can tailor the size of the alcohol plant to his own needs and resources. He can use the crops he grows best, produce as much fuel as he needs, adjust his livestock numbers for the amount of high-protein feed he will produce, and work at making fuel during slack times. He will never have to wonder if fuel will be available when he needs it, and at what price.

Grain contaminated with aflatoxins can be made into alcohol and the residue buried. Soil burial is accepted as a safe method for detoxification.

Watermelon crops have a high percentage of culls that rot in the fields. These could make alcohol. Potato farmers get docked 25% of their production each year for culls. Weather-damaged crops could be made into alcohol instead of being thrown on an already depressed market. Overripe fruits and vegetables could be thrown into the fermentation vat and turned into liquid energy.

There is a strong push for getting more energy from coal, shale, and nuclear reactors. All these sources are nonrenewable. They will be controlled by the multinational corporations that sell us energy now. The government has given these companies huge subsidies in the past to develop this energy, and it will increase the subsidies in the midst of each energy crisis.

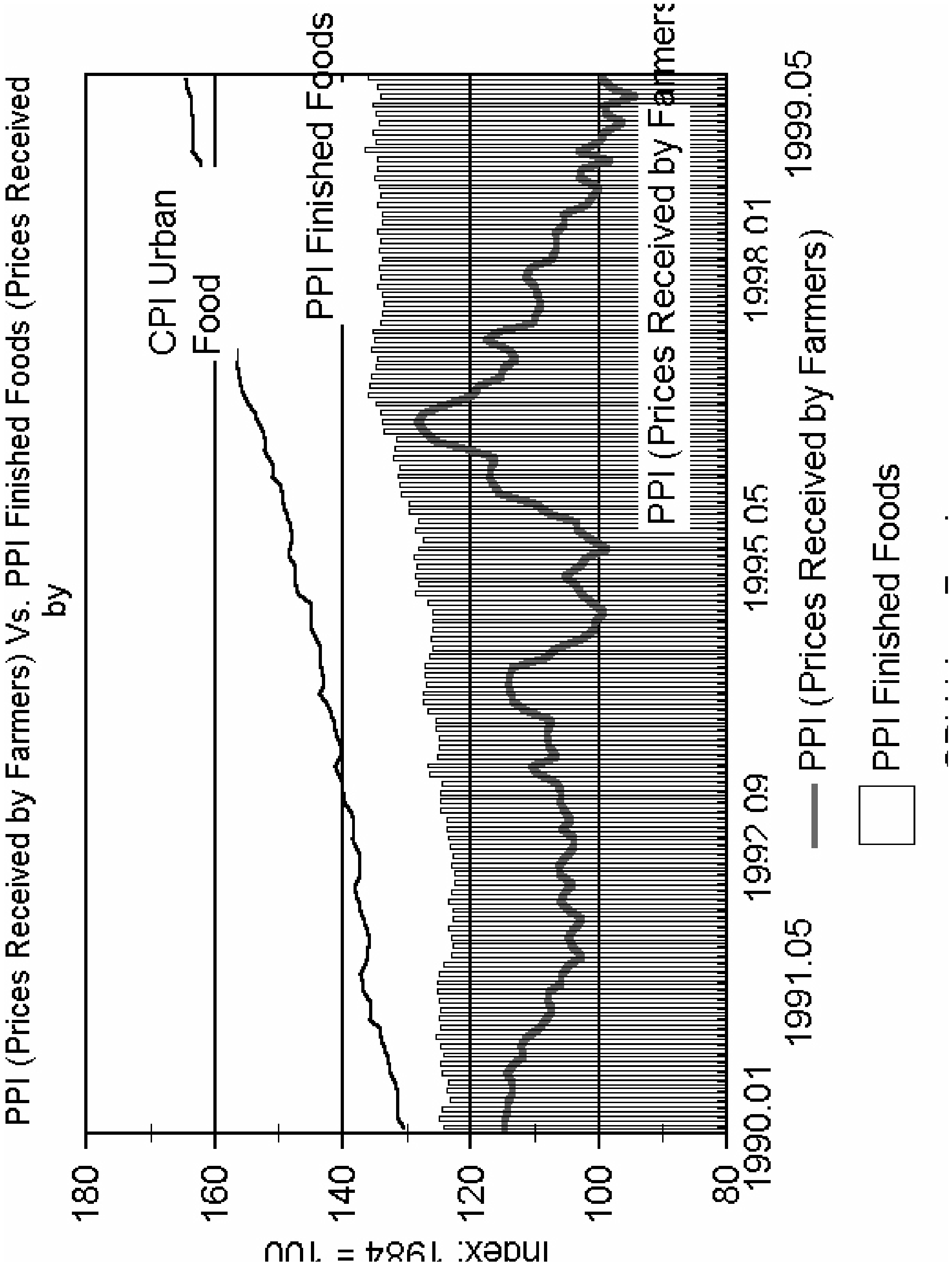
Alcohol from farm products and solar energy development are poor stepchildren in the government's plans. If farm alcohol is to be a reality, farmers will have to do it for themselves.

If they will, then the rest of the country can continue buying energy from the multinational corporations if they choose, while the farmers quietly make their own fuel. This accomplishment would be a giant step toward true independence on the farm.

If the farmer is allowed to sell alcohol fuel to others, then the whole country can take a step toward independence.

Food Prices Do Not Relate to Farm Prices

The cost of food in the grocery store has no relation to the prices paid to farmers, as shown in the chart following. Source, USDA.


PPI (Prices Received by Farmers) Vs. PPI Finished Foods (Prices Received by
Index: 1984 = 100
180
160
140
120
100
80
1990.01
1991.05
1992.09
1995.05
1998.01
1999.05
CPI Urban Food
PPI Finished Foods
PPI (Prices Received by Farmers)
PPI (Prices Received by Farmers)
PPI Finished Foods

Chapter Two

Principles of Alcohol Production

Two types of alcohol will work equally well for fuel. They are ethanol and methanol. In this book, we refer to ethanol when we speak of alcohol, unless we specifically say methanol.

Alcohol content is measured in proof. The proof is twice the percent. Thus 100 proof alcohol is 50% alcohol and 50% water. 200 proof alcohol is 100% alcohol.

Ethanol

Ethanol is also called ethyl alcohol or grain alcohol. All industrial ethanol was produced from grain fermentation until the industry discovered they could make it cheaper from petroleum. This was in pre-OPEC days.

The ethanol industry was geared to producing high-purity industrial alcohol or drinkable alcohol. For this reason, they were locked in to using stainless steel and copper equipment, and also to the process of distillation. Distillation served not only to separate the alcohol from the water, but to separate other impurities from the alcohol - impurities that might make a person sick if he drank it.

That is why the fuel alcohol industry started with technology developed for the liquor and industrial alcohol industry. That was all the technology there was. As more people experiment with making alcohol strictly for fuel, ways will quickly be found to do it cheaper when we get away from the traditional thinking of the old distillers. Ethanol can be made from anything containing starch or sugar. The higher the starch or sugar content, the higher is the alcohol potential of the crop.

Cellulose in stalks, wood or paper can also be used to make ethanol, but the process is expensive with present technology.

Starch is the most important storage form of carbohydrates in the plant kingdom. However, another significant form is inulin. Artichokes, Dahlias and Dandelions all store carbohydrates as inulin. The inulin is made up of fructose molecules instead of glucose, as in starch.

It has been found that most of the carbohydrate is stored in the Jerusalem artichoke stem before the bulb starts to form. If it is stored as fructose, and if it does not change to inulin soon after harvesting, the fructose can be fermented as is. But if it is inulin, we know of no commercial, economical enzymes available to break down inulin. (Bitter almonds do contain inulinase.) The carbohydrate can be broken down with high heat and strong acid, but with a lot of energy input and 20% or more destruction of the sugar.

If the fructose in the stem is useable, the tops can be cut off and the bulb left in the ground to grow again.

Fermentation

Enzymes break down starch into simple sugars, and yeast ferments sugars into ethanol, giving off carbon dioxide gas as a by product. The process has been used since civilization began.

Starch is made up of long chains of glucose molecules coiled together. The starch must be broken down into sugars that are only one or two molecules long for the yeast to feed on.

In the process described in this book, the liquefying enzyme breaks the chemical bonds at random inside the chain, producing shorter chains, or dextrins, as they are called.

The saccharifying enzyme works on the end of the chain only. It could take off the glucose molecules one by one from the ends of the starch chains and eventually would convert all the starch to sugar. The liquefying enzyme gives the saccharifying enzyme more ends to work on, however, and speeds up the process considerably.

There are other monosaccharicles (one molecule only) besides glucose, but glucose is the most common.

Disaccharides are two monosaccharicles joined together. Table sugar (sucrose) is one glucose and one fructose molecule. Milk sugar, or lactose, is one galactose and one glucose joined together. Maltose is a disaccharide made up of two glucoses.

Yeast can ferment glucose, maltose, and sucrose rapidly, and galactose and lactose slowly.

Enzymes are proteins that change a chemical entity, or molecule, of one substance into a molecule of something else. The enzyme acts on the substance, but is not used up. The enzyme changes one molecule, then detaches from it and works on another molecule. A few molecules of enzyme will eventually get around to all the molecules of whatever it works on, but the right amount of enzyme will do the job faster.

People have enzymes in their mouths that break down starch. If you hold a piece of soda cracker in your mouth, it will begin to taste sweet. This is exactly the process that takes place in the mash. Enzymes are highly specialized. Each one does only one thing. In this process, one enzyme chops up the long chains of starch into shorter chains. Another enzyme changes the short chains of starch into sugar.

Enzymes, like humans, function within a fairly narrow range of physical conditions. They must have a certain temperature and degree of acidity. They can be rendered useless by chemical poisons, heavy metals, high heat, etc. Each enzyme has a certain set of conditions under which it works best.

When grain sprouts, enzymes change the starch into sugar that the new plant can use for food. Before enzymes were available for purchase, grain was sprouted, or “malted,” then dried, ground, and mixed with the rest of the grain as a source of enzymes. This method can still be used, but it is quicker to use commercially available enzymes. Starch can be broken down without enzymes with strong acid and high heat. However, the process takes a lot of time and energy, and then the excess acid has to be neutralized with alkali before fermentation can take place. After the starch is changed to sugar by enzymes, yeast changes the sugar to alcohol in the absence of air. The process is called fermentation, and it takes about 21/2 days.

Carbon dioxide gas is produced as the yeast changes sugar to alcohol. A bushel of grain yields by weight about 1/3 carbon dioxide, 1/3 ethanol, and 1/3 high-protein residue. The carbon dioxide gas can be allowed to escape through an air lock or a one-way vent valve, or it can be collected and used.

The fermented mash contains about 10% alcohol. At this concentration, the alcohol begins to kill the yeast. The batching should be done so that all the sugar and starch in the mash will have been used up by the time this 10% alcohol content is reached.

It takes 13 pounds of sugar to yield 1 gallon of 190 proof ethanol. The amount of raw material in the mash will be determined by its starch and sugar content. In order to get fuel alcohol, the alcohol content must be increased f rorn 10% to 90 - 95%. At present, the only workable way to do this is to distill it. In the future, other ways may be discovered which take advantage of the different properties of alcohol and water.

Distillation

The temperature of the water-alcohol mixture is raised to above the boiling point of ethanol (173 degrees F at sea level) but below the boiling point of water (212 degrees F). The alcohol changes to vapor and rises in the column, but some of the water vaporizes with it.

In a simple still, like that used by the moonshiner, the distillate is about half water. If this is re-distilled, a higher concentration of alcohol can be obtained, up to about 195 proof. Further separation cannot be obtained by distillation because of a quirk in the chemistry of the mixture. (Water and alcohol form an “azeotrope” at this point.) The final fraction of water must be removed by other methods, if this is necessary.

Farm alcohol plants can produce 190 to 192 proof alcohol with one pass through a still equipped with a reflux column, which is a device for making the mixture of liquids vaporize, condense, then revaporize over and over until the alcohol is nearly free of water.

In summary, the starch is changed to sugar by enzymes. The yeast changes the sugar to alcohol during fermentation, giving off carbon dioxide gas and leaving a high-protein residue in the mash. The mash contains about 10% alcohol after fermentation. It is then distilled to make a fuel alcohol that is 160 to 190 proof, or 80 to 95% alcohol.

After the mash has been distilled, the protein and the water are left. The water can be reused after the protein is separated, or the entire stillage can be flowed over straw or hay and fed to livestock.

Methanol

Methanol, also called methyl alcohol or wood alcohol, works just as well as ethanol for fuel, but the process for making it is completely different. This book does not tell you how to make methanol.

Methanol is a highly poisonous liquid. It will kill you if you drink it, and it can kill you if it soaks into the skin.

Methanol is made by heating wood wastes, stalks, etc., under relatively low heat and high pressure and then purifying the product by fractionating columns. It can be made from material that is not suited to ethanol production, but if grains, for instance were used to make methanol, all the protein would be destroyed. Methanol can also be made from coal. Both ethanol and methanol have their place in farm fuel plants.

Chapter Three

Success Stories

Albert Turner

Albert Turner, Selma, Alabama, and other members of the South west Alabama Farmers Cooperative began making alcohol in early 1978. Their' was the first fuel alcohol plant built in the United States in recent years. They had a small Office of Minority Business grant, crude equipment, and not even a shed over the still.

Albert Turner used corn, a wood fire, and produced 130 to 180 proof product. He had one 2,000 gallon fermentation tank that would produce 200 gallons of alcohol at best in 72 hours, in favorable weather. He had no extra heat for the fermentation, and in cold weather it slowed down. He had to distill one batch to empty the fermentation tank, then mix up another batch and wait 72 hours to distill again. He produced a maximum of 300 gallons a week, although the distillation column could have handled 30 gallons an hour.

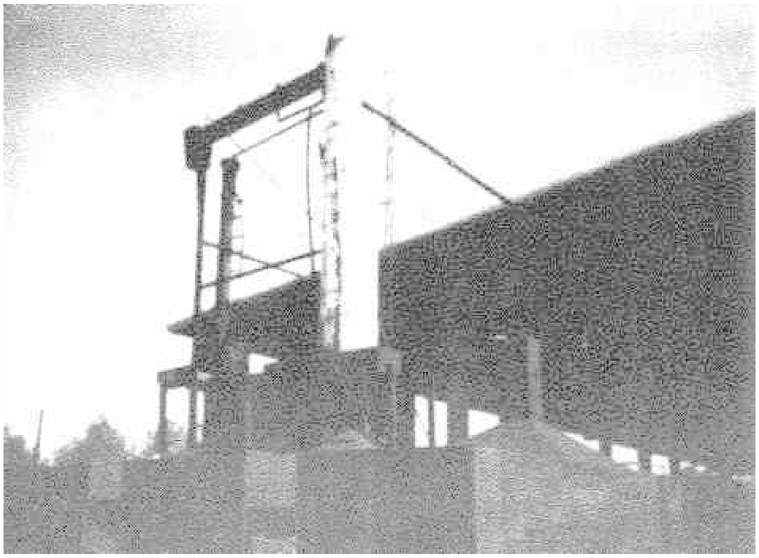
The single column was 10" in diameter and 12' tall. Inside were circles of heavy gauge 1/8" mesh wire spaced 4" to 6" apart the length of the column.

Turner's still produced no waste material. The wood that fired the still was completely burned. The spent mash was fed to the hogs.

Turner said he could sell the alcohol for 65 cents a gallon as long as he could sell the protein byproduct, did not have to transport the alcohol and didn't have to pay a middleman to sell it.

Albert Turner envisioned an alcohol plant every 100 miles across the country.

"It would be the best thing that ever happened to agriculture - there would be no more surpluses," Turner said of farm alcohol. And then he said he was tired of hearing people compare the cost of alcohol with the cost of gasoline. "Any time you can raise the octane rating of fuel that much, you can't compare it with gasoline." Turner explained that alcohol cut down on pollution and stopped the flow of the dollar out of the country, could provide jobs in agriculture and take care of all surpluses. "I would rather pay more for alcohol than gasoline for those reasons alone," Turner said.


Albert Turner and the Southwest Alabama Farmers Cooperative built the first farm alcohol fuel plant in Selma, Alabama. This is their second plant - bigger and better. Photo by J. W. Watford, Valdosta, Georgia.

The alcohol was tested in about 200 vehicles, everything from farm trucks to Cadillacs. There were no problems. The Environmental Protection Agency said they wanted to do extensive testing before they okayed it.

Turner himself was pushed to the forefront as a proponent of alcohol or gasohol. He met with the Secretary of Agriculture, testified before congress, and was written about in many newspapers. Albert Turner carried the banner well. Turner drove his old John Deere G tractor to Washington D.C. to prove a point. After the oil companies and the auto manufacturers had testified against farm alcohol, saying that alcohol fuel was not feasible, that it would ruin cars, that an alcohol fuel would take years to perfect, and besides, it could be made cheaper from coal, Senator Birch Bayh, Indiana, asked Turner to testify. Turner described his plant and explained the costs of making alcohol. He said he had been burning straight alcohol in his pickup for two years and it had 120,000 miles on it. Then he turned to the experts in the audience and asked “When is it supposed to ruin it?”

After the first still had served its purpose, Turner started working on a bigger one. On June 27,1979, he was notified by the Bureau of Alcohol, Tobacco and Firearms that he had been granted a regular distillers license to make and sell alcohol. His new plant was ready to be fired up. This still had two columns, 30” in diameter by 15’ tall. He again used heavy gauge mesh discs, spaced 6" apart, this time with 1/4" size mesh. Turner said he has a unique system for attaching the mesh, which he did not reveal. Turner distilled by injecting steam into the 5,000 gallon fermen tation vat and letting the vapor climb the column.

Archie and Alan Zeithamer

Archie and Alan Zeithamer, father and son from Alexandria, Minnesota, had been studying alcohol for four years. When Albert Turner and the cooperative got a small grant, the Zeitham-

The Archie and Alan Zeithamers, Alexandria, Minnesota, became the first farm families to obtain a commercial license to produce and sell alcohol. Here Diane, Alan's wife, makes an adjustment.

ers worked with them on that first plant. After they finished the work in Alabama, the Zeithamers went back to Minnesota and started building their own plant. They became the first farm alcohol plant in the United States to be granted a regular distillery permit on October 13,1978. A few experimental permits, good only for two years, had been awarded before that time.

Alan Zeithamer said the whole family made a commitment to produce their own alcohol, burn it in their tractors, farm equipment, trucks, and heat their home and farm buildings with it. They used it straight, not mixed with gasoline, while others were still debating the feasibility of gasohol.

The Zeithamers built a 30’ x 50’ concrete block building, put together a distillation column out of used pipe, and set up used tanks for fermentation and storage. The total cost of the building and equipment, not counting labor, was about $10,000.

The Zeithamers, Archie and Arlene, Alan and Diane, began to make alcohol out of wheat, corn, and barley. Their cost of production, including labor, grain, denaturing, and all other expenses, was 500 a gallon.

The Zeithamers fired their still with crop residues - cornstalks, sunflower stalks, corncobs, etc. They built a fire under the tank containing the mash, and the alcohol vapors went through a single distillation column that would produce 160 proof alcohol.

The size of the fermentation tanks was the limiting factor in their output. They made about 800 gallons a week, or 20,000 gallons during the Minnesota winter.

The Zeithamers put most of their farm tractors on straight alcohol with no changes. One old Allis Chalmers tractor quit running after two days. They tore into it and found the alcohol had caused a neoprene needle valve to swell. It was replaced with a steel valve and the problem was solved. (Alcohol will affect certain rubbers and plastics.)

Alan and Archie found that, contrary to what they had been told, engines did not have to be started on gasoline, then switched to alcohol. Only under certain conditions did a carburetor have to be preheated. Once, they wrapped heavy-duty kitchen foil around the carburetor and part of the exhaust manifold so the heat was transferred across. Most carburetors are heated by the way the manifold is constructed.

"Nobody wants to tell you alcohol will work in a diesel engine," said Alan, "but the old literature says it does." Despite an $80,000 University of Minnesota study just completed saying it didn't work, the Zeithamers set about making their diesel tractors run on 95% to 98% 160 proof alcohol with 2-5% vegetable oil. They have achieved good progress but not total success.

They fed the distillers grain to their 50 dairy cows as a protein supplement. After a little experimentation, they found the cows would no longer lick mineral blocks, because all their mineral needs were being met in their feed.

The Zeithamers further experimented on making alcohol from potatoes, sugar beets, and cassava roots (the source of tapioca.)

Meanwhile, the Zeithamers began conducting tours of their plant. Six thousand people visited the Zeithamers' plant the first six months it operated.

The Zeithamers don't sell plans of their plant because, as Alan said, "You have to understand what's happening."

Lance Crombie

Lance Crombie, Webster, Minnesota corn farmer who held a PhD in microbiology, won fame when he set up a small solar still in his yard and had it confiscated by the law.

Dr. Paul Middaugh and his graduate students from South Dakota State University built this farm alcohl plant and operated it at an exhibit on the mall in Washington, D. C.

Dr. Paul Middaugh unceremoniously stirs a batch of fermenting brew in Washington D.C. On the column in the background, Crombie's first still cost about $17 and consisted of a piece of plywood with strips around the edges to form a tray, lined with black cloth and covered with glass. The mash flowed over the black cloth inside the tray, was heated by the sun, and the alcohol condensed on the glass and trickled down to a collection spot. The first distillate could then be rechanneled into another similar chamber to purify it, and so on. Crombie estimated his cost of production at around 10 cents a gallon. He experimented and found his home furnace would run on the alcohol.

Crombie's story was picked up by the wire services, and he became a popular speaker at alternate energy conferences.

Crombie began planning larger solar stills that could be mounted on rooftops, but would cost a lot more money.

Dr. Paul Middaugh

In Brookings at South Dakota State University, Dr. Paul Middaugh and his graduate students built an alcohol plant out of used, scrap and make-do equipment. They produced their own enzymes in an old cheese tank, and used a 1,000 gallon bean oil tank for fermentation.

Dr. Middaugh introduced some new distillation ideas. By using two columns instead of one and making each shorter than the customary one tall column, his columns were short enough to be placed in a normal sized barn. Dr. Middaugh injected live steam into the bottom of the first column while pumping the mash in at the top of the first column. This did away with having to build a fire under the mash. The steam stripped the alcohol out of the mash as the mash made its way to the bottom of the column, slowed down by perforated plates.

Dr. Middaugh's still produced 20 gallons an hour of 190 proof alcohol, the highest proof obtained from a farm plant at that time.

The first column contained downcomer pipes to allow the mash to get to the bottom of the first column. The perforated plates allowed the steam to penetrate the mash from below as the mash lay on the perforated plates during its slow descent through the downcomer pipes. The vapors rose to the top of the first column, about half alcohol and half water vapor, and went through a pipe to the bottom of the second column. Here they rose through more perforated plates and exited the top of the second column, went through a condenser and emerged as 190 proof alcohol.

A pump returned the water that fell to the bottom of the second column to the top of the first column. An alcohol reflux pump returned part of the cooled alcohol to the top plate of the second column to control the temperature. The temperature of the top plate of the second column, in turn, controlled the proof of the final product.

Dr. Middaugh's plant was financed with not one penny of government money. The Rural Electric Association gave $10,000 and the rest came from 50 cent donations from the community.

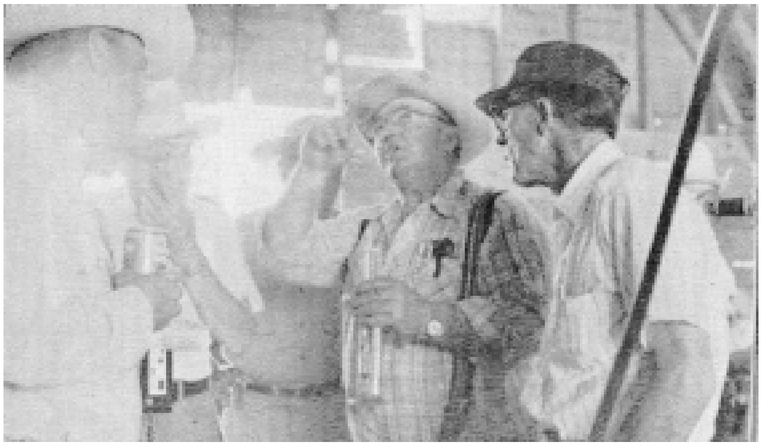
When Dr. Middaugh began to speak at alternate energy meetings, he was swamped with questions. He was asked to display his unit in Washington D.C. during the Appropriate Community Technology fair in April, 1979, and he was asked to chair the alcohol section of the Biomass Conference at Purdue University in May, 1979.

Dr. Middaugh and his graduate students built a second ethanol plant in three weeks to demonstrate in Washington, D.C. - while others talked of lead times of two to three years.

Many farmers went to Washington D.C. and to Brookings, South Dakota, to see Dr. Middaugh's still. The still left D.C. and headed for Colby, Kansas, for another demonstration set up by farmers. Alcohol fever had spread like wildfire!

Dr. Middaugh was a well-qualified champion of farm alcohol. He has had 30 years of industrial experience, was a pilot plant director for Grain Processing Corporation at Muscatine, Iowa, and worked for seven years with enzyme conversion of starch and sugar.

The Schroders



Derral Schroder, center, explains to other farmers how the alcohol plant works.

Gene Schroder, a farmer from Campo, Colorado, had been following the farm alcohol possibilities for over a year. The American Agriculture Movement, which Gene helped start, had made farm alcohol a priority in September of 1978.

Gene was disgusted with farm prices and the dying agricultural economy in general. He decided to take the bull by the horns and do something positive on his own farm.

Bill Schroder, Gene's brother, went to a National Gasohol meeting in Denver in late March, 1979. Most of the speakers were from companies that built huge alcohol plants, and they insisted that small farm plants were not economical. When Dr. Paul Middaugh rose to say a farm still could be operating in three weeks that would make a farm or a community self-sufficient, he was swamped with questions from farmers who had just heard what they wanted to hear.

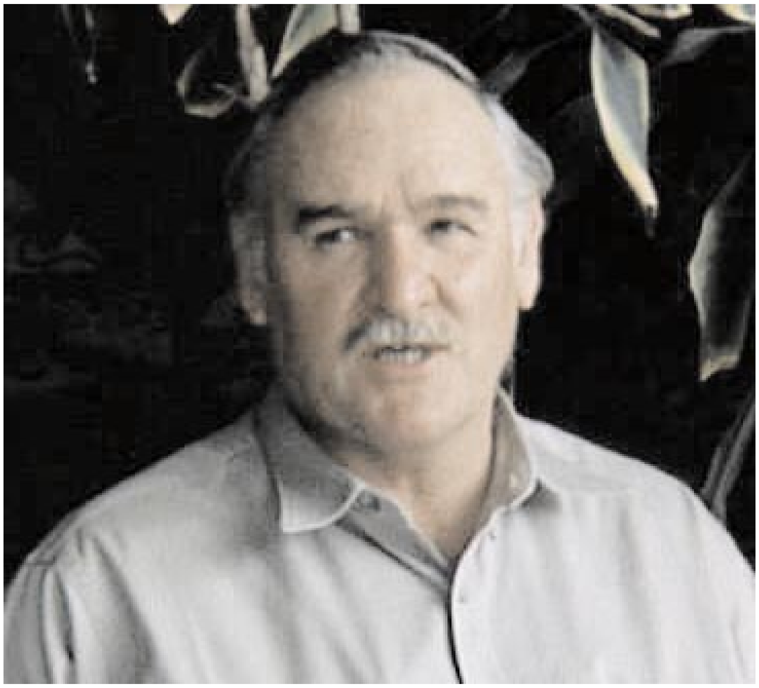
Gene saw Dr. Middaugh's still at Colby, Kansas in May, and the Schroder brothers and their father, Derral, set to work building an alcohol plant in an old barn. They did not have all the information they needed, but set out to make it work as they went.

On June 16, 1979, the Schroders held an open house to demonstrate their farm alcohol plant. They could run off 25 gallons per hour of 190 proof ethanol. All three being mechanically inclined, they had added ingenious touches of their own. This still, like Alan and Archie Zeithamer's plant, showed how a farmer could make his own fuel out of his own crops on his own farm.

The Schroders put hinges on the bottom of their columns so they could be laid down and the plates pulled out with a tractor if they need cleaning. The hinges take the place of the clean-out ports up and down the columns.

We have used this still to describe in detail exactly how to make ethanol. There is nothing theoretical about any of the process - it works. The Schroders kept improving their plant, and ended up being part of a commercial operation, Baca Food and Fuel.

The description of this process is not meant to be the final word on making alcohol. Far from it - it is just a beginning. If farmers understand the process and start building their own, the body of knowledge will grow by leaps and bounds in a short time. Many people will have better ideas and put them to work. Everyone will benefit from what others have learned.



Dr. Eugene Schroder today is still a farm activist and has authored three books: *Constitution: Fact or Fiction; War, Central Planning and Corporations*, and *War and Emergency Powers Special Report..* All are available from Buffalo Creek Press at http://buffalo-creek-press.com

Chapter Four

Measurements and Calculations

This chapter is not intended to scare anyone. It is, however, a necessary evil. The tests described below are not hard to do - most are as simple as dipping a strip of paper in liquid and looking at the color. We suggest you read through it without trying to absorb all of it, then refer to it when the test is called for in the instructions.

Temperature affects the test results. The standard temperature is 60 degrees F., but room temperature is close enough.

pH is a measure of acidity of alkalinity on a scale of 0 to 14. The lower the pH number, the more acid the substance. The higher the pH, the more alkaline the solution. pH is measured by dipping a strip of pH paper into the liquid, then comparing the color with a standard color chart supplied with the paper.

Sugar content can be read on paper strips similar to pH paper, or tested with tablets available at wine supply shops. In both tests, the color is matched to a standard and the concentration read. “Tes Tape" and other strips like “Clinistix” for detecting glucose in urine are available at any drug store. Since it only reads up to 2% glucose, a 1 to 10 dilution should be made of the mash before using the low range paper. A one to ten dilution is made by mixing one drop of mash with 9 drops of water in a dry container and shaking. The strip is dipped, and the sugar concentration reading multiplied by 10 to get the concentration in your mash.

Starch can be detected with iodine. When starch is present, a drop of iodine added to the solution will turn it blue. This test solution should always be discarded after the iodine is added. If no starch is present, the solution will be reddish-brown. This test will show whether or not there are big clumps of starch still present during cooking, and after liquefaction, if all the starch has been changed to sugar. Ordinary tincture of iodine from the drug store works for this test. A sample of the mash should be diluted for the test, and the sample containing iodine should not be returned to the mash.

Alcohol proof is measured with a Proof and Tralle hydrometer, a glass device with a long calibrated stem. The hydrometer floats at different levels in liquid, depending on the liquid's specific gravity (weight relative to water). The more alcohol is mixed with the water, the less the specific gravity will be. The alcohol proof is read on the marked stem where it emerges from the liquid.

Alcohol potential is read on a triple scale wine hydrometer that reads specific gravity, sugar content by weight on the Balling or Brix scale, and potential alcohol by volume. To determine alcohol con tent of fermented mash, a reading must be made on the alcohol scale before fermentation and after fermentation. The second reading is subtracted from the first to give the alcohol content of the fermented mash.

Proof test - Alcohol begins to burn at 100 proof. If a little alcohol in a spoon burns when a lighted match is passed across it, it is at least 100 proof. Caution: take the sample away from the still before lighting the match. The blue flame is hard to see in a well-lighted area.

Most of the equipment mentioned can be bought at wine-making supply shops or ordered from a laboratory supply house. Your local hospital, clinic, or any type of laboratory can put you in touch with a laboratory supply company.

Cost of test equipment

We found all the test equipment needed and prices at the very helpful wesite of The Brew Hut at http://www.thebrewhut.com. The physical store is in Aurora, Colorado.

From the Wine Supply Shop

pH paper	3.95
Finishing hydrometer (alcohol proof)	14.95
Triple Scale hydromter (for alcohol potential)	7.50
Hydrometer flask (tall skinny cylinder)	7.95
Sample baster (for withdrawing samples)	2.95
Iodine	3.95
Eye dropper	1.50
Stem thermometer	7.95

In addition, they have wine yeast and beer yeast, 5 grams for $1.00.

From the Drugstore

Test paper for detecting sugar in urine	10.75

Some brand names are Clinitest, Clinistix, Diastic, and Tes-Tape. There are usually 50 strips in a package.

From Enzyme Suppliers

Small quantities of enzymes are helpful for experimenting on small batches. If you don't have enzymes, fermentation takes longer. You can use sprouting grain as a fermentation aid.

Enzyme Calculations

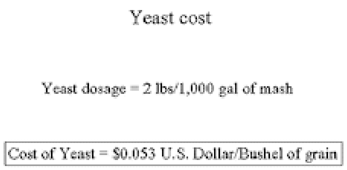
The amount of enzyme needed may be calculated on a dry starch basis (DSB) according to the concentration recommended by the manufacturer. One bushel of corn (56 lbs) containing 60% starch would contain 33.6 lbs starch. If the enzyme is needed in the concentration of .1 % of DSB, multiply.001 x 33.6 to get.0336 lbs of enzyme. If the enzyme weighs 10 lbs/gallon, divide .0336 by 10 to get .00336 gallons of enzyme. There are 128 ounces in a gallon. So .00336 x 128 gives .43 ounces, or just less than 1/2 ounce per bushel of corn.

Enzymes will have different brand names, depending on the manufacturer, and may used at different concentrations and temperatures. The enzyme supplier will furnish recommendations for the amount of enzyme needed and its temperature requirements.

See appendix for a list of enzyme sup pliers.

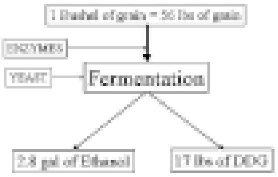
Some farm alcohol makers use two to three times as much enzyme as recommended by the supplier. Use the tests at the end of each step to see if the desired results have been obtained. If not, the enzyme concentrations may need to be increased. There are other enzymes available to refine the process or for special cases. After you become familiar with the batching, consult your enzyme supplier about any special applications or problems.

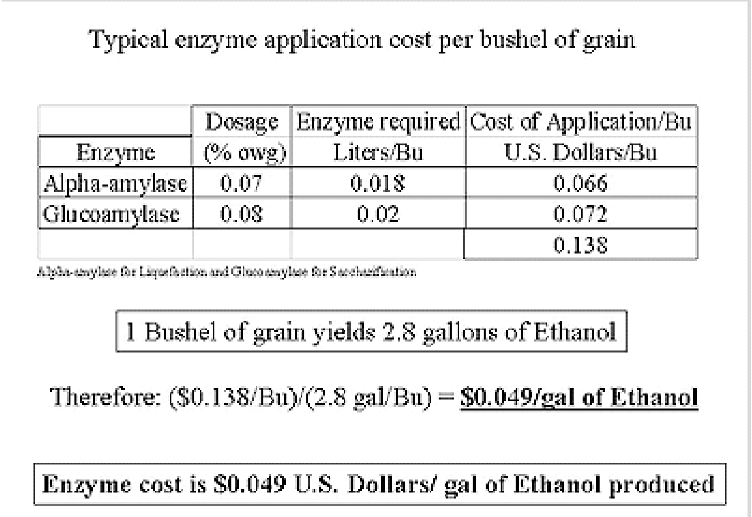
Alltech furnished the following charts showing enzyme concentration, sample costs per bushel, and yield of alcohol and byproducts.


Yeast cost

Yeast dosage = 2 lbs/1,000 gal of mash

Cost of Yeast = $0.053 U.S. Dollar/Bushel of grain





Typical enzyme application cost per bushel of grain

	Dosage	Enzyme required	Cost of Application/Bu
Enzyme	(% owg)	Liters/Bu	U.S. Dollars/Bu
Alpha-amylase	0.07	0.018	0.066
Glucoamylase	0.08	0.02	0.072
			0.138

Alpha-amylase for Liquefaction and Glucoamylase for Saccharification

1 Bushel of grain yields 2.8 gallons of Ethanol

Therefore: ($0.138/Bu)/(2.8 gal/Bu) = **$0.049/gal of Ethanol**

Enzyme cost is $0.049 U.S. Dollars/ gal of Ethanol produced

Chapter Five

Step By Step Instructions For Making Ethanol

Preparation

The Schroders have used wheat, corn and milo to make ethanol. The process for making ethanol from other crops is the same except for preparation of the raw material. Potatoes, for instance, would have to be sliced or chopped first. If you are using something besides grains, you will have to experiment a little as to how to prepare the feedstock.

If the raw material contains sugar, not starch, the batch does not have to be treated with enzymes. The sugar, as in sugar cane, is ready to be changed to alcohol by the yeast without pretreatment. The batch may need to be cooked briefly to sterilize it before adding the yeast.

Crack wheat, corn, or milo with rollers or a hammer mill grinder. The Schroders prefer rollers because fines in the mash are harder to separate from the liquid. If using corn, it should be screened to separate any whole kernels that escaped cracking. Whole corn kernels are likely to plug up columns.

Making The Mash

Materials Needed - Brewers yeast from the bakery; liquefying and saccaharifying enzymes (See appendix for suppliers); sulfuric acid diluted half and half with water (Caution: Always add the acid to the water, not the other way around); lime; a little sugar; plastic bag; thermometer to read up to 212 degrees F; pH paper; triple scale wine hydrometer that reads sugar content, potential alcohol, and specific gravity.

Batching

Start out using 10 gallons of water per bushel of grain. You will end up with 30 gallons of water per bushel of grain.

Into a 4,000 gallon tank equipped with cooling coils and stirrer, put 1,000 gallons of hot water, then 100 bushels of ground grain. Inject live steam and bring to 212 degrees F.

Calculate how much liquefying enzyme you need. Measure out the entire amount needed.

Add 1/5 of the liquefying enzyme you have measured out. Boil the batch 30 minutes with stirring.

Cool to 195 degrees F. Add the rest of the liquefying enzyme measured out, and hold the batch at 195 degrees for one hour, with stirring.

Note: Follow the instructions of your enzyme manufacturer.

Take a sample and add a drop of iodine to it. If a blue to purple color forms, the starch has not all been broken down. If the sample containing iodine is colorless or red-brown, all the starch has been broken down. It is possible to break down all the starch in this step so that it gives a negative iodine reaction. Stirring is very important to bring the enzyme in contact with the starch. This is probably the most difficult step in batching.

(If all the starch has not been broken down, the saccharifying enzyme will do it, in time, but you run the risk of not changing all the starch in the batch to sugar.) Cool quickly to 140 degrees F by adding cold water to the batch. Add sulfuric acid, diluted half with water, to bring the pH to 4.2 when tested with pH paper. (If you overshoot with the acid, bring the pH back up with lime.)

Add the saccharifying enzyme. Maintain the batch at 140 degrees F for 30 minutes with stirring.

Add cold water until the temperature is about 80 degrees F.

Test with the triple scale wine hydrometer. The specific gravity should be about 1.08. Record the potential alcohol reading for later use. if the sugar content is above 20%, add more water. Over 20% sugar will kill the yeast.

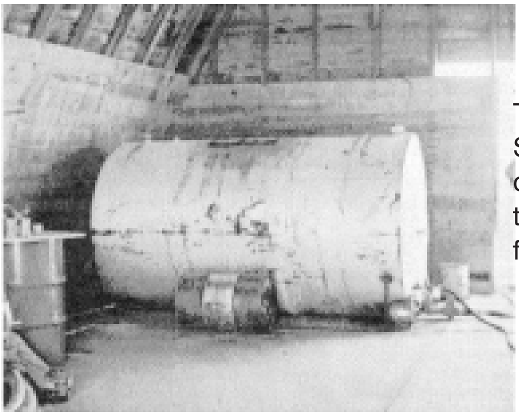
Fermentation

Add 2 to 21/2 pounds of brewers yeast for a 3,000 gallon batch. Crumble the yeast up in a little warm water in a plastic bag. Sprinkle in a little sugar and mix the yeast with your hands on the outside of the bag. As soon as the mixture starts to bubble, the yeast is growing and should be mixed in with the batch. (You can grow your own yeast in a "supermash.")

Maintain the batch at between 80 and 90 degrees F for 21/2 days with agitation. The tank should be covered with a pressure cap or air lock to keep the air out but let the carbon dioxide gas out. The fermentation itself will produce some heat. When the yeast is producing carbon dioxide, it is making alcohol.

The Schroders used an augur pump to mix the batch. Any pump designed for high volume, low pressure, would be ideal.

After 21/2 days, take the potential alcohol reading on the triple scale wine hydrometer again. Subtract this figure from the first figure obtained before fermentation. The difference is the amount of alcohol in the batch now. The mash should contain between 8% and 10% alcohol. If it does not, either something was wrong in the batching, or the fermentation is not complete. If fermentation temperature was below 80 degrees F, the yeast probably needs more time to work. If the temperature was above 90 degrees, the yeast has stopped making alcohol. In that case, the temperature



This was the Schrod ers' first cooker/fermentation tank. Small barrel in front is to stand on.

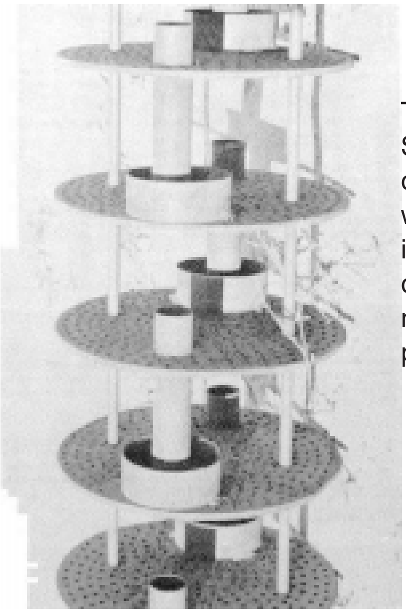
should be brought down, more yeast added, and fermentation continued.

All the sugar should be gone from the batch when fermentation is complete. Dip a glucose test strip in the mash to see if any sugar is still there.

It is important to keep the air out of the batch, change temperatures quickly, and be clean in handling the equipment and the mash. Also, it is possible, but not probable, that your mash may turn “sour” or make vinegar instead of alcohol.

Distillation

The cold mash is pumped by a variable speed pump through the outside jacket of a 60’ long preheating pipe. The hot spent stillage is flowing through the inside of the pipe, thus heating the incoming mash and further being cooled itself. The center pipe is 3" copper pipe. The outer pipe is 4" steel pipe.



This is a set of plates the Schroders made for the second column, then replaced with a set with smaller holes in the plates. The downcomer pipes and cups alternate on each side of the plates.

The preheated mash is pumped to the top of column one, called the beer still. At the same time, steam enters the bottom of the beer still. The steam is furnished at the rate of about 21/4 gallons per minute at around 280 degrees F. The steam goes through a steam dryer before entering the columns. The barrel-shaped dryer contains four baffles. As the steam goes around the baffles, it drops out water. The drier the steam going in, the less water has to be separated out later. By injecting steam from the bottom as the mash comes down from the top, the alcohol vapors are stripped out of the mixture and carried to the top of the column. The water, since it vaporizes at a higher temperature, is not vaporized and continues to fall to the bottom of the column.

The descent of the mash in the beer still is slowed by perforated plates that fit snug against the inside column wall. Downcomer pipes are inserted in the plates and empty into cups welded on the plates below. See picture for a clear understanding of the configuration of the inside of the columns.

The mash is pumped onto the 4th plate down on the first column and builds up to a height of 11/2" on that plate, then overflows into the downcomer pipe. It spills into the cup below, overflows the cup and builds up to a height of 11/2" again. It then overflows into the downcomer pipe on the other side of the plate, spills into the cup below, and the process is repeated over and over down the column.

The mash cannot go through the perforations in the plates, and the steam cannot rise through the downcomer pipes because the cups block it off. Therefore, the mash is making its way slowly down the column, with about 11/2 " lying on the plates at all times. The steam is traveling up the column through the plate perforations. As the steam goes up, it heats the alcohol to vapor and carries the alcohol vapor to the top of the column.

The first column, also called the beer still or stripper column, contains 18 plates, each 1/4" thick with 30 1/2" holes. The plates are spaced 91/2" apart all up and down the length of the first column. The downcomer pipes are 2" in diameter and protrude 11/2 " through the tops of the plates. They go down to just the top of a 4" diameter cup 11/2" tall fastened on the plate underneath. The space between the downcomer pipe and the cup should be large enough for a kernel of corn to flush out.

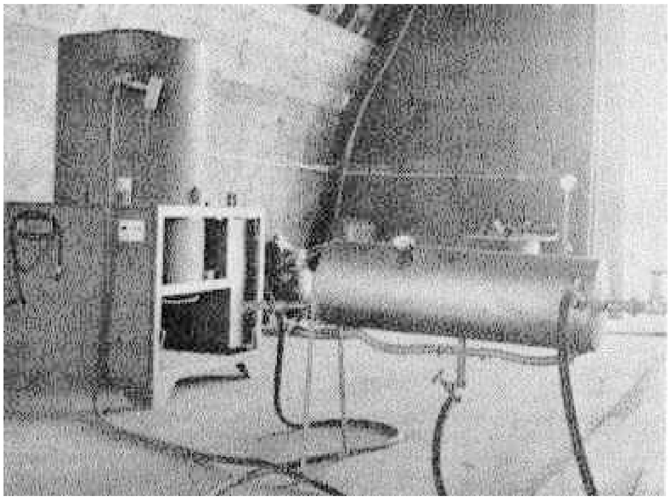
The mash enters the top of the beer still through a 2" pipe near the vaporization temperature of alcohol. At the Schroders' elevation of 4,500 feet, alcohol boils at 171 degrees F. At sea level, it boils at 173 degrees F.

After the steam has stripped out the alcohol vapors, they rise and exit the top of the first column at 198 degrees F and at about 120 proof.

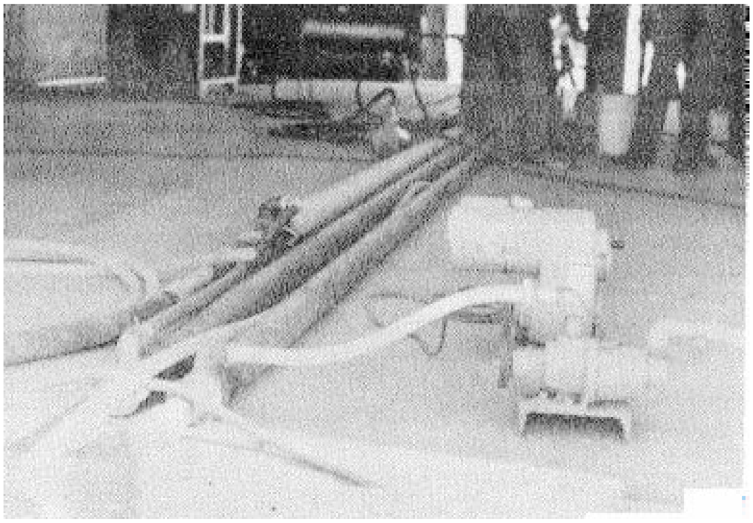
The vapors travel through a 4" pipe to the bottom of the second column for more purification.

The second column, also called the rectifying column or absorption column, is also 12” in diameter and 16’ tall. It contains 27 plates 51/2 “ apart. Each plate has 970 7/64" holes. 8% of the surface area is drilled out on plates in both the first and second columns, but the holes are different sizes in columns one and two. The plates in the second column also have downcomer pipes, but now they are 11/2 “ in diameter.

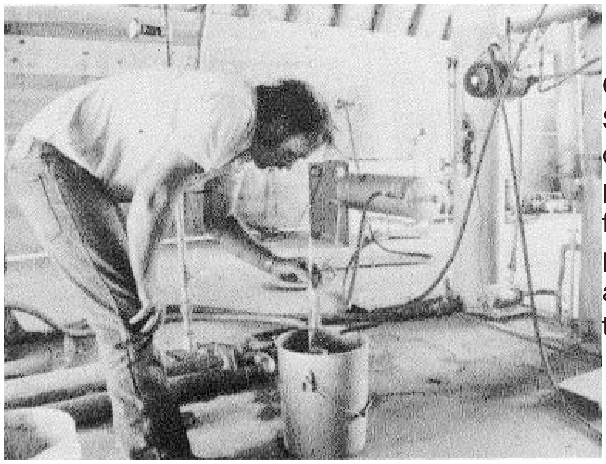
The alcohol vapors rise in the second column and more water falls out. The vapors exit the top of the second column at 170 to 175 degrees F and 190 proof. (An exit. temperature of 186 degrees will give about 160 proof.)



The steam generator, left, and the steam dryer, right. The steam dryer has 4 baffles inside that change the direction of the steam flow and cause it to drop out water.



The fermented mash travels in the outside jacket of this preheater pipe into the columns. Hot spent stillage flows through the inside pipe, heating the incoming mash while itself being cooled. The liquid flows through 60 feet of heat exchanger, doubling back twice.



Gene Schroder check the proof of the finished product with a hydrometer.

The alcohol vapors go through a 2" line into the condenser. The original condenser on the Schroders' plant contained 150' of 5/8" copper tubing inside 10' of 12" pipe, but this did not cool the vapors enough once the weather turned hot. They added 120 more feet of 11/2 " copper tubing in a 20' length of 12" steel pipe.

At the bottom of the condenser is a line leading back up to the top of the second column. Some of the alcohol is returned to the column for the sole purpose of lowering the top plate temperature. The top plate temperature of the second column determines the proof of the final product.

The condensed alcohol goes then to a locked alcohol storage tank. A pump picks up the water from the bottom of column two and returns it to the top of column one. If only one column were being used, twice as tall, this would not be necessary. In the two-column system, the column has, in effect, been cut in half so that the plant is not too tall for the ordinary barn.

At full capacity, the mash is pumped into the beer still at 250 gallons per hour at up to 170 degrees F to produce 25 gallons per hour of 190 proof alcohol.

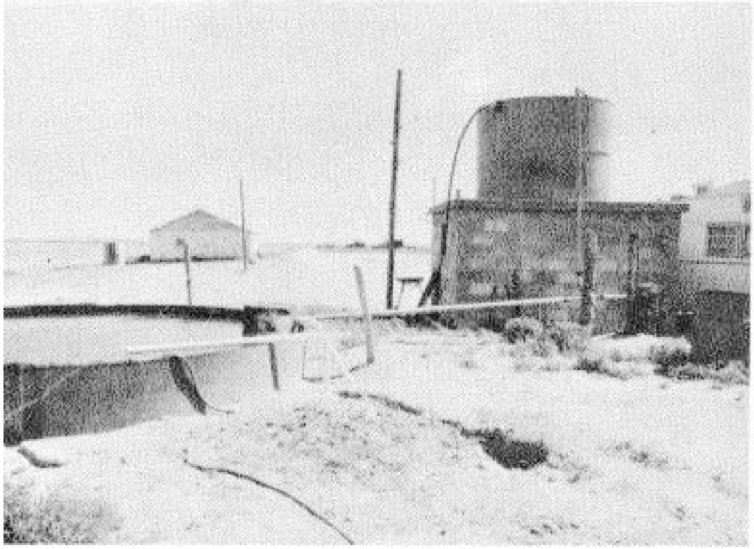
Cooling

Cooling water for the fermentation tank and the condenser can be recirculated from a pond or large holding tank. Irrigation water can be used before it goes on crops.

Handling the ByProduct

Stillage

The stillage exits the bottom of the first column, the beer still, and flows through the inside of the mash pre-heater pipe away from the still for some type of further treatment. The stillage can be flowed over straw or hay and fed to livestock, fed to hogs, or the solids can be separated from it and the water re-used in fermentation. The solids can be fed wet within two days, or they can be dried and transported or stored. The Schroders had fairly good success separating the solids from the liquid in a settling tank.



Condenser cooling is accomplished by recirculating water from a holding tank. The fermentation vat may need some cooling also.

Carbon Dioxide Use

Carbon dioxide gas given off during fermentation can be used to preserve wet grain instead of drying the grain. Every pound of car bon dioxide could save one pound of propane gas now used to dry wet grain. The carbon dioxide from one bushel of fermented corn could save 3.9 gallons of propane.

Carbon dioxide can also be vented to a greenhouse, where it stimulates plant growth. Plants take in carbon dioxide and give off oxygen, just the reverse of what animals do.

Carbon dioxide can also be compressed and used as a refrigerant. This requires compressing equipment.

Drying The Alcohol

The highest concentration of alcohol obtainable from a still is about 195 proof. The final fraction of water must be removed by other means, if this is deemed necessary. Alcohol with water can be burned in engines as is, but most experts claim all the water has to be removed if it is mixed with gasoline. There are conflicting claims on this.

The alcohol need not be dried if it will be used straight in a vehicle, without mixing it with gasoline, or if it will be injected into the carburetor.

Evidence indicates that when alcohol is burned straight in an engine, the water serves a useful function. It changes to steam in the engine and gives extra power, and is emitted as steam through the muffler. Those using straight alcohol prefer about 160 proof.

If the alcohol will be mixed with gasoline, the accepted method is to dry it to about 197 proof. There is no specific recipe for doing this, but there are several possibilities.

The alcohol possibly can be dried by running it over aluminum oxide or lime. The chemical takes up the water. After use, the chemical can be dried with heat and used again.

Conservation Is Important

Conserve energy wherever possible. Wasted energy cuts down on your still's efficiency and costs money. In general, wherever heat is produced, it should be used to warm something else. Cooling water is recirculated into a large body of water. Irrigation water can be used for cooling. Preheating the incoming mash while cooling the outgoing stillage in a jacketed pipe is an example of good energy conservation.

Water used in fermentation can be re-used after the solids are separated unless the feedstock causes a salt buildup in the water. You should not plan to dump large quantities of water.

The EPA has regulations against runoff that would go into any major stream or tributary. If you must put water on the land, plan to use it on your own farm.

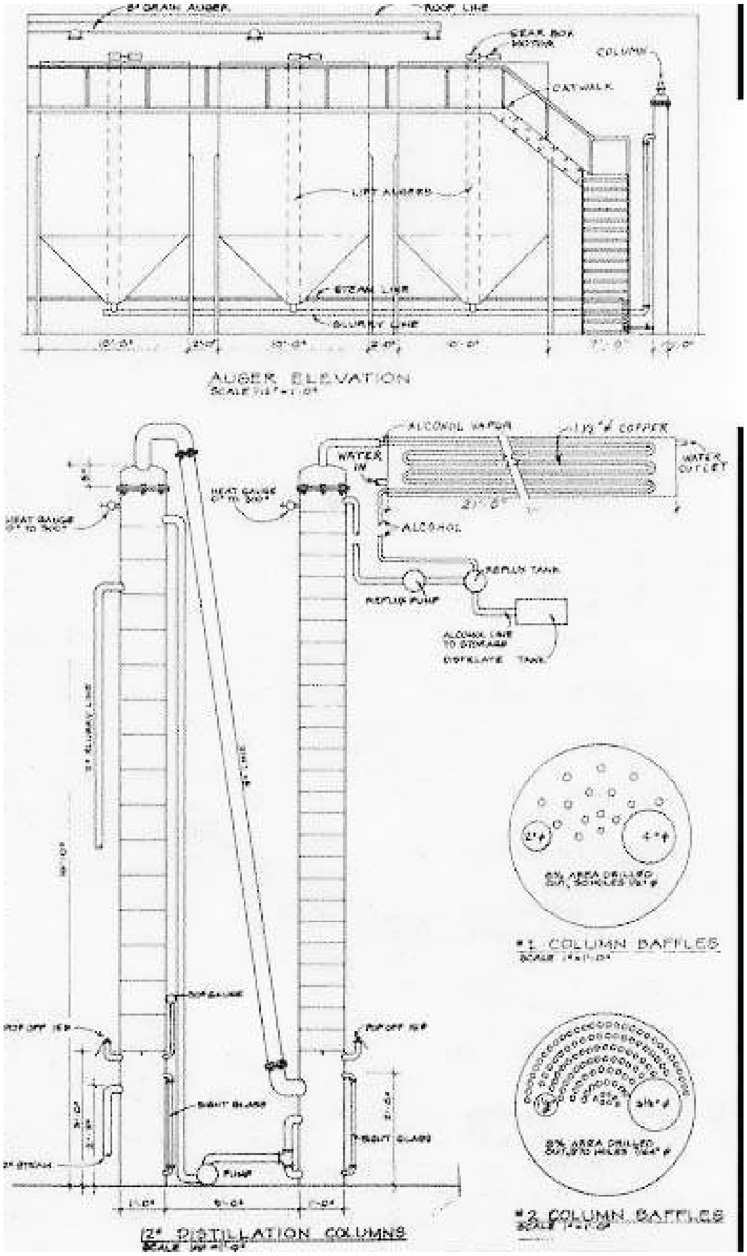
Equipment Needed

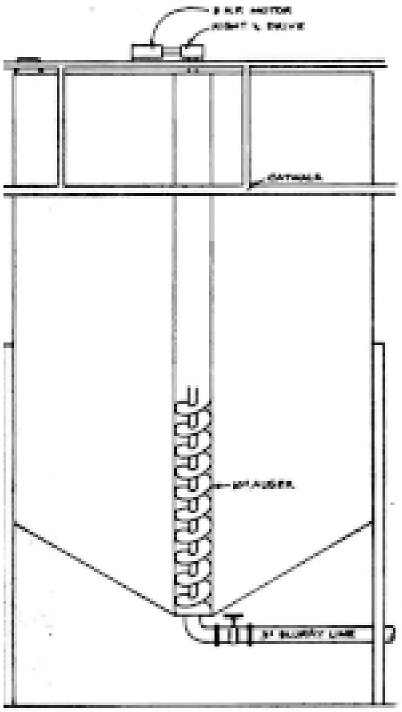
Mild steel tanks and equipment can be used for fuel alcohol production. Stainless steel and copper will last longer, but are more expensive. Alcohol swells certain rubbers and plastics. Test materials that will be in contact with the alcohol before use.

Fermentation

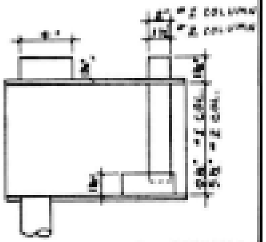
Almost any kind of tank can be used for fermentation. The size and number of the fermentation tanks determine how much alcohol you can make in a week. Three fermentation tanks will allow you to distill a batch of alcohol every day.

One fermentation tank containing 1,000 gallons of mash will allow you to produce 100 gallons of alcohol every 3 days, since the alcohol fermented brew contains about 10% alcohol and


8" GRAIN AUGER
ROOF LINE
GEAR BOX MOTOR
COLUMN
CATWALK
LIFT AUGERS
STEAM LINE
SLURRY LINE
10'-0"
2'-0"
10'-0"
2'-0"
10'-0"
7'-6"
AUGER ELEVATION
ALCOHOL VAPOR
1 1/2" ⌀ COPPER
WATER IN
WATER OUTLET
21'-6"
HEAT GAUGE 0° TO 300°
HEAT GAUGE 0° TO 300°
ALCOHOL
REFLUX TANK
REFLUX PUMP
ALCOHOL LINE TO STORAGE
DISTILLATE TANK
3" SLURRY LINE
2'⌀
4"⌀
#1 COLUMN BAFFLES
POP OFF 15#
POP OFF 15#
SIGHT GLASS
SIGHT GLASS
PUMP
2" STEAM
3/4"⌀
#2 COLUMN BAFFLES
12" DISTILLATION COLUMNS



AUGER
SCALE



COLUMN BAFFLES SECTION
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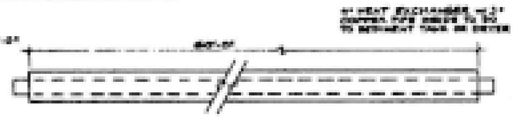
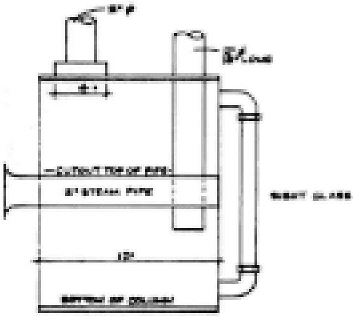
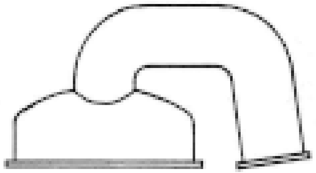


4" HEAT EXCHANGER
SCALE





COLUMN DOME
SCALE

STEAM PIPE IN #1 COLUMN
SCALE

it takes 21/2 days to ferment. The Schroders started with a 1300 gallon fermentation tank, but soon installed three 4,000 gallon conical-bottom fermentation tanks with stirrers and cooling coils. Augurs transported the grain through the roof into the tanks.

Column Materials Needed

31’ of 12" pipe. Must be round, no dents, 1/4 sidewall
64 square feet of 1/4 “ plate
16’of 4" pipe
2 pair of 4" weld-on pipe flanges
One 2" steel ball valve full opening
Two % ” steel ball valve full opening
Two % “ x 2’ glass sight gauges with valves.
Two 0 to 400 degree F. heat gauges
One 0 to 15 lb gauge for steam pressure
One 15 lb pop-off valve
Two 3/4 hp pumps, Model 6K581 Dayton RPM 3450
One Teel Rotary Screw Pump Model 1 P898 with Dayton
    1/2 hp variable speed drive Model 5K994,
    Code L-RPM 1725 RPM Min. 705 Max 4230 1D
    No. F2212-04-M73-0292031
One 15 gallon per minute reflux pump with return
Two 2" weld elbows
Three 4" weld elbows
One 2" to 3/4 ” reducer, weld type
One 1” to 2" reducer, weld type
Three 3/4” valves, iron ball, full opening
Five 3/4” couplers
One 2" coupler
Two 12" dome caps
Two pair 12" f langes
Two pair 2" flanges

Original Condenser Materials

10’of 12" pipe
150’ of 5/8" copper
One 3/4” valve
Two 3/4” couplers

Condenser Materials Added Later

19’ of 12" steel pipe
120’ of 11/2 ” copper tubing
6 1-1/2" U shaped copper connectors

Heat Exchanger Materials

60’of 4" pipe
62’ of 3" copper or brass pipe
Two 3" to 1 “ reducers

NOTE: The Schroders added a third column to their still later. The third column is just like the second column. With this system, the Schroders got about 30 gallons an hour of 192 proof ethanol. The temperature at the top plate is kept at 168 degrees F to produce 192 proof alcohol. All three columns have been insulated with duct insulation.

Mistakes To Avoid

If the batching is not right, alcohol yield will be lost. Ideally, all the starch should be converted to sugar and all the sugar should be converted to alcohol. If the spent stillage contains sugar, more water should be added to the batch. If the stillage still contains starch, the enzymes should be allowed to work longer, or slightly more should be added.

During batching, after the liquefying enzyme has broken down the starch, the starch can re-form if the batch is allowed to set at below 100 degrees F without continuing the process.

The alcohol kills the yeast at above 10% alcohol concentration. If all the sugar is not used up at this point, it is lost.

It takes about an hour and a half for the column temperatures to balance out. For that reason, it is better to run off large batches at one time.

There are six variables that have to be adjusted for maximum output: (1) flow rate of mash coming into the still (2) temperature of incoming mash (3) flow rate of steam injected into the still (4) temperature of steam (5) flow rate of ref lux (condensate returned to top, of column two for higher proof) and (6) temperature of reflux. These six factors have to be balanced with each other.

The columns should be insulated to cut down on heat loss after all the bugs in the plant have been worked out.

Chapter Six

Solar Stills

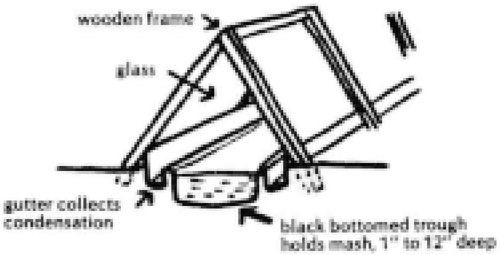
Simple solar stills have been used for years to purify salt water for drinking. Solar stills are used in dry areas to provide up to 10 gallons of drinking water per day at very little cost. The technology is at least 100 years old.

Simple stills are said to be about 35% efficient. With higher initial costs, 60% efficiency can be reached. The biggest loss is from reradiation.

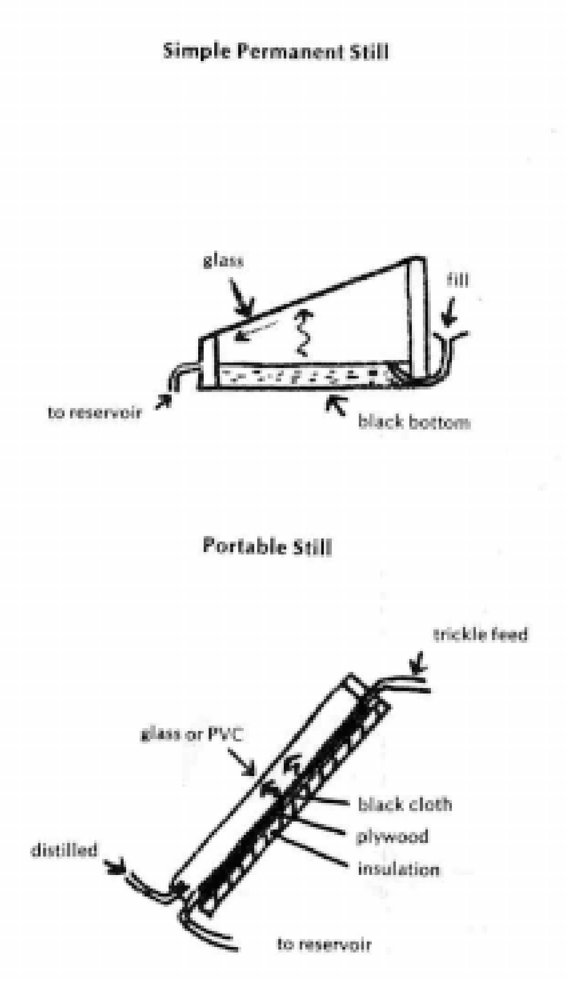
Plastic stills are cheaper than glass, are lighter and tougher, but are not as good as glass because the liquid tends to form drops and fall back into the undistilled portion, instead of forming a sheet as on glass and running into the collection reservoir.

To separate alcohol from water in a solar still, the temperature must be maintained above the vaporization point of alcohol but below the vaporization point of water. This is done by increasing or decreasing the flow of mash into the still.

Common Still



Two or three small solar stills can be hooked together so that after alcohol vaporizes and is collected, it runs into the next still to repeat the process and be purified further.



Simple Permanent Solar Still and Portable Solar Still

Chapter Seven

Home Made Gas And Methanol

Kenneth Schmitt, Hawkeye, Iowa, built small plants to make a low-BTU gas and /or methanol. The gas, called “producer gas” is made from wood waste, straw, cornstalks, or any other organic waste. The gas does not transport well, but can be used in any engine using natural gas that is near the site of production. The gas is a mixture of methane and other gases.

The producer gas, Schmitt explains, could be used to provide the heat to cook the mash and make the steam for the distillation columns of an ethanol plant.

Schmitt’s producer gas generator can also power irrigation pumps, and can even be constructed to automatically augur in its own straw or waste as needed to keep the unit running.

Schmitt’s plant has another option - the gas can be burned to heat wood wastes under high pressures and relatively low temperatures to cause pyrolysis. The pyrolyzed wastes can then be fractionated (separated) and methanol produced. Methanol can be used as a liquid fuel just like ethanol.

At first glance, it might seem that with a methanol plant, there would be no need for an ethanol plant. That is not so. There is no high-protein byproduct left from methanol production. It would be a waste of protein to use grain, for instance, to make methanol. The ideal situation would be to use the wastes not suitable for making ethanol to make producer gas to fire the still, or make methanol if any is left over.

One advantage to methanol is that it is not drinkable, and the Bureau of Alcohol, Tobacco and Firearms does not regulate it.

A highly significant fact is that any plant that can produce methanol can also produce ammonia, which is used as fertilizer. If a farmer had a methanol plant, he could produce his own fuel, his own fertilizer, and apply the fertilizer to the land to grow more crops for food and fuel.

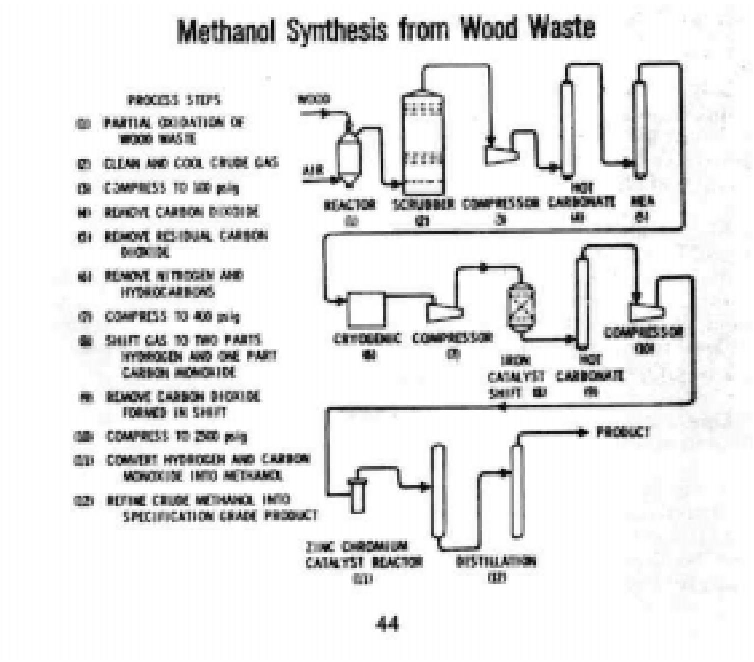
Now almost all methanol is made from petroleum gases, mainly natural gas. But one ton of methanol can also be made from one to two tons of coal, 3.5 tons of municipal garbage, or 1.9 tons of wood.

Methane can also be produced by digestion without air of manure, crop wastes, or sewage. The methane can be converted to methanol with Schmitt's plant.

Methanol has less BTU per gallon than ethanol or gasoline. Methanol has 56,560 BTU per gallon, compared with 84,400 BTU per gallon for ethanol and 115,400 BTU per gallon for gasoline.

Kenneth Schmitt, a young man who never went to college but had a strong interest in chemistry since he was 12 years old, owned and operated a construction company, which was his main business. He founded Schmitt Energy Systems and went into production of producer gas generators, methanol units, and ethanol plants.

Schmitt's invention was set up at the energy fair in Washington D.C. right next to Dr. Paul Middaugh's ethanol plant and Richard Blaser's alcohol engine. Somehow the inventions just seemed to go together, and all three left Washington D.C. on the same truck headed for a demonstration at Colby, Kansas.



Methanol Synthesis from Wood Waste

Chapter Eight

Using Heat From Irrigation Motors

by Elmer Wagner, Belpre, Kansas

Using information available from various sources, the production potential for making alcohol from the waste heat of irrigation motors seems very promising.

In order to find the efficiencies of internal combustion motors, information from the University of Nebraska Tractor Tests was used. These motors would be comparable to irrigation motors. Using the conversion factors, 1 HP equals 2546.4 BTU/hr, diesel fuel has 140,000 BTPU/gal and gasoline has 125,000 BTU/gal.

The test figures were used to calculate the following PTO efficiencies:

J D 7020	26%
J D 4630	28%
Case 1470	32%
Case 2470	28%
Ford 4000 gas	23%

For the purpose of illustration, a Case 1470 Turbo at 75% draw bar load consuming 7.188 gallons of diesel fuel/hour was used. It would use 1,006,320 BTU/hr.

The Popular Science Magazine of July, 1976, gave the following division of heat usage: 1/3 for power, generator, and water pump; 1/3 to heat water (335,440 BTU/hr); and 1/3 as exhaust (338,440 BTU/hr). This is 670,880 BTU/hr wasted, or 16 million BTU per day now wasted.

It takes about 80,000 BTU to process a bushel of corn or wheat into alcohol if the byproduct is dried. 16 million divided by

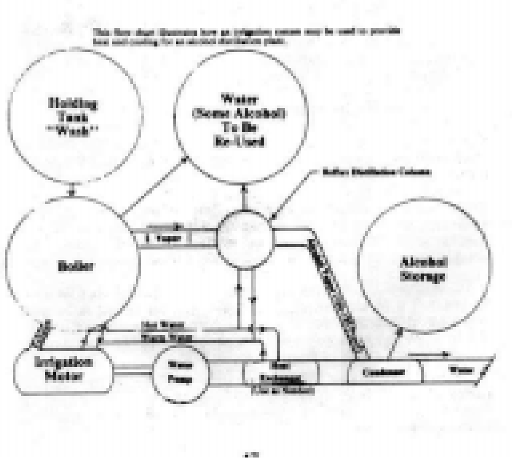
80,000 is 201 bushels per day, or, times 2.6 gallon alcohol yield per bushel, 552 gallons per day of 190 proof alcohol, or 21.8 gallons per hour.

An irrigation motor runs about 1500 hours a season, or 62.5 days. 1500 hours times 21.8 gallons per hour is 32,700 gallons a season. Divide by 2.6 gallons per bushel and you get 12,577 bushels per season that can be processed from heat now wasted.

The value of the 32,700 gallons of alcohol at $1.15 a gallon totals $37,605, and the byproducts are worth about as much as the original wheat. 12,577 bushels at $3 is $37,731. If you have a better figure, use it.

Adiesel turbo motor is more power-efficient than the other internal combustion motors such as natural gas, LP or gasoline. The natural gas motor would be the best choice of all to operate the process.

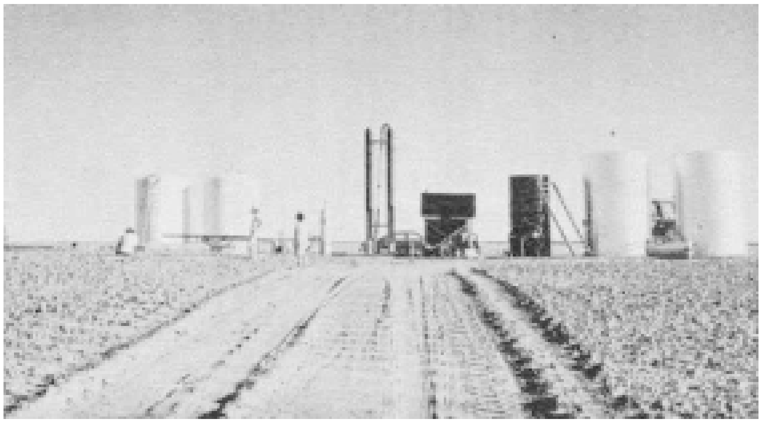
This application relates to irrigation motors being used about 2 months per year, but look beyond this. A farm or commu-



This flow chart illustrates how an irrigation system may be used to provide heat and cooling for an alcohol distillation plant.

nity with a bigger motor operating a generator and a water pump could provide electricity, hot and cold water, heating and power fuel, food from irrigated crops, and meat from feed lots. All of this would make it basically self-sufficient for the essentials. There would be no surplus of grain. Straw, wood chips and other cellulose fibers could also be converted to alcohol in the process.

An irrigation system is now wasting the two elements which are the main requirements of a distillation process - heat from the motor and cooling f rom the water coming from the ground.



Jerry Wright, Baca County, Colorado, built his farm alcohol plant next to an irrigation well in order to use cooling from irrigation water.

Chapter Nine

Using The Alcohol

Burning Gasohol

It is generally accepted that up to 15% alcohol can be mixed with gasoline and used without vehicle modification, if the alcohol has been dried so that it contains less than 2% water.

Burning Straight Alcohol

Straight alcohol that is as low as 160 proof can be used in many vehicles with no modification whatever. The carburetor jets can be replaced with larger ones to make the vehicle run better. Users report no trouble starting the car on straight alcohol.

A dual fuel system can be installed consisting of two fuel tanks, and two fuel pumps fixed so that when the engine gets up to about 1,000 RPM, the car switches from gasoline to alcohol.

In cars with a 4 barrel carburetor such as the Holley dual feed 4 barrel carburetor with mechanical linkage, 2 barrels can be fixed to run on gasoline and 2 barrels can run on alcohol, or the fuels can be mixed. An electric cutoff could switch the fuels. A 2 to 3 gallon gas tank might be installed for emergencies.

An injection system can be installed on a car for a few hundred dollars. This injects alcohol and water into the carburetor. Any good mechanic, hot rodder or race car enthusiast already knows how to do this. Carburetor injection devices have long been used in Europe.

Dr. William B. Harris and others in the Department of Engineering at Texas A & M University at College Station, Texas, adapted two cars to run on alcohol. Although they use methanol, Dr. Harris said the cars would also run on ethanol. The cars were driven for thousands of trouble-free miles. Dr. Harris estimated the changes cost about $350 in 1979. The car could still run on gasoline, because the gasoline system wa not changed. The car started on gasoline, then switched to methanol vapor as soon as the system was warm.

The additions include a standard propane regulator without the high pressure side, a standard propane venturi mounted between the carburetor and air cleaner, a standard electric fuel pump, a standard low pressure fuel tank, and a custom-made heater that fits on the exhaust pipe.

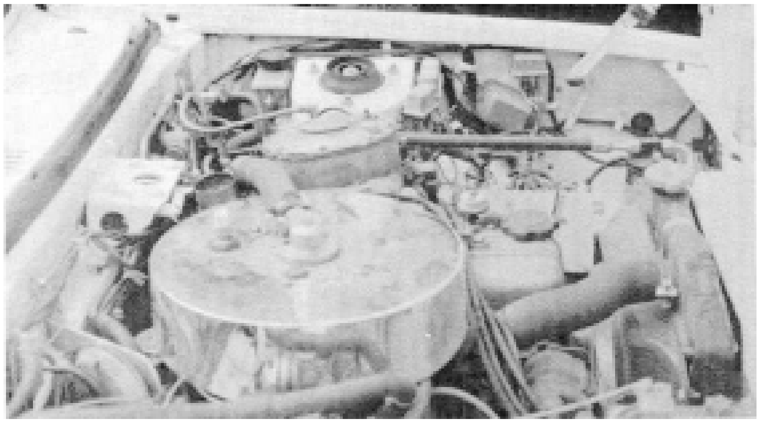
The heater's job was to vaporize the alcohol in such a way that the vapor pressure was not changed, there was no liquid in the vapor, and the vapor was not superheated. In addition, the heater needs to be compact and easy to install. Texas A & M holds patents on the heater, but to date they have not been able to interest people with the money to buy the patents and manufacture the conversion kits.

The disadvantage to alcohol injection systems that do not vaporize the alcohol are several, according to Dr. Harris. First, it takes 8 times as much heat to vaporize methanol as gasoline. Therefore, the alcohol enters as a mist or spray that doesn't distribute to the cylinders uniformly and causes uneven burning. It gets on the cylinder walls and washes oil off, causing wear. Also, below 50 degrees F, you have trouble starting because of alcohol's low volatility, Dr. Harris said. Also, generally the gasoline system is modified so that the automobile loses its ability to run on straight gasoline. The Texas A&M cars got about 60% as much mileage per gallon on methanol containing 10% water as on gasoline. Dr. Harris estimated that with ethanol they would get 75% of the gasoline miles per gallon. But, he said, the alcohol cars have shown superior carburetion and engine operation, and pollution is cut 20%.

Using Alcohol in Diesel Engines

R. P. McWelsh, Virginia farmer, adapted his small Massey Ferguson tractor to run on 100% agrifuels and demonstrated it in Washington D.C. He said all he did was make minor modifications in the fuel injection system to accommodate the different density fuel. He added nothing to the tractor.

McWelsh used 80% ethanol and 20% vegetable oil. (He preferred sunflower oil.) He says the tractor had more power on alcohol, did not miss, pop or crack, and the exhaust fumes were so clean they could be breathed. McWelsh, an American Agriculture farmer, said "If it's mechanical, it can be fixed ... Right out in the field is where the answers are."



Texas AA&M developed a methanol vapor injection system which allows cars to run on either gasoline or vaporized alco-

Diesel engines can be modified so that 10% to 50% diesel fuel is injected into the cylinders with 192 proof alcohol.

Special Engines

Richard Blaser, Argentina, spent 8 years working on engines to burn alcohol. He said he could easily retrofit existing engines.

Blaser adapted one engine to burn 100% alcohol, 100% gasoline, or anything in between by increasing the compression ratio and reshaping the pistons.

Blaser pointed out that it is highly unfair to test alcohol against gasoline in an engine designed for gasoline. He said gaso-

Richard Blaser's engine could run on 100% alcohol, 100% gasoline, or any blend in between.

line is not nearly as manageable as alcohol because one batch varies greatly from another batch.

Blaser's engine ran on 120 proof alcohol produced by Dr. Middaugh's still at the Appropriate Community Technology Fair in Washington D.C.

Blaser said since the Model A Ford was designed for either alcohol or gasoline, but for some shadowy events in history, alcohol might be the primary fuel today and we might be looking at gasoline as an alternate fuel.

Alcohol Vehicles Available Today

Today in the year 2000 there are cars and sports utility vehicles available to buy which were designed to use alcohol fuel with no gasoline. The Department of Energy maintains a website to let the consumer search for these vehicles by model and also maintains a site showing the consumer where alternate fuels can be purchased.

Chapter Ten

Possibilities For The Future

New Developments

Several improvements are possible to make farm alcohol plants more efficient. Without going into much technical detail, we will touch on some of them.

It is possible that membranes can be used in several places in the alcohol production process. Membranes could separate salts out of the stillage when molasses is used as the feedstock. (Molasses stillage is too salty to feed to livestock without treatment.)

Membranes could be used to take the alcohol out of the fermenting brew as it was produced, thereby avoiding the alcohol buildup which kills the yeast. A continuous flow fermentation system could then be used, with raw materials being constantly fed in instead of letting one batch set for 21/2 days.

Membranes might be used to take off the last bit of water to make anhydrous ethanol, which can be used as an industrial alcohol or mixed with gasoline.

Protein can be removed before the mash is sent through the distillation columns. There is no need to subject the protein to the heat of the still. It can be separated at the beginning of distillation and used immediately.

Enzymes that work faster or at a higher temperature may be isolated. This would cut down on the time needed for cooking and holding before fermentation begins.

Yeast strains that tolerate a higher alcohol concentration can probably be used. These are already being used in wine making.

It is already known that cellulose can be broken down into starch and sugar to make alcohol. Improvements in the process could make it more economical.

A way to take the last bit of water out of the alcohol to make it anhydrous may be found that is not patentable and can be used on the farm. Some techniques include flowing the alcohol across solid aluminum oxide crystals. The chemical takes up the water, and then can be heated to drive the water off again. The aluminum oxide is re-used.

Improved engines designed especially for alcohol may become popular if there is enough demand.

Solar energy may be used to power the still.

Heat of irrigation engine exhausts may be used in the alcohol making process.

New markets may open up for the distillers dried grain solids. It makes good livestock, pet, and human food.

Better ways may be found to use the carbon dioxide gas produced in fermentation. Hot water that occurs naturally in some areas might be used to cut down on energy costs for distillation. A combination of wind power, solar heat, and geothermally heated water might be used.

New crops for alcohol production may be grown. For instance, it has been found that Jerusalem artichokes have a lot of potential, because the sugar is deposited in the stems before the bulb begins to form. The tops can be chopped off, the sugar harvested, and the bulbs left in the ground to regenerate. Cassava, a starchy root, can be grown on marginal land.

Experiments are being done burning coal and alcohol. Results indicate that high-sulfur coal can be used, and the sulfur that is released can go into fertilizers

Some are planning to use a vacuum pump to create a partial vacuum in the distillation columns. This could take less energy since the alcohol vaporizes at a lower temperature under vacuum.

Farmers Must Help Themselves

Fuel alcohol production on the farm is in the dark ages as far as technology is concerned. America's farmers stand on the threshold of the greatest new market for their products in years, and there are few to break through the first barriers. There will be no government leadership in this movement, nor a lot of encouragement, either financial or verbal. The energy crunch has a stranglehold on the country, but there are far too many enemies of farm alcohol in high places to expect any help for it. The consumer is told that making alcohol from grain would cause a food shortage. The farmer is told that grain prices are low because of burdensome surpluses.

Many researchers are working on renewable sources of energy. In general, they face the same kind of discouraging attitude the farmer does. But many are attacking bits and pieces of the problem, and if the work goes on and communication continues, there may, indeed, be an alcohol plant every 10 miles across America.

It is up to the farmers if they want to push into this new market. With the agricultural economy in the shape it is in today, farm alcohol may be the only thing that saves the family farm system.

We need to point out again to consumers that the price paid to farmers has absolutely no relation to the price the consumer pays in the grocery store, and that world hunger is not due to a shortage of food but due to people not having money to buy food.

Chapter Eleven

Regulations

State Regulations

Alcohol is controlled by different state agencies. State laws as well as federal will have to be complied with. The main regulations controlling alcohol fuel are federal.

Federal

There are no Bureau of Alcohol, Tobacco and Firearms regulations on the manufacture, sale or use of methanol, since it is not drinkable.

Production and sale of ethanol is regulated by the Bureau of Alcohol, Tobacco and Firearms of the Department of the Treasury. Liquor tax brings in billions of dollars a year to the federal coffers. Most regulations are designed to make sure that everyone who drinks alcohol pays the high tax on it.

There is no cost for the permit to make fuel alcohol. However, once a medium or large alcohol fuel plant begins operations they must pay a Special Occupational Tax (due each July 1st) which is explained on ATF F 5630.5. This tax stamp is normally $1000 per year but taxpayers whose gross receipts are less than $500,000 per year may qualify for a reduced rate of $500. No Special Tax Stamp is required for the "small" Alcohol Fuel Plants.

BATF regulations were revised in 1980 to allow for simplerqualification for those who want to produce alcohol strictly for fuel use.

Those regulations are now codified in 27 CFR Part 19 which are available on ATF's website at www.atf.treas.gov and clicking on "Regulations". The applicable Section of Part 19 is Subpart Y, beginning with paragraph 19.901 through 19.1008. The law cite is 26 U.S.C. 5181.

The Special Occupational Tax Return, ATF F 5630.5 that is to be filed annually by medium and large plants should be sent along with a check to:

Bureau of Alcohol, Tobacco and Firearms
P. O. Box 371962
Pittsburgh, PA 15250-7962

How to Apply for a Permit

Application for an Alcohol Fuel Producer permit should be submitted on ATF F 5110.74 and directed to the address below:

Alcohol, Tobacco and Firearms
National Revenue Center
Room 8002 Federal Office Building
550 Main Street
Cincinnati, OH 45202

According to the BATF, as of this writing, the application forms still list seven discontinued regional offices and some of the other information in the packets they send out may also be out of date. With the new interest in fuel alcohol, they will probably correct their information packets.

Alcohol Denaturants

The Bureau of Alcohol, Tobacco and Firearms require that ethanol be denatured, or rendered unfit for human consumption. The fact that the alcohol you make in your fuel-grade still is not drinkable anyway does not eliminate these requirements.

Approved denaturants are 2 gallons or more per 100 gallons of alcohol of any of the following: unleaded gasoline, kerosene, deodorized kerosene, rubber hydrocarbon solvent, methyl isobutyl ketone, mixed isomers of nitropropane, heptane, or any combination of the above, or 1/8 ounce of denatonium benzoate N. F. (Bitrex) and 2 gallons of isopropyl alcohol.

The BATF may change the list of required denaturants from time to time. Current lists are available free from the ATF Distribution Center, 7943 Angus Court, Springfield, Virginia 22153.

Labeling Containers

BATF requires that each container of fuel alcohol containing 55 gallons or less that will be moved from the plant premises be marked as follows:

WARNING
FUEL ALCOHOL
MAY BE HARMFUL OR FATAL IF
SWALLOWED

Chapter Twelve

Experiments With A Small Alcohol Plant

An Inexpensive Learning Method

No matter how many books you read on making alcohol, you will not learn how to do it without doing it.

Our own learning experience started after we had read all the books, talked to the experts, and seen the operating plants. After all that, we thought we could go out and whip up a batch and have it turn out right the first time. Wrong! The process is still more an art than a science. You have to develop a feel for it, a judgment, and you have to understand what's happening.

The plant we put together is not efficient, not easy to operate, and only produces about a gallon an hour. But instead of making a $10,000 mistake, we made a $200 mistake, so to speak. Instead of ruining a 3,000 gallon batch, we ruined a 50 gallon batch.

The entire plant is put together out of a 55 gallon drum and things you can find in any hardware store. (Two exceptions might be some air conditioning duct and a small pump.)

The first important lesson we learned is to start out in the morning. Don't think you will cook up a batch after supper and get to bed before 3 a.m. It never worked that way for us, anyway, and it was truly a "moonshining" experience.

The first thing you must do is decide on a site for your experimental energy plant. Take into account the degree of privacy you want. Pick a scenic spot that you don't mind spending several hours at, because you will. Drag up some chairs, a porch swing, or some stumps. Spray for chiggers or mosquitoes or whatever pest plagues your part of the land. An old table is handy for holding test equipment. Get yourself a record book so you can write down what did and didn’t work, because you won’t remember it all later.

Building The Plant

We started from the ground up with the fire box. After leveling the ground for the plant site, and cleaning off the grass and brush that might catch fire, we stacked 8 4x8x16 concrete pier blocks and 4 8x8x16 concrete pier blocks in the arrangement shown in the picture, with the holes at the bottom allowing the fire to draw air. A piece of valley tin was used to shut down the air flow when we wanted to bank the fire.

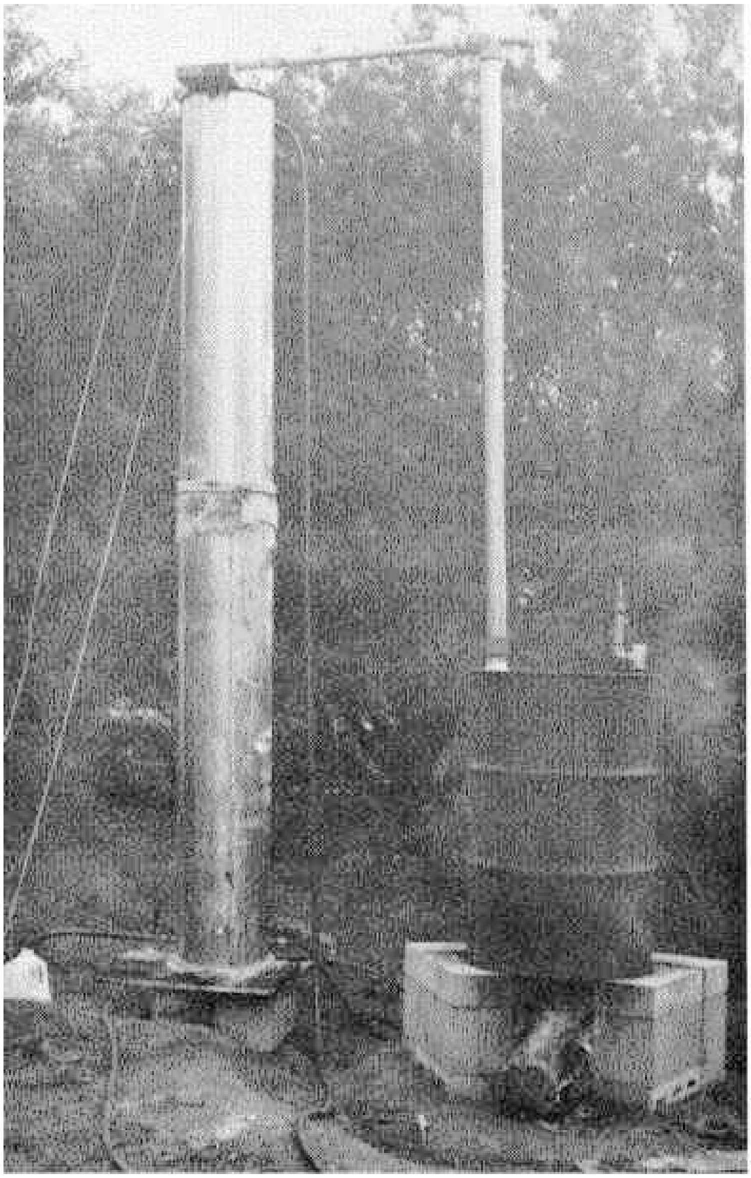
Trenches in the ground insure that water will flow around the fire and not through it.

A standard 55 gallon steel drum with a 2” bung hole and a %” bung hole was used as the cook pot and fermentation vat combined. Needless to say, the drum should be clean and free of holes.

A% “ nipple in the % ” hole of the drum is attached to a % “ Tee. Into one opening of the Tee is a meat thermometer, sealed in with bread dough. In the other opening, a Street Ell is plumbed to a pop off valve, which in this case is a wooden plug in a 3/8" copper flare adapter.

The distillation column was a 6’ long piece of 2" steel pipe. This was packed with 50 standard porcelain electric fence insulators, placed in the column at random. A retainer plate at the bottom was made of 1/4 “ steel with 6 1/2 ” holes. The 2" column pipe was threaded to screw into the bung hole of the drum.

Pipe fittings were used to reduce from the 2" column to the 1" crossover pipe, then to reduce to %" and connect to %" copper tubing used for the condenser. The fitting from the column to the



An inexpensive do-it-yourself alcohol plant that is not efficient, not easy to operate, and could stand a lot of improvement.

crossover pipe was a 2" x %" x 2" Tee. A meat thermometer was placed in the % " opening and sealed in with bread dough.

In the other outlet of the %" Tee, an alcohol reflux line is to be attached.

At the condenser end of the crossover pipe, all" x %" reducing Ell reduces to the 1/4 " copper coil condenser.

The condenser consisted of 40' of 1/4 " coiled copper tubing inside 9' of 12" galvanized steel air conditioning duct. The condenser is oversized because we want to use it later on a larger plant. A proper size condenser for the 2" column would be 40' to 50' of 1/2 " copper tubing coiled in '' of 8" to 10" air conditioning duct.

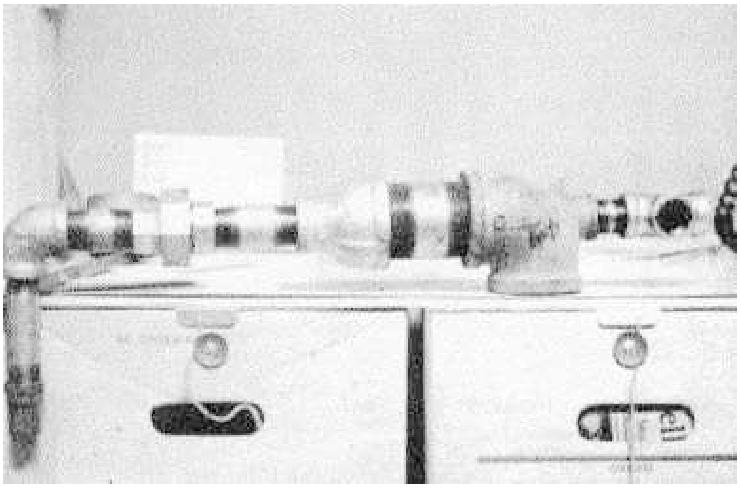
The finished product comes out the bottom of the condenser into a reservoir (not shown in picture), where part of it will be pumped back up to the top of the column for reflux to control the temperature at the top of the column and thereby thq proof of the product. The rest will go into the finished product holding tank, here a milk jug, but according to law, should be locked.

Two garden hoses circulate the water in the condenser jacket. The water goes in at the bottom and flows out through the hose at the top and then onto the garden.

The column was packed randomly with ordinary electric fence line insulators. Experiments are continuing on packing material.

Guy wires and concrete blocks were used to adjust the condenser to the proper height for connection to the column and stabilize the condenser.

The distillation column is removed during batching and fermentation. A Union in the 1 " crossover pipe allows disconnection of the column.



Close up of manifold and crossover assembly that connects column to condenser. The alcohol reflux is attached to the hole facing foreground on the right. Thermometer goes in other opening of the tee on right.

Cooking the Mash

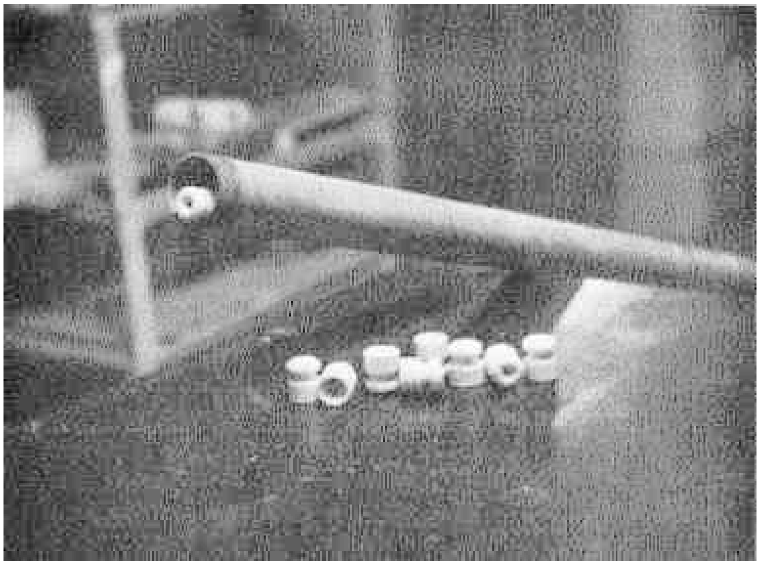
On the first batch, we made a terrible mistake. We added all the water at the beginning. As a result, it took hours to heat the batch to boiling.

On the second batch, we didn't add enough water. The mash was impossible to stir with a 2x2" piece of yellow pine lumber, and the enzyme did not get good contact with the raw material. The bottom also scorched. We followed the Schroders' recipe, adding 10 gallons of water for every bushel of grain. But we forgot that we were not adding steam, but boiling off steam.

After you get the plant built, the best way to start off is with a sauce pan on the kitchen stove. Go through the batching procedure in miniature, add tiny amounts of the enzymes as called for in the recipe, and do the starch and sugar tests at various stages. In this way you will learn what the tests look like and get an idea of how the raw material looks after the starch crystals are swollen and what it looks like when it is liquefied. This will save you a lot of uncertainty later on. (if it's 2 a.m. and the batch is still liquefying, it's nice to know what the starch test is supposed to look like.)

We added 100 pounds of ground corn to the drum, then added the water. This was another mistake. The water should have been added first. It mixes better.

Then build a roaring fire and find something to amuse you while you wait. It takes a lot longer than you would think to bring 100 pounds of corn to a boil. As the mash approaches boiling, add 1/5 of the liquefying enzyme you have measured out. The total amount of Taka-Therm needed is about 1/2 ounce.



The column was packed randomly with ordinary electric fence line insulators.

Boil the mash for at least 30 minutes. The purpose of this is to swell the starch crystals. The small amount of enzyme added liquefies the batch slightly and makes it easier to work with.

After boiling, add cold water to bring the temperature down to 195 degrees F. Then add the rest of the Taka-Therm, and hold the batch at 195 degrees for one hour. That's the easy part. The hard part is that the mash must be stirred a good part of the hour to bring the enzyme in contact with the starch. The enzyme is depending on you to get it around.

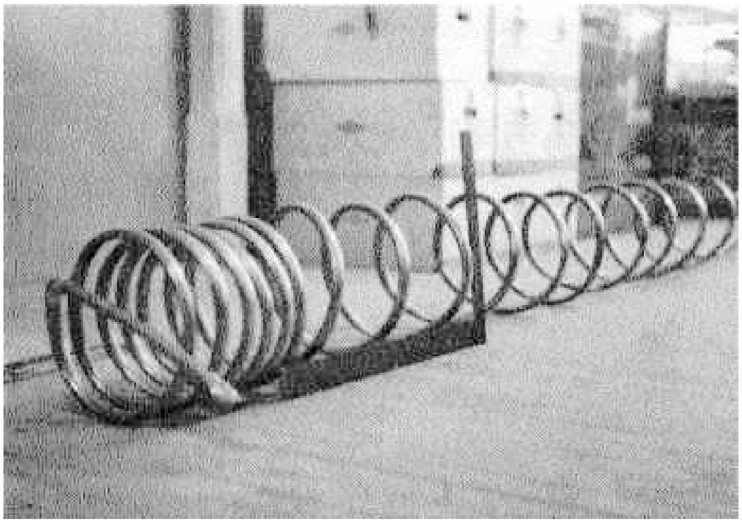
Temperature is measured by lowering a meat thermometer into the mash with a piece of baling wire. You may have to read it with a flashlight. It's a little difficult when there's steam coming out of the drum. A thermocouple device would be more convenient.

At the end of the hour, add a little iodine to a sample of the mash. If it turns blue or purple, hold the batch longer at 195 degrees. When the starch is broken down, the iodine test will be colorless or red brown.

After the starch is broken down, add cold water to bring the batch down to 140 degrees F. Take the pH of the sample and add diluted sulfuric acid to bring the pH down to 4.2. We started out with a pH of 7, and it took about 1 cup of battery acid to get the pH to 4.2. Battery acid is nothing but sulfuric acid and water. It comes in a handy plastic container, You need some lime on hand in case you over shoot and get the pH lower than 4.2.

After the proper pH and temperature are reached, add the saccharifying enzyme, Diazyme L 100. For 100 pounds of corn, it takes a little over an ounce. Hold the batch at 140 degrees F for 30 minutes, again with stirring. This enzyme has no swimmers either.

Now add cold water until the drum is almost full and the temperature is about 80 degrees F.



Forty feet of %" copper tubing was coiled around an 8" plastic pipe to form this condenser coil, which was placed inside the water jacket.

Mix well and take a potential alcohol reading on the triple scale wine hydrometer. The reading you get is probably the alcohol percentage you will get out of the batch. You are hoping for a 10% alcohol yield.

Mix yeast with warm water and a little sugar and dump in, stirring well. Keep the batch between 80 and 90 degrees, stirring once in a while without working a lot of air into the mixture. Keep the cap on the 2" drum opening. The %" opening has a piece of tubing attached to the nipple in the opening on the drum. The tubing is bent down into a container of water. This lets the carbon dioxide bubble out, but keeps the air out of the drum.

When bubbles start coming out of the tube in the water, you know you are making alcohol.

Fermentation produces heat. The temperature of the drum may get too high. Spray the drum with a water hose, stir, and provide a shade to help control temperature.

Under ideal conditions, the fermentation will take 21/2 days. But since your batch is not being stirred constantly, it may take 3 or 4 days. When the bubbling slows down a lot or stops, you can distill.

Distillation

Again, don't start after supper if you like to sleep any at all. Start in the morning. This set-up will produce about a gallon an hour. If you have 5% alcohol, that's roughly 5 hours after the mixture comes to a boil. (Remember, we told you before we started this description that it wasn't easy or efficient!) Attach the distillation column to the barrel and put the pop-off valve and thermometer holder in place of the water trap. Build a roaring fire and get set to wait.

You can follow the rise of the vapors in the column by feeling how high the column is getting hot. Alcohol will start to flow out of the condenser when the thermometer at the top of the column reads about 175 degrees F. Try to keep the temperature at the top of the column at 175 degrees.

The alcohol reflux pump comes into play at this time. Without returning some of the product to the top of the column, you will get only about 100 proof alcohol. The column packing encourages the water to drop out and flow back down, but after the system reaches equilibrium, everything is the same temperature, including the column packing, and this doesn't happen. Part of the cooled product has to be returned to the top of the column for cooling. The amount of product returned to the top of the column and the top plate temperature control the proof of the alcohol produced. You will have to experiment with just how much to return for the desired proof. This plant could probably be vastly improved in several ways. At the moment, these are unproven, but logical, speculations.

This is how the moonshiners did it. Note how the copper cook pot on the left is shaped. The small cylinder behind the barrel on right is a “slobber box” to drop out some impurities. Condenser coil is inside the wooden barrel. This still sits in the Somervell County museum in Glen Rose, Texas.

Next, we plan to get a drum with a bung hole on the side, lay the drum down over the fire box, and attach the column to the side bung hole. All the moonshine stills had domes in the center for the vapor to rise into. The hole on the side of the drum top makes it more difficult for the vapor to climb the column and probably requires more heat. Someone who should know also told us there is a lot more danger of explosion the way we did it.

The new drum will also have holes in the ends where we can insert some type of stirrer that can be turned by hand or a motor.

The fire built the length of the barrel will heat the mash quicker. The column will be insulated, and packed with various other experimental materials.

As we said, this starter energy plant is far from perfect. Now that you know what doesn't work, you can profit by our mistakes. You design a better plant!

Materials List

Fire Box

4 8 x 8 x 16 concrete pier block
8 4 x 8 x 16 concrete pier block

Cook Pot

1 55 gallon steel drum

Column

10' 2" steel pipe
50 electric fence insulators

Condenser

50' of ¾ copper tubing
1' of 3/8 copper tubing
2 ¾ sweat ell
1 ¾ sweat x ¾ FIT
1 ¾ x ½ x ½ sweat tee
1 3/8 flare nut

2 3/8" flare x ½ MPT adapter
10’ of 12" air conditioning duct
4’ of 18" valley tin
1 pound solder
1 ¾ ball valve
16" of ½ copper tubing
1 chemical pump
1 hose repair kit
2 ¾ sweat x ¾

Cross Pipe to Condenser

2 ½ x ¾ bell galvanized reducers
1 ¾ x 4 nipple
1 ¾ x 5 nipple
1 ¾ close nipple
1 ¾ street ell
2 ¾ tee
1 2" collar
2 2" x 3”nipple
1 2” x 1” bell reducer
1 2" x 2" x ¾ tee
1 ¾ close nipple

Miscellaneous

1 Marking Pen
2 Meat Thermometers
2 garden hoses on hand

Appendixes

Comparison of Raw Materials for Alcohol

Produce	Gallons Alcohol	Protein Yield	% Pro Dry	Lbs CO2
Wheat	2.6/bu	20.7/bu	36	16-17
Grain sorghum	2.6/bu	16.8/bu	29-30	16-17
Corn	2.6/bu	18 lb/bu	29-30	16-17
Average Starch Grains	2.5/bu	17.5/bu	27.5	16-17
Potatoes (75% Moist)	1.4/cwt	14.8/cwt	10	12-14
Sugar Beets	20.3/ton	264/ton	20	120-140
Molasses (50% sugar)	.4/gal 68/ton		20	.2-.3 400-440

Alcohol Yields of Various Crops

Crop	Yield of 200 proof alcohol (gallons)
Corn	2.5/bu
Milo	4.4/cwt
Spring Wheat	2.65/bu
Winter wheat	2.65/bu
Cane Molasses	75/ton
Beet molasses	75/ton
Barley	2.1/bu
Cull potatoes	1.5/cwt
Sweet sorghum	10.5/ton

(Compiled by Grain Processing Corporation)

Percent Sugar and Starch in Grains

Grain	% Sugar	% Starch
Barley	2.5	64.6
Corn	1.8	72.0
Grain sorghum	1.4	70.2
Oats	1.6	44.5
Rye	4.5	64.0
Wheat		63.8

Source: Composition of Cereal Grains and Forages, National Academy of Sciences publication.

Sample Costs for Ethanol Production

	Corn per Bushel		Milo per cwt	
	$2.00	**$3.00**	**$3.00**	**$5.00**
Grain costs (1)	67.5	101.2	57.8	96.3
By-Product Credit (2)	-43.7	-43.7	-45.7	-45.7
Net Grain Cost	23.8	57.5	12.1	50.6
Conversion Cost (3)	30.0	30.0	31.0	31.0
Interest on Loan (4)	9.8	9.8	9.8	9.8
Ethanol Cost	63.6	97.3	52.9	91.4
Depreciation (5)	11.5	11.5	11.5	11.5
Taxes (50%)	7.0	7.0	7.0	7.0
20% Return (6)	7.0	7.0	7.0	7.0
Ethanol Value	89.1	122.8	78.4	116.9

(From Dr. William Scheller's sixth progress million mile road test, January 31,1977)

Notes:

1. Assumes 75% marketable grain plus 25% distressed grain at 50% of the marketable grain price.
2. $120 per ton from corn and $116 per ton from milo based on protein content.
3. Based on coal as the fuel source.
4. Based on a $19,500,000 loan at 10% for a plant to produce 20,000,000 gallons per year of 200 proof ethanol.
5. Depreciation is 10% per year.
6. Return is 20% on $7,000,000 of private capital invested.

Summary of ERDA Emissions

and Fuel Consumption Tests at 75 degrees F
All figures in grams per mile

Emissions	**Gasohol**	**No-Lead**
Carbon monoxide	20.7	30.6
Hydrocarbons	2.3	2.3
Nitrogen oxides	2.3	2.3
Subtotal	25.3	35.2
Carbon dioxide	705.3	711.1
Total	730.6	746.3
Fuel Consumption		
Urban, mi/gal	10.9	11.0
Hwy mi/gal	15.6	16.1
Combined mi/gal	12.7	12.8

From Dr. William Scheller and the University of Nebraska

Typical Analysis of Distillers Dried Grain Solids

Component	**%**
Moisture	9.0
Protein	28.0
Crude Fat	11.0
Crude Fiber	8.0
Ash	4.0
Pentosans	15.0
Lignin	5.5
Dextrose (Glucose)	2.3
Dextrin	3.4
Lactic Acid	1.8
Acetic and Succinic Acids.	1.0
Glycerin	2.3
Hemicellulose	1.5
Pectin	3.0
Riboflavin	(gamma/gram) 9.0
Thiamin	(gamma/gram) 6.3
Pantothenic Acid	(gamma/gram) 10.1
Niacin	(gamma/gram) 63.4

From *Food for Thought*

Water, Protein, and Carbohydrate Content of Selected Farm Products

Source: Handbook of Nutritional Contents of Foods, USDA

Crop	% Water	% Protein	Carbohydrate
Apples,raw	84.4.	2	14.5
Apricots, raw	85.3	1.0	12.8
Artichokes, (French)	85.5	2.9	10.6
Artichokes, jerus.	79.8	2.3	16.7
Asparagus, raw	91.7	2.5	5.0
Beans, lima, dry	10.3	20.4	64.0
Beans, white	10.9	22.3	61.3
Beans, red	10.4	22.5	61.9
Beans, pinto	8.3	22.9	63.7
Beets, red	87.3	1.6	9.9
Beet greens	90.9	2.2	4.6
Blackberries	84.5	1.2	12.9
Blueberries	83.2	.7	15.3
Boysenberries	86.8	1.2	11.4
Broccoli	89.1	3.6	5.9
Brussels sprouts	85.2	4.9	8.3
Buckwheat	11.0	11.7	72.9
Cabbage	92.4	1.3	5.4
Carrots	8.2	1.1	9.7
Cauliflower	91.0	2.7	5.2
Celery	94.1	.9	3.9
Cherries, sour	83.7	1.2	14.3
Cherries, sweet	80.4	1.3	17.4
Collards	85.3	4.8	7.5
Corn, field,	13.8	8.9	72.2

Crop	**% Water**	**% Protein**	**Carbohydrate**
Corn, sweet	72.7	3.5	22.1
Cowpeas	10.5	22.8	61.7
Cowpeas, undried	66.8	9.0	21.8
Crabapples	81.1	.4	17.8
Cranberries	87.9	.4	10.8
Cucumbers	95.1	.9	3.4
Dandelion greens	85.6	2.7	9.2
Dates	22.5	2.2	72.9
Dock, sheep sorrel	90.9	2.1	5.6
Figs	77.5	1.2	20.3
Garlic cloves	61.3	6.2	30.8
Grapefruit pulp	88.4	.5	10.6
Grapes, American	81.6	1.3	15.7
Lambsquarters	84.3	4.2	7.3
Lemons, whole	87.4	1.2	10.7
Lentils	11.1	24.7	60.1
Milk, cow	87.4	3.5	4.9
Milk, goat	87.5	3.2	4.6
Millet	11.8	9.9	72.9
Muskmelons	91.2	.7	7.5
Mustard greens	09.5	3.0	5.6
Okra	88.9	2.4	7.6
Onions, dry	89.1	1.5	8.7
Oranges	86.0	1.0	12.2
Parsnips	79.1	1.7	17.5
Peaches	89.1	.6	9.7
Peanuts	5.6	26.0	18.6
Pears	83.2	.7	15.3
Peas, edible pod	83.3	3.4	12.0
Peas, split	9.3	1.0	62.7
Peppers, hot chili	74.3	3.7	18.1
Peppers, sweet	93.4	1.2	4.8

Crop	% Water	% Protein	Carbohydrate
Persimmons	78.6	.7	19.7
Plums, Damson	81.1	.5	17.8
Poke shoots	91.6	2.6	3.1
Popcorn	9.8	11.9	72.1
Potatoes, raw	19.8	2.1	17.1
Pumpkin	91.6	1.0	6.5
Quinces	83.8	.4	15.3
Radishes	94.5	1.0	3.6
Raspberries	84.2	1.2	13.6
Rhubarb	94.8	.6	3.7
Rice, brown	12.0	7.5	77.4
Rice, white	12.0	6.7	80.4
Rutabagas	87.0	1.1	11.0
Rye	11.0	12.1	73.4
Salsify	77.6	2.9	18.0
Soybeans, dry	10.0	34.1	33.5
Spinach	90.7	3.2	4.3
Squash, summer	94.0	1.1	4.2
Squash, winter	85.1	1.4	12.4
Strawberries	89.9	.7	8.4
Sweet potatoes	70.6	1.7	26.3
Tomatoes	93.5	1.1	4.7
Turnips	91.5	1.0	6.6
Turnip greens	90.3	3.0	5.0
Watermelon	92.6	.5	6.4
Wheat, HRS	13.0	14.0	69.1
Wheat, HRW	12.5	12.3	71.7
Wheat, SRW	14.0	10.2	72.1
Wheat, white	11.5	9.4	75.4
Wheat, durum	13.0	12.7	70.1
Whey	93.1	.9	5.1
Yams	73.5	2.1	23.2

New Car Warranties Cover Alcohol Blends

Every major car maker in the world approves the use of ethanol-blended gasoline under new car warranties. In fact, General Motors and Chrysler specifically recommend the use of oxygenated fuels such as ethanol blends.

If you have questions about the use of ethanol blends in your car, check your owner's manual.

Enzyme Suppliers

Alltech, Inc
3031 Catnip Hill Pike
Nicholasville, KY 40356
Telephone 606-885-9613
Fax 606-887-3228
Http://www.alltech.com
(Very Cooperative and Informative)

Genencor Enzymes Division
PO Box 4859, Elkhart, IN 46514
Phone 219-266-2400, Cust. Service 800-847-5311
(Plant personnel said prices were confidential and customer service did not respond to two inquiries)

How to Apply for a Permit from BATF

Application for an Alcohol Fuel Producer permit should be submitted on ATF F 5110.74 and directed to the address below:

Alcohol, Tobacco and Firearms National Revenue Center
Room 8002 Federal Office Building
550 Main Street
Cincinnati, OH 45202

The BATF defines three sizes of plants:

Small - Produces and receives not more than 10,000 proof gallons of alcohol per year.

Medium - Produces and receives more than 10,000 but not more than 500,000 proof gallons of alcohol per year.

Large - Produces and receives more than 500,000 proof gallons of alcohol per year.

Small plant are not required to file a bond. Medium and Large plants are required to post bonds, generally obtainable from insurance companies.

Warning - If your plant premises are in a or eligible for inclusion in the National Register of Historic Places and you plan to make any changes to construction or us of those premises, you need to contact your State Historic Preservation Offices and follow their guidelines.

There is no cost for the permit to make fuel alcohol. However, once a medium or large alcohol fuel plant begins operations they must pay a Special Occupational Tax (due each July 1st) which is explained on ATF F 5630.5. This tax stamp is normally $1000 per year but taxpayers whose gross receipts are less than $500,000 per year may qualify for a reduced rate of $500. No Special Tax Stamp is required for the “small” Alcohol Fuel Plants.

BATF regulations were revised in 1980 to allow for simpler qualification for those who want to produce alcohol strictly for fuel use. Those regulations are now codified in 27 CFR Part 19 which are available on ATF’s website at www.atf.treas.gov and clicking on “Regulations”. The applicable Section of Part 19 is Subpart Y, beginning with paragraph 19.901 through 19.1008. The law cite is 26 U.S.C. 5181. The Special Occupational Tax Return, ATF F 5630.5 that is to be filed annually by medium and large plants should be sent along with a check to:

Bureau of Alcohol, Tobacco and Firearms
P. O. Box 371962, Pittsburgh, PA 15250-7962.

List of Large Alcohol Plant Manufacturers

as of January, 1996, The Renewable Fuels Association

Company/Location	**MGY**
Archer Daniels Midland P.O.Box 1470 Decatur, IL 62525 (217) 424-2550 Carla Miller X6182, Decatur, IL, Peoria, IL, Cedar Rapds, IA Clinton,IA	750
Minnesota Corn Processors 400 W. Main St., Ste. 201 Marshall, MN 56258-1236 (507) 537-0577, Columbus, NE (80 mgy) Marshall, MN (40 mgy)	120
Cargill 1 Cargill Dr. Eddyville, IA 52553 (515) 969-3671 650 Industrial Rd. Blair, NE (402) 533-4150, Blair, NE (75 mgy) Eddyville, IA (30 mgy)	105
Pekin Energy Company P.O. Box 10 Pekin, Il 61555 (309) 347-920 Pekin, IL	100
New Energy Company of Indiana 3201 W. Calvert South Bend, IN 46680 (219) 234-3495 South Bend, IN	88

High Plains Corporation 200 West Douglas, Suite 820 Wichita, KS 67202, York, NE (402) 362-2285, York, NE (30 mgy) Colwich, KS (20 mgy) 50

A.E. Staley Mfg. Co. 198 Blair Bend Dr. Loudon, TN (615) 458-5681 Loudon, TN 42

Midwest Grain Products 1301 South Front St. Pekin, Il 61554 (309) 353-3990, Pekin, IL (12 mgy) Atchison, KS (26 mgy) 38
Ag Processing, Inc. P.O. Box 49 Hastings, NE 68902 (402) 463-5290 Omaha, NE 30

Nebraska Energy, L.L.C. P.O. Box 226 Aurora, NE 68818 (402) 694-3635 Aurora, NE 30

Chief Ethanol Fuels East Highway 6 Box 488 Hastings, NE 68901 (402) 463-6885,Hastings, NE 28

Corn Plus 711 6th Ave. Southeast Winnebago, MN 56098 (507) 893-4747 Winnebago, MN 15

Roquette America 1417 Exchange St. Keokuk, IA 52632 (319) 524-5757 * Getting out of ethanol business ,Keokuk, IA 14.5
Heartland Corn Products P.O. Box A Hwy. 19 East Winthrop, MN 55396 (507) 647-5000, Winthrop, MN 14

Alchem Ltd. P.O. Box 32 35 Division St. Grafton, ND 58237 (701) 352-0602, Grafton, ND 12

Broin Enterprises 900 Washington St. Scotland, SD 57059
(605) 583-2258, Scotland, SD 10

Reeve Agri-Energy P.O. Box 1036 Garden City, KS 67846
(316) 275-7541, Garden City, KS 9

J.R. Simplot P.O. Box 1059 Caldwell, ID 83606 (208) 459-0071, Caldwell, ID (4 mgy) Burley, ID (4 mgy) 8

Burns-Philip Food Kingstree, SC (803) 382-5131,Kingstree, SC 6
Manildra 100 George St. Hamburg, IA 51640 (712) 382-2265, Hamburg, IA 6

Morris Ag Energy P.O. Box 111 Morris, MN 56267 (612) 589-2931 Morris, MN 5

Heartland Grain Fuels LP 38469 133rd St. Aberdeen, SD 57401-8406 (605) 225-0520, Aberdeen, SD 4

Wyoming Ethanol ,Torrington, WY 4

Georgia-Pacific Corporation Bellingham Operations, 300 West Laurel St. Bellingham, WA 98225 (360) 733-4410.Bellingham, WA 3.2
Parallel Products 12281 Arrow Route Rancho Cucamonga, CA 91739 (909) 980-1200, Rancho Cucamonga, CA 3

Golden Cheese of California 1138 West Rincon St. Corona, CA 91720 (909) 737-9260, Corona, CA 2.7

Reyncor Industrial 10845 LA Hwy. 1 Shreveport, LA 71115
(318) 797-0087, Shreveport, LA 2.5

Kraft, Inc. Glenville, IL (708) 646-3946 , Glenville, IL
1.5
Permeate Refining 205 Locust St. Hopkinton, IA 52237 (319)
362-0844, Hopkinton, IA 1.5

Ag Power of Colorado 4845 Forest St. Denver, CO 80227 (303)
329-6424 * Will stop producing ethanol in June ‘96 Golden,
CO 1.4
Minnesota Clean Fuels P.O. Box 188 312 Railway St. Dundas,
MN 55019 (507) 663-7704, Dundas, MN 1

Pabst Brewing P.O. Box 947 Schmidt Place 100 Custer Way
Tumwater, WA (360) 754-5000, Olympia, WA .7

ESE Alcohol P.O. Box 848 Leoti, KS 67861 (316) 375-4904,
.6
Jonton Alcohol Route 3 Box 151-E Edinburg, TX 78539 (210)
842-3378, Edinburg, TX .6

Vienna Correctional P.O. Box 200 Hwy. 146 East Vienna, IL
62995 (618) 658-2211, Vienna, IL .5

Total 44 Plants MGY 1,475

Web Links to Alcohol Plants

Agri-Energy, LLC Agri-Energy is cooperatively-owned, and produces 15 million gallons of corn-derived ethanol annually.

Al-Corn Al-Corn, a cooperatively-owned ethanol plant produces 15 million gallons of corn-derived ethanol annually.

Cargill, Inc. Cargill is a producer of more than 100 million gallons of corn-derived ethanol per year.

Central Minnesota Ethanol Coop Central Minnesota Ethanol Coop produces over 15 million gallons of corn-derived ethanol per year.

Chippewa Valley Ethanol Company, LLC Chippewa Valley Ethanol Company, a joint venture between farmer-owned cooperative and private company Delta-T, produces 18 million gallons of corn-derived ethanol annually.

Corn Plus Corn Plus is a farmer-owned cooperative with 650 members, converting 7.2 million bushels of corn into 19 million gallons of ethanol per year.

Diversified Energy Company DENCO is a producer of corn-derived ethanol, with a capacity of 8 million gallons per year.

Ethanol 2000 Ethanol 2000 is a producer of corn-derived ethanol with a production capacity of 15 million gallons per year.

Exol Corporation Exol, a 100% farmer-owned ethanol plant produces 15 million gallons of corn-derived ethanol annually.

Heartland Corn Products Heartland Corn Products is farmer-owned cooperative that produces 16 million gallons per year of corn-derived ethanol.

Minnesota Corn Processors Minnesota Corn Processors, a farmer-owned cooperative produces ethanol, corn starch, corn syrup, 42% high fructose corn syrup, a bio-based deicer (Ice-Ban) and feed products from its plant in Marshall, Minnesota.

Minnesota Energy Minnesota Energy, a cooperatively-owned ethanol plant, produces 11 million gallons of corn-derived ethanol per year.

Pro-Corn LLC Pro-Corn, a joint venture between South East Minnesota Ethanol Cooperative and private investors, produces 15 million gallons of corn-derived ethanol annually.

Alcohol Plant Builders

Recommended by American Coalition for Ethanol

There are six companies that belong to the American Coalition for Ethanol that have designed and built ethanol production facilities. These companies have a track record in the industry and have been responsible for the continuing effort to improve the efficiency of the ethanol production industry. If you are interested in the development of an ethanol production facility ACE would recommend you consider designer/builders that have a track record in the industry, including the following ACE members.

Bibb Swain, Delta-T Corporation
460 McLaws Circle, Ste. 50
Williamsburg, VA 23185
757-220-2955
Email: bswain@deltatcorp.com

Jeff Broin, Broin & Associates
25784 Cottonwood Ave.

Sioux Falls, SD 57107
605-543-5090
Email: jeffbroin@broin.com

Gunter Brodl
Vogelbusch USA, Inc.
10810 Old Katy Rd. #107
Houston, TX 77043
713-461-7374
Email: vbusa@msn.com

Lee Allen
North Central Construction
3350 35th Avenue, SW
Fargo, ND 58106
701-232-0941
Email: leea@northccinc.com

Dave Vander Griend
ICM
PO Box 397
Colwich, KS 67030
(316) 796-0900
Email: enginfo@icminc.com

Bill Wells
Fagen, Inc.
501 W Hwy. 212
Granite Falls, MN 56241
320-564-3324
Email: wwells@fageninc.com

Useful Measurements

1 barrel equals 42 gallons
1 gallon of ethanol weighs 6.6 pounds
1 gallon of water weighs 8.3 pounds
1 U.S. liquid gallon = 4 quarts = 231 cubic inches = 3.78 liters
2 pints = 1 quart
4 quarts = 1 gallon
8 gallons = 1 bushel
128 ounces = 1 gallon
1 liter = 1.057 U.S. liquid quarts
1 fluid ounce = 30 milliliters
1 inch = 2.54 centimeters
1 pound = 453.6 grams
1 gram = 0.035 ounce
1 ounce = 28.349 grams
1 kilogram = 2.2 pounds
1 BTU x 252 equals calories
Celsius temperature x 9/5 plus 32 equals degrees Fahrenheit.
Fahrenheit temperature minus 32 x 5/9 equals degrees Celsius.
1 lb of starch yields 0.568 lbs of ethanol
1 lb sugar yields 0.511 lbs ethanol

A rule of thumb is that a 12” diameter column will produce 25 gallons per hour. If you double the column diameter, you increase the output by 4. If you halve the column diameter, you get only 1/4 the output.

Websites for More Information

U.S. Government Agencies

U.S. Department of Energy - (www.doe.gov)

Alternative Fuel Vehicle Fleet Buyer's Guide

Cooperative Automotive Research for Advanced Technologies (CARAT) Program

Energy Efficiency & Renewable Energy Network (EREN) - (www.eren.doe.gov)

Energy Information Administration (EIA) Renewables and Alternate Fuels Page - (www.eia.doe.gov/fuelrenewable.html)

EIA's Energy Related Sites Page - (www.eia.doe.gov/links.html)

Office of Transportation Technologies - (www.ott.doe.gov)

Federal Energy Technology Center- (www.fetc.doe.gov)

National Renewable Energy Laboratory - (www.nrel.gov)

Idaho National Engineering Laboratory: Transportation Projects - (www.inel.gov/capabilities/transportation/index.html)

Idaho National Engineering Laboratory: Hybrid Electric Vehicle R&D - (ev.inel.gov/)

Environmental Protection Agency (EPA) - (www.epa.gov)

Transportation Action Network - (www.transact.org)

Federal Transit Administration

FedWorld - (www.fedworld.gov)

ARPA Electric & Hybrid Vehicle Data Center - (www.ev.hawaii.edu)

Link to Clean Cities Coordinators - (www.ccities.doe.gov/contacts/ccoord.cgi)

Non-U.S. Government Agencies

Canadian Center for Pollution Prevention

Federal Environmental Assessment in Canada (CEAA)- (www.ceaa.gc.ca)

BC Research Inc. Centre for Alternative Transportation Fuels (http://catf.bcresearch.com)

IEA Newsletter on Dimethyl-ether (DME) as an Alternative Fuel (www.automotive.tno.nl/icengines/html/lob/dme1.html)

Distill.com http://www.distill.com

State Agencies

Alabama

Alabama Alternative Fuels Program - (leibnitz.me.ua.edu/~adeca)

California

California Air Resources Board (CARB) - (www.arb.ca.gov)

California Energy Commission - (www.energy.ca.gov/)

Illinois

Chicago Area Clean Cities

Hawaii

Hawaii State Energy Office - (www.hawaii.gov/dbedt/ert/)

Michigan

Michigan Energy Resources Division
- (www.cis.state.mi.us/opla/erd/ehome.htm)

New York

Clean Communities of Western New York - (members.aol.com/Legis14/clean.htm)

Puget Sound Clean Cities Coalition (PSCCC) - (www.energy.wsu.edu/ep/altfuels/clean)

West Virginia

West Virginia: National Research Center for Coal and Energy - (www.nrcce.wvu.edu)

Energy and Transportation Organizations

Advanced Transit Association (ATRA) - (weber.u.washington.edu/~jbs/itrans/atra.htm)

American Coalition for Ethanol - (www.ethanol.org)

American Gas Association - (www.aga.org)

American Methanol Institute - (www.methanol.org/)

American Petroleum Institute - (www.api.org)

American Public Transit Association (APTA) - (www.apta.com)

The Automotive Consulting Group, Inc. - (www.autoconsulting.com)

CALSTART - (www.calstart.org) (Advanced Transp. Technologies - EVs, NGVs, etc.)

Donlen Corp (www.donlen.com)

Dynetek Industries Ltd - *a supplier of natural gas vehicle fuel tanks* (www.dynetek.com)

Edison EV - (www.edisonev.com)

EPRI EV Site

Electric Auto Association - (www.eaaev.org)

Electric Vehicle Association of the Americas (EVAA) - (www.evaa.org/)

EV World (http://evworld.com)

Energy & Environmental Research Center - (www.eerc.und.nodak.edu)

Gas Research Institute - (www.gri.org)

Global Electric Motorcars, LLC -(www.gemcar.com)

Independent Petroleum Association of America - (www.ipaa.org)

Inform, Inc. - (www.informinc.org)

Libra Electric Company - (www.qns.com/~libra)

Minnesotans for an Energy-Efficient Economy’s Sustainable Minnesota

National Association of Fleet Administrators, Inc. - (http://www.nafa.org/)

National Biodiesel Board - (www.biodiesel.org)

National Conference of State Legislatures - (www.ncsl.org)

National Hydrogen Association - (www.ttcorp.com/nha)

National Propane Gas Association - (www.propanegas.com/npga)

National Petroleum Council - (www.npc.org)

Natural Gas Vehicle Coalition - (www.ngvc.org)

NYSTEC Alternative Fuel Technology Center - (www.nystec.com/aftc)

Northeast Alternative Vehicle Consortium (NAVC) - (www.navc.org/)

Propane Vehicle Council - (www.propanevehicle.org)

Pure Energy Corporation *a bio-based fuels and chemicals company* - (www.pure-energy.com/)

Pure Energy Corporation *a bio-based fuels and chemicals company* - (www.pure-energy.com/)

PetroChemical Industry Resource (The U.S. Motor Fuels Information Center) - (www.petrochem.net)

Renewable Fuels Association - (www.ethanolrfa.org)

Society of Automotive Engineers - (www.sae.org/index.htm)

Southern Coalition for Advanced Transportation, Inc. - (www.advtrans.org)

Tata Energy Research Institute (TERI) - (www.teriin.org)

U.S. Fleet Leasing - (www.usfleetleasing.com)

Energy Suppliers

Allegheny Power - (www.alleghenypower.com)

Amoco Corporation - (www.amoco.com)

Atlantic Richfield Corporation (ARCO) - (www.arco.com)

British Petroleum - (www.bp.com)

Chevron Corporation - (www.chevron.com)

Clark Refining and Marketing, Inc. - (www.clarkusa.com)

Conoco - (www.conoco.com)

Consolidated Natural Gas Company - (www.cng.com/)

Mobil Corporation - (www.mobil.com)

NOPEC Corporation (www.nopec.com)

Occidental Petroleum Corporation - (www.oxy.com)

Shell Oil - (www.shellus.com)

Texaco - (www.texaco.com)

Automobile Manufacturers

Refer to our alternative fuel automotive links

Corporate

Autotronic Controls Corporation - www.dualcurve.com

Cummins Engine Co - (www.cummins.com/bus/altfuels.html)

Curtis Instruments, Inc. - (www.curtisinst.com)"...instruments for battery-powered vehicles and equipment..."

Dwights Energy Research - (www.dwights.com/research/der.htm)

ECO Fuel Systems, Inc. - (www.ecofuel.com/)

EPRI EV Site - (www.epri.com/csg/trans/evrn/default.html)

Equitable Resources Incorporated - (www.eri2000.com/)

Frost and Sullivan (Industrial Market Engineering) - (www.frost.com/industrial/)

Global Electric Motorcars - (www.gemcar.com)

Impco Technologies, Inc. - (www.impcotechnologies.com/)

Universities

West Virginia University, National Alternative Fuels Training Consortium - (http://naftp.nrcce.wvu.edu)

Center for Urban Transportation Research - (www.cutr.eng.usf.edu)

University of Kansas (Alternative Fuel Options) - (www.engr.ukans.edu/)

Colorado School of Mines - (WWW.WorldEnergy.com/)

Ethanol Efficiency - Student Challenge

Fourteen university student teams from across the United States and Canada took delivery of 1999 four-wheel-drive Chevrolet Silverados to kick off the 1999 Ethanol Vehicle Challenge. The student teams converted the full-size, gasoline-powered pickup trucks to run on ethanol fuel.

The teams spent six months adapting their trucks to run on E-85, a blend of 85% denatured ethanol and 15% gasoline. The goal was to build a vehicle with high fuel efficiency and lower emissions, but without sacrificing performance or consumer acceptability. The teams then met for seven days of rigorous testing from May 19-25, 1999, at General Motors Corporation's Milford Proving Grounds in Michigan.

Following are the results - miles per gallon gasoline as compared to miles per gallon after conversion to ethanol.

Vehicle	School	Combined (MPG)	Combined (MPGE)	% Efficiency Improvement
1	University of Waterloo	14.71	20.71	4.20
2	University of Texas at El Paso	15.13	21.31	7.21
3	Kettering University	14.86	20.93	5.30
4	University of Nebraska-Lincoln	14.00	19.71	-0.83
5	Cedarville College	15.52	21.85	9.94
6	Crowder College	15.92	22.42	12.79
7	Idaho State University	13.97	19.67	-1.03
8	University of California, Riverside	15.60	21.97	10.50

9	Wayne State University	14.43	20.32	2.25
10	Minnesota State University, Mankato	14.52	20.45	2.87
11	University of Illinois at Chicago	15.64	22.02	10.78
12	Illinois Institute of Technology	14.40	20.27	2.00
13	University of Texas at Austin	14.68	20.68	4.02
	Gasoline Control Vehicle	19.88	19.88	0.00

For More Information

Miscellaneous Sources

Purdue University - West Lafayette, Indiana. Has done much research on alcohol fuel.

Mother Earth News - P. 0. Box 70, Hendersonville, North Carolina 28739. A magazine that regularly carries how-to articles on solar stills, alcohol powered cars, and other alternate energy information.

Your Local Extension Agent - Can steer you to sources of alcohol information in your state, and has access to land grant college studies on alcohol.

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Small-scale Ethanol Production
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Small-scale Ethanol Production January 1979 - October 1991; Quick Bibliography Series: QB 92-46

1 NAL Call. No.: 1AG84Y

The ABC's of making farm alcohol and gas.

Miller, D.L.

Washington, D.C., The Department; 1980.

The Yearbook of agriculture - United States Dept. of Agriculture. p. 309-313; 1980. 2 ref. Language: ENGLISH

2 NAL Call. No.: FICHES-72

Alcohol distillation system performance test procedures
(On-farm biomass fuels).

Rein, B.K.; Bashford, L.L.; Walker, C.E.; Sullivan, N.W.; Ogden, R.L. St. Joseph, Mich. : The Society; 1983.

Paper - American Society of Agricultural Engineers (Microfiche collection) (fiche no. 83-3063): 1 microfiche : ill; 1983. Paper presented at the 1983 Summer Meeting of the American Society of Agricultural Engineers. Available for purchase from: The American Society of Agricultural Engineers, Order Dept., 2950 Niles Road, St. Joseph, Michigan 49085. Telephone the Order Dept. at (616) 429-0300 for information and prices. Includes references.

Language: English

3 NAL Call. No.: 100 SO82

(1) Alcohol fuel from fodder beets: economic feasibility of a small-scale plant. Dobbs, T.L.; Habash, M.K.

Brookings, S.D. : The Station; 1986 Aug.

Bulletin - Agricultural Experiment Station, South Dakota State University (699): 24 p. ill., maps; 1986 Aug. Includes references.

Language: English

Descriptors: Fodder beet; Alcohols; Fuel resources; Cost
analysis; Returns

4 NAL Call. No.: S27.A3 no.94

1980 Alcohol fuel workshop proceedings.

Great Plains Agricultural Council, Farm Foundation (Chicago, Ill.) Alcohol Fuel Workshop 1980 : Kansas State University. , Manhattan : Cooperative Extension Service, Kansas State

University, Manhattan,; 1980.

117 p. : ill. ; 28 cm.. (Publication / Great Plains Agricultural Council ; no. 94). Cover title. Includes bibliographies.

Language: English

Descriptors: Alcohol as fuel; Congresses

5 NAL Call. No.:TP358.S7

Alcohol fuels : handbook for Australian farmers..

Utilization of solar energy for the production of fuel

Strong, M. J.; Globus, Alfred R.

Sydney, Australia Bio-Energy (Australia) Pty. Ltd. (1980?); 1980. 46, 8 leaves : ill. ; 30 cm. Cover title. Bibliography: leaf 8.

Language: ENGLISH

Descriptors: Alcohol as fuel

6 NAL Call. No.: 275.29M76C

Alcohol production on the farm.

Clarey, B.

Bozeman, Mont., The Service; Apr 1981.

Bulletin - Cooperative Extension Service. Montana State University (1253): p. 33-38; Apr 1981.

7 NAL Call. No.: No Call No.(ENR)

Alcohol production with a farm-size still.

Marley, S.J.; Smith, R.J.; Buchele, W.F.; Tevis, J.W.; Chaplin, J.; Smith, D.R.

KS; Kansas State University, Cooperative Extension Service.

Forum on Alcohol Fuels, Kansas State University, 1980.
Energy in agriculture collection - Michigan State University, Department of Agricultural Engineering. p. 20-24. ill; Feb 1980.
Language: ENGLISH
Descriptors: Organic; Ethanol; Fermentation; Distillation; Requirements; 033

8 NAL Call. No.: 302.8P11
Alcohol pulping appears feasible for small incremental capacity. Katzen, R.; Fredrickson, R.E.; Brush, B.F.
San Francisco, Miller Freeman; Aug 1980.
Pulp and paper v. 54 (8): p. 144-149. ill; Aug 1980.
Language: ENGLISH

9 NAL Call. No.: aTJ810.S6 1983
Alternate extraction and fermentation processes for sweet sorghum (Biomass fuel, small-scale production of ethanol).
Bryan, W.L.
Washington, D.C. : The Department, 1983?; 1983.
3rd annual Solar and Biomass Workshop, April 26-28, 1983, Holiday Inn, Atlanta Airport/North Atlanta, Georgia / co-sponsors United States Department of Agriculture ... (et al.).. p. 147-150. ill; 1983. Includes references.
Language: English

10 NAL Call. No.: 472 N21
Alternative energy: fuels from the farm.
Lubinska, A. Basingstoke, Eng. : Macmillan Journals; 1985 Apr04., Nature v. 314 (6010): p. 395; 1985 Apr04.
Language: English
Descriptors: European communities; Surpluses; Biomass; Fuel resources; Ethanol

11 NAL Call. No.:TP360.E532
Anaerobic digestion of thin stillage from a farm-scale alcohol plant (Methane production for fuel).
Seely, R.J.; Spindler, D.D.
Chicago, Ill., Institute of Gas Technology; Apr 1981.
Energy from biomass and wastes ; symposium papers (5): p. 295-305. ill; Apr 1981. Presented at a symposium held January 26-30, 1981 at Lake Buena Vista, Florida. Includes 7 ref.
Language: English

12 NAL Call. No.: TP358.I52 1980
An analysis of five on-farm ethanol units in the United States. Sklar, S.
Sao Paulo, Brasil : Instituto de Pesquisas Tecnologicas do Estado de Sao Paulo-IPT, 1980; 1980.
Proceedings of the IV International Symposium on Alcohol Fuels Technology, Guaruja-SP-Brasil, 5-8 Oct. 1980. v. 3 p. 1019-1022; 1980.
Language: English
Descriptors: USA

13 NAL Call. No.:TP360.B58
Biogas and alcohol fuels production : proceedings of a seminar on biomas energy for city, farm, and industry.
Compost science/land utilization.
Emmaus, Pa. JG Press; 1980.
246 p. : ill. Includes bibliographical references.
Language: ENGLISH
Descriptors: Biomass energy; Congresses

14 NAL Call. No.: TP360.B58 1981
Biogas and alcohol fuels production : proceedings of the second Seminar on Biomass Energy for City, Farm, and Industry.
BioCycle.
Biomass Energy for City, Farm, and Industry Chicago 1981.
Emmaus, Pa. JG Press; 1981.
250 p. : ill., maps ; 28 cm. Seminar was organized March 12-13, 1981. Includes bibliographies and index.
Language: English
Descriptors: Biomass energy; Congresses

15 NAL Call. No.:S494.5.E5E62
Biomass: Solar energy from farms and forests.
Grace, A.
Energy in agriculture collection - Michigan State University, Department of Agricultural Engineering (SERI/SP-69-242): 13 p. ill; Aug 1979. Includes bibliography.
Language: ENGLISH
Descriptors: Organic; Biomass; Anaerobic Fermentation; Energy Crops; Wastes; Alcohol; Ethanol; Wood; 033

16 NAL Call. No.:aHD1415.G5
Brazil.
Allen, E.W.
Washington, D.C. : USDA, ERS, Agriculture and Trade Analysis Division; 1988. Global review of agricultural policies. p. 81-85; 1988. (Staff report ; AGES990304). Includes references.
Language: English

Descriptors: Brazil; Agricultural policy; Economic policy; Trade policy; Farm sector; Goals; Structural change; Food consumption;

Exports; Alcohols; Fuels; Program evaluation

17 NAL Call. No.: 58.8 P87
Brewing fuel on the farm (Alcohol from crops, Australia).
Barnes, C.S.
Sydney, Pacific Publications (Aust.).; Nov 1979.
Power farming magazine v. 88 (11): p. 25, 27, 29. ill; Nov 1979.
Language: ENGLISH
Descriptors: Australia

18 381
J8224 A continuous, farm-scale, solid-phase fermentation process for fuel ethanol and protein feed production from fodder beets.
Gibbons, W.R.; Westby, C.A.; Dobbs, T.L.
New York, N.Y. : John Wiley & Sons; 1984 Sep.
Biotechnology and bioengineering v. 26 (9): p. 1098-1107. ill; 1984 Sep. Includes references.
Language: English
Descriptors: Ethanol; Fermentation; Fuel resources; Beta vulgaris; Saccharomyces cerevisiae

19 NAL Call. No.: TJ163.3.E539 1981
Controls for farmers' ethanol plants.
Bonne, U.
Atlanta, Ga. : Fairmont Press, c1981; 1981.
Energy management : a sourcebook of current practices. p. 211-225. ill; 1981. Paper presented at the 3rd World Energy Engineering Congress, October 1980, sponsored by the Association of Energy Engineers. Includes references.

Language: English

20 NAL Call. No.: FICHE S-25

Corn, alcohol, farm fuel] Things you need to know.

Iowa Corn Promotion Board.; Iowa Development Commission.

Michigan State University Energy for Agriculture Series ENR (80-15): 16 p. ill; 1979.

Language: ENGLISH

Descriptors: Organic; 033

21 NAL Call. No.: 281.9 N27

Cost of production of fuel ethanol in farm-size plants.

Atwood, J.A.; Fischer, L.K.

Lincoln, The Department; Dec 1980.

Report - University of Nebraska, Agricultural Experiment Station, Dept. of Agricultural Economics (115): 58 p.; Dec 1980.

Bibliography p. 37-43.

Language: English

Descriptors: Synthetics; Fuel; Production; Costs; On-farm

Abstract: Extract: This study is intended to identify and present the various costs of producing alcohol in on-farm plants with currently available technology. The study is further designed to provide a method whereby these costs can be quantified for specific plants. This information should be of value to those considering the construction of a small-scale alcohol plant, as well as for persons involved in related public policy and financial decisions.

22 NAL Call. No.:aT223.V4A4

Dehydration of ethanol.

Robertson, G.H.; Pavlath, A.E.
Washington, D.C.? : The Department; 1985 Dec03.
United States Department of Agriculture patents (4,556,460): 1 p. ill; 1985 Dec03. Copies of USDA patents are available for a fee from the Commissioner of Patents and Trademarks, U.S. Patents and Trademarks Office, Washington, D.C. 20231. Includes references.
Language: English
Descriptors: U.S.A.; Ethanol; Dehydration; Patents; Small businesses; Usda; Fuel moisture content
Abstract: A process and apparatus for dewatering an ethanol-water solution is disclosed wherein a carrier gas is used to vaporize the solution and transport the vapors to a sorbent where water is sorbed in preference to ethanol. The invention is particularly suited for small-scale production of fuel-grade ethanol for blending with gasoline.

23 NAL Call. No.:TP360.E544
Design, construction, operation, and costs of a modern small-scale fuel alcohol plant (Corn as feedstock, biomass fuels).
Leeper, S.A.; Dawley, L.J.; Wolfram, J.H.; Berglund, G.R.; Richardson, J.G. Chicago : The Institute, c1982; 1982.
Energy from biomass and wastes VI : symposium, January 25-29, 1982, Lake Buena Vista, Florida / symposium chairman D.L. Klass ; sponsored by the Institute of Gas Technology. p. 871-886. ill; 1982. Includes references.
Language: English

24 NAL Call. No.: 65.9 SO83
The development of a micro distillery for fuel alcohol in Brazil. Hulett, D.J.L.
Mount Edgecombe, The Association; 1981.
Proceedings ... annual congress - South African Sugar

Technologists' Association (55th): p. 64-66. ill; 1981.

25 NAL Call. No.:SB249.N6

Economic factors affecting agriculture in the southeast in the 80s. Sullivan, G.D.

Memphis, Tenn. : National Cotton Council and The Cotton Foundation; 1981 Jan04.

Proceedings - Beltwide Cotton Production Research Conferences. P. 189-191; 1981 Jan04. 1981 Proceedings Beltwide Cotton Production Research Conferences in New Orleans, Louisiana, Jan. 4-8, 1981.

Language: English

Descriptors: U.S.A.; Energy; Costs; Irrigation; Drought; Pollution; Farm structure; Interest rates; Ethanol

Abstract: Extract: Demand for food products will expand rapidly, with vigorous growth in effective demand in foreign markets. Southeastern producers have the advantage of a strategic location to share in the growth in export markets for agricultural products. The growth in demand will raise prices sufficiently to offset cost increases for major enterprises, so that farmers will continue to bring marginal land into production and hold down their expansion of grazing livestock enterprises. On balance, total agricultural output will expand but shifts in competitive positions will cause traditional enterprises to diminish in importance. The structure of southeastern agriculture will continue to change rapidly in the decade ahead. I believe that commercial agriculture of the 1980's will differ remarkably from its predecessor of a short two decades ago.

26 NAL Call. No.:HD1750.W4

Economic prospects for small-scale fuel alcohol production. Dobbs, T.L.; Hoffman, R.; Lundeen, A.

Lincoln, Neb. : Western Agricultural Economics Association; 1984 Jul. Western journal of agricultural economics v. 9 (1): p. 177-185; 1984 Jul. Includes 25 references.
Language: English
Descriptors: South Dakota; Alcohols; Fuels; Energy; Cost analysis

27 NAL Call. No.: HD1761.A1M5 no.86-12
The economics of ethanol production and its impact on the Minnesota farm economy.
Fruin, Jerry E.; Halbach, Daniel W.
University of Minnesota, Dept. of Agricultural and Applied Economics St. Paul, Minn. : Dept. of Agricultural and Applied Economics, University of Minnesota,; 1986.
40 p. : ill. ; 28 cm. (Staff paper P, no. 86-12). Title from cover. March, 1986. Bibliography: p. 40.
Language: English; English
Descriptors: Alcohol as fuel; Economic aspects; Minnesota

28 NAL Call. No.:S27.A3
The economics of producing fuel alcohol in farm size plants. Fischer, L.K.
Alcohol Fuel Workshop, (1980, Kansas State University,. Manhattan, Kansas, Kansas State University; May 13, 1980. Publication - Great Plains Agricultural Council (94): p. 103-117; May 13, 1980. 14 ref.
Language: English
Descriptors: Synthetics; Fuel; Production; Economic analysis

29 NAL Call. No.: FICHE S-25
The economics of producing fuel alcohol in farm size

plants. Fischer, L.K.
Michigan State University Energy for Agriculture Series ENR
(MCA/BIO 67): p. 103-117; May 1980. Source: Kansas State Univ.,
Coop. Ext. Service, no. 94. Proceedings: Alcohol Fuel Workshop,
Kansas State University. Available on microfiche for a fee from
Microfilming Corp. of America, 1620 Hawkins Ave.,/P.O. Box 10, Sanford, N.C. 27330, Energy and Agriculture collection. 14 ref.
Descriptors: Organic; Alcohol; Ethanol; Economics; 033

30 NAL Call. No.:S27.A3
The economics of producing fuel alcohol in farm size
plants (USA). Fischer, L.K.
Alcohol Fuel Workshop, (1980, Kansas State University,.
Manhattan, Kan., Kansas State University; 1980.
Publication - Great Plains Agricultural Council (94): p. 103-117;
1980. 14 ref.
Descriptors: USA

31 NAL Call. No.:HD1407.C6
The economics of small scale alcohol production.
Casler, G.L.
Ithaca, N.Y., The Station; Feb 1981.
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Descriptors: Synthetics; Fuel; Production; Costs; On-farm

32 NAL Call. No.:HD1775.N8E35

Economics of small scale on-farm alcohol
distilleries.
Nichols, T.E. Jr; Jackson, J.D. Jr
Raleigh, N.C., The Service; Jan 1981.
Economics information report - N. Carolina State Univ., Dept. of Economics and Business, N. Carolina Agricultural Extension Service (64): 46 p.; Jan 1981. 6 ref.
Descriptors: Synthetics; Fuel; Production; On-farm; Costs; Values; Planning; Break-even analysis

Abstract: Extract: This report documents the costs of producing ethanol from five small on-farm distilleries and compares the production costs with the value of ethanol when used as a motor fuel. Important factors useful in planning a farm distillery are discussed and production costs for five model distilleries, producing 190 proof ethanol and ranging in output from 840 gpy (gallons per year) to 201,600 gpy, are derived using a base set of input prices with a breakeven analysis used to evaluate the profitability of each distillery.

33 NAL Call. No.:QR53.B56
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ethanol production by Saccharomyces cerevisiae.
Hoppe, G.K.; Hansford, G.S.
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Includes references.
Language: English

Descriptors: Saccharomyces cerevisiae; Ethanol; Production; Fermentation; Aerobiosis

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economics.
Dovring, F.
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Language: English

35 NAL Call. No.: FICHE S-72
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(Corn, Zea mays, biomass fuel, South Dakota).
Stampe, S.; Chisholm, T.; Westby, C.
St. Joseph, Mich. : The Society; 1982.
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Language: English
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36 NAL Call. No.:TJ163.5.A37E5
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Language: English

37 NAL Call. No.: 58.8 AG83
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Language: English

38 NAL Call. No.: FICHE S-25
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Michigan State University Energy for Agriculture Series ENR (MCA/BIO 72): 52 p. ill; Feb 1980. Source: Univ. of Missouri-Columbia, College of Agri. Ext. Div., no. MX100. Available on microfiche for a fee from Microfilming Corp. of America, 1620 Hawkins Ave.,/P.O. Box 10, Sanford, N.C. 27330, Energy and Agriculture collection. Includes bibliography.
Descriptors: Missouri; Organic; Alcohol; Ethanol; Energy Crops; Animal; 033

39 NAL Call. No.: FICHE S-72
Energy recovery and utilization on a Texas farm (Alcohol from biomass). Raley, D.K.; Malish, D.A.
St. Joseph, Mich. : The Society; 1984.
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Language: English
Descriptors: Texas

40 NAL Call. No.: No Call No. (ENR)
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Energy in agriculture collection - Michigan State University, Department of Agricultural Engineering United States National Alcohol Fuels Commission: 137 p. ill., maps; Aug 1980. Source: Schnittker Associates. Includes bibliography.

Language: ENGLISH
Descriptors: Organic; Alcohol; Ethanol; Energy Crops; Corn; Policy; 033

41 NAL Call. No.:S17.N4
Ethanol from farm crops (Corn, sugarbeet, cellulosic residues, economics, New Zealand).
Spriggs, T.W.
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42 NAL Call. No.:916937(AGE)
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Language: English
Descriptors: Ethanol; Grains; Fuel; Cost analysis; Economic evaluation; By-products; Feed
Abstract: Extract: We evaluate the economics of three operating plants producing ethanol from grain in and around Illinois with rated capacities of 625 to 1,500 thousand gal./yr. We first present anecdotal results on capital costs, operating difficulties, and success in marketing the ethanol and the feed by-product. All three plants are viable because, among other things, their indirect costs are low due to acquisition of used tanks. We then analyze the sensitivity of production costs to changes in costs of inputs, and, assuming uncertainties in inputs, the total uncertainty in production cost. Besides the cost of grain and fuel, the most important factor in cost is the "duty cycle", the fraction of total capacity actually realized.

43 NAL Call. No.: aTJ810.S6 1983
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Garcia, A. III; Fischer, J.R.; Iannotti, E.L.
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Language: English
Descriptors: Missouri

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Hinz, W.W.
Arizona, University, United States, Dept. of Agriculture.
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Language: ENGLISH
Descriptors: Organic; Alcohol; Ethanol; Safety; Energy Source; 033

45 NAL Call. No.:TP374.C6C6
Ethanol—increasing farm income.
Vaughn, E.
Washington, D.C. : Corn Refiners Association, Inc; 1988.
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Language: English
Descriptors: Fuel crops; Maize; Ethanol; Trends

46 NAL Call. No.:HD1401.A56
Ethanol's role: an economic assessment.
Kane, S.; Reilly, J.; LeBlanc, M.; Hrubovcak, J.
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Descriptors: U.S.A.; Ethanol; Grain; Prices; Petroleum; Production costs; Subsidies; Energy shortages; Market competition; Environmental protection; Farm income

47 NAL Call. No.: TEXAS A&M
MASECR79034NTI Farm alcohol fuel plant.
Zeithamer, A.E.
Bloomington, Minn. : Mid-American Solar Energy Complex, 1979; 1979. Mid-American biomass energy workshop, May 21-23, 1979 : Conference proceedings including recommendations for direct combustion, alcohol fuels, anaerobic digestion, and gasification.

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Language: English

48 NAL Call. No.: TEXAS A&M TP358.A28
Farm alcohol fuel plant.
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West Lafayette, Ind. : Agricultural Engineering Dept., Purdue University, 1981; 1981.
Alcohol and vegetable oil as alternative fuels : proceedings of regional workshops. p. 209-215. ill; 1981. Available on microfiche for a fee from Microfilming Corp. of America. 1982. Energy and Agriculture: BIO 384. Also available from: Interlibrary Loan Service Div., Texas A&M Library, College Station, TX 77843.
Language: English

49 NAL Call. No.: aTJ810.S6 1983
Farm alcohol/methane production model (Biomass fuel).
Broder, J.D.; Waddell, E.L. Jr
Washington, D.C. : The Department, 1983?; 1983.
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50 NAL Call. No.:TP358.F37
Farm and forest produced alcohol : the key to liquid fuel independence : a compendium of papers submitted to the Subcommittee on Energy of the Joint Economic Committee, Congress of the United States. United States, Congress, Joint Economic Committee, Subcommittee on Energy. Washington U.S. Govt. Print. Off; 1980. v, 76 p. : ill. ; 24 cm. At head of title: 96th Congress, 2d

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Language: ENGLISH
Descriptors: Alcohol as fuel; Economic aspects; United States; Addresses, essays, lectures; Liquid fuels; Addresses, essays, lectures; Biomass energy; United States; Addresses, essays, lectures

51 NAL Call. No.: No Call No (ENR)
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Language: ENGLISH
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52 NAL Call. No.: 23 N472
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Quick, G.R.
Sydney, Australia, New South Wales, Dept. of Agriculture; Feb 1982. Agricultural gazette of New South Wales 93 (1): p. 37. ill; Feb 1982.
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Descriptors: Australia

53 NAL Call. No.: 58.8 P87
Farm fuel production—ethanol.
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Language: English

54 NAL Call. No.: No Call No. (ENR)
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Language: ENGLISH

Descriptors: General; Solar; Organic; Biomass; Alcohol; 016

55 NAL Call. No.: Document available from source. Farm production of alcohol fuels.
Document available from: Ohio State University, Extension Office of Information, 2120 Fyffe Road, Columbus, Ohio 43210; 1980. 3 p..
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Descriptors: Agricultural engineering; Fuel production; Ethanol
Abstract: This publication is a question and answer sheet about using by-products for fuel on the farm.

56 NAL Call. No.: Not available at NAL.
Farm scale alcohol production : the Iowa State University ethanol distillery. Ozkan, H. Erdal; Chaplin, Jonathan; Marley, Stephen J.
1981; 1981.
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Language: English
Descriptors: Agronomy; Grain crops; Utilization; Energy; Agriculture; Ethanol fuel; Agricultural engineering; Fuel

produciton; Equipment

Abstract: This publication discusses making ethanol fuels out of grain crops. The process of distilling agriculture products is examined with diagrams and figures.

57 NAL Call. No.: HD9502.5.A433N2 1980

Farmers Home Administration funding programs for ethanol projects. Thornton, J.E.

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Language: English

Descriptors: Ethanol; Funds; Usda; Industry; Investment policy; Program development

58 NAL Call. No.: 6 SU12

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Mowitz, D.

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Language: English

Descriptors: Biomass; Energy resources; Fuel resources; Ethanol; Production potential; Marketing; Agricultural production; Maize; Plant production; Product development; Product markets

59 NAL Call. No.: FICHE S-72

Farm-produced alcohol and methane model.

Broder, J.D.; Waddell, E.L.

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Language: English

60 NAL Call. No.: No Call No. (ENR)
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Includes bibliography.
Language: ENGLISH
Descriptors: Organic; Energy Source; Alcohol; 033

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Farm-scale alcohol: fuel for thought (Biomass fuels, Canada). Hayes, R.D.
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Language: English
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Descriptors: Canada

63 NAL Call. No.: 100 SO82 (3)
Farm-scale conversion of cellulose to glucose for fuel alcohol production. Cass, C.M.; Gauger, W.K.
Brookings, S.D., The Station; 1985 Feb.
Technical bulletin - Agricultural Experiment Station, South Dakota State University (87): 6 p.; 1985 Feb. Includes references.
Language: English
Descriptors: Cellulose; Glucose; Conversion; Fuels; Saccharification; Trichoderma; Conversion

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Language: English

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Language: English
Descriptors: South afRica; Saccharum; Fuel crops; Ethanol; Distilling

67 NAL Call. No.: 56.8 J822
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Language: English
Descriptors: California; Starch crops; Sugar crops; Biomass determination; Ethanol; Fuel resources; Distilling industry; Models

68 NAL Call. No.: TP358.F47 1981
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Bank. Washington, D.C. U.S. G.P.O. Copies may be purchased
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Language: English

Descriptors: Alcohol as fuel; Fermentation

69 NAL Call. No.: TP593.F4 1981
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Descriptors: Alcohol; Alcohol as fuel; Potatoes; Fermentation;
Biomass energy

70 NAL Call. No.: KF26.A3533 1980a
FmHA biomass energy program : hearing before the
Subcommittee on Agricultural Credit and Rural Electrification of
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Descriptors: Biomass energy; Government policy; United States; Gasohol; Government policy; United States

71 NAL Call. No.:TP358.L8

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Language: English

Descriptors: Alcohol as fuel; Biomass energy; Energy crops

72 NAL Call. No.:916937(AGE)

Fuel alcohol from grain: energy and dollar balances of small ethanol distilleries and their economies of size and scale.

Dovring, F.; Herendeen, R.; Plant, R.; Ross, M.A.

Urbana, Ill., The Department; Dec 1980.

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Descriptors: Synthetics; Fuel; Production; Grain; Energy; Prices; Feed grains

Abstract: Extract: This paper calculates energy and economic balance for three sizes of ethanol-for-grain plants: (1) Single-farm size (10,000 gallons a year), (2) Farm-consortium size (250,000 gallons a year), and (3) Industrial size gasohol plant (2.5 million gallons a year).

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Whitehurst, B.M.
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Descriptors: North Carolina; Sweet potatoes; Fuel resources; Ethanol; Agricultural wastes; Waste utilization; Economics; Farm enterprises

74 NAL Call. No.:TP358.U485
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Washington The Commission; 1980.
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Language: ENGLISH
Descriptors: Alcohol as fuel; Biomass energy; United States

75 NAL Call. No.: FICHE S-25
Fuel alcohol on the farm: a primer on production and
Use. Michigan State University Energy for Agriculture Series ENR (MCA/BIO 38): 37 p. ill; 1980. Source: U.S. National Alcohol Fuels Commission. Available on microfiche for a fee from Microfilming Corp. of America, 1620 Hawkins Ave.,/P.O. Box 10, Sanford, N.C. 27330, Energy and Agriculture collection. 12 ref.
Descriptors: Organic; Alcohol; Ethanol; Safety; 033

76 NAL Call. No.:TJ163.2.E42
Fuel and feed co-products from farm and community
scale processing of agricultural wastes.
Malcolm, D.G.; Paul, S.E.

Winnipeg : Solar Energy Society of Canada; 1982.
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Language: English

Descriptors: Agricultural wastes; Biotechnology; Processing; Feeds; Fuels; Production; Ethanol

77 NAL Call. No.: A281.9 AG8A
Fuel ethanol and agriculture: an economic assessment.
Gavett, E.E.; Grinnell, G.E.; Smith, N.L.
Washington, D.C. : The Department; 1986 Aug.
Agricultural economic report - United States Dept. of Agriculture (562): 54 p.; 1986 Aug. Includes 37 references.
Language: English
Descriptors: Ethanol; Economic analysis; Farm income; Legislation; Costs; Cost benefit analysis

Abstract: Increased fuel ethanol production from renewable resources like grain through 1995 would raise net farm income benefiting mainly corn and livestock producers. Production of additional byproduct feeds would depress prices of soybeans. Large ethanol subsidies, which are required to sustain the industry, would offset any savings in agricultural commodity programs. Increased ethanol production would also raise consumer expenditures for food. Any benefits of higher income to farmers would be more than offset by increased Government costs and consumer food expenditures. Direct cash payments to corn growers would be more economical than attempting to boost farm income through ethanol subsidies.

78 NAL Call. No.: 381 J8224
Fuel ethanol and high protein feed from corn and corn-whey mixtures in a farm-scale plant (Kulyveromyces fragilis, Saccharomyces cerevisiae). Gibbons, W.R.; BIBIA; Westby, C.A. New York : John Wiley & Sons; Sept 1983. Biotechnology and bioengineering v. 25 (9): p. 2127-2148. ill; Sept 1983. Includes references.

Language: English

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Brown, L.R.
Washington, D.C., World Future Society; June 1980.
The Futurist v. 14 (3): p. 16-28; June 1980. 1 ref.
Language: ENGLISH

80 NAL Call. No.: No Call No. : (ENR)
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Williams, J.E.
Arizona, University, United States, Dept. of Agriculture.
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Language: ENGLISH
Descriptors: Organic; Alcohol; General; 033

81 NAL Call. No.: TP358.S6 1980
Fuel from farms : a guide to small-scale ethanol production., 1. ed. Solar Energy Information Data Bank; United States, Dept. of Energy Oak Ridge U.S. Dept. of Energy; 1980. vi, 89 p., (68) p. : ill. ; 28 cm. Contract no. EG-77-C-01-4042. Issued Feb. 1980. SERI/SP-451-519, UC-61. Includes

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Language: ENGLISH
Descriptors: Alcohol as fuel

82 NAL Call. No.: HD9502.5.A43U55 1980
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Bibliography: p. F1-F5.
Language: English
Descriptors: Alcohol fuel industry; United States; Gasohol industry; United States; Alcohol as fuel; Energy conservation; United States; Biomass energy; United States

83 NAL Call. No.:S494.5.E5E62
Fuel from farms—A guide to small-scale ethanol production. Solar Energy Research Institute.
Energy in agriculture collection - Michigan State University, Department of Agricultural Engineering (SERI/SP-451-519, UC-61): various pagings. ill; Feb 1980. Includes bibliographies.
Language: ENGLISH
Descriptors: Organic; Distillation; Fermentation; Ethanol; Alcohol; Economics; 033

84 NAL Call. No.:TP593.L37
Large and small scale ethyl alcohol manufacturing processes from agricultural raw materials.
Paul, J. K.

Park Ridge, N.J. Noyes Data Corp; 1980.
xiii, 576 p. : ill. ; 29 cm.. (Chemical technology review no. 169
Energy technology review no. 58). Bibliography: p. 565-569.
Language: English
Descriptors: Alcohol; Alcohol as fuel; Biomass energy

85 NAL Call. No.: KF27.A344 1981d
Loan guarantees for alcohol fuels and biomass programs :
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Energy of the Committee on Agriculture,
House of Representatives, Ninety-seventh Congress,
first session, March 16, 1981.
United States Congress House Committee on Agriculture
Subcommittee on Forests, Family Farms, and Energy.
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86 NAL Call. No.: TP358.N44 1979
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independence., 1st ed. Nellis, Micki; Nellis, Alden
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Note New Address 3/2000: Buffalo Creek Press,
PO Box 2424, Cleburne, Texas 76031

87 NAL Call. No.: 275.29 M58B
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Ofoli, B.; Stout, B.
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88 NAL Call. No.: FICHE S-25
Making the product on a small scale.
Middaugh, P.
Michigan State University Energy for Agriculture Series ENR (ENR80-83): p. 14-17. ill; June 1979. Source: Gasohol USA, 1.

Language: ENGLISH
Descriptors: Organic; Alcohol; Ethanol; Fermentation; Distillation; 033

89 NAL Call. No.: 6 M58
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Black, R.
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Language: ENGLISH
Descriptors: Michigan; Distillation; Corn; 033

90 NAL Call. No.: KF27.B542 1979
The National alcohols and alcohol fuel and farm commodity production act of 1979 : hearing before the Subcommittee on Economic Stabilization of the Committee on Banking, Finance, and Urban Affairs, House of Representatives, Ninety-sixth Congress, first session, on H.R. 3905 ... October 22, 1979. United States
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Descriptors: Alcohol as fuel; Loans; United States; Government

guaranty; Agricultural laws and legislation; United States

91 NAL Call. No.: KF27.A3226 1979a
National fuel alcohol and Farm Commodity Production Act
of 1979.. Farm Commodity Production Act of 1979
United States Congress House Committee on Agriculture
Subcommittee on Conservation and Credit; United States,
Congress, House, Committee on Agriculture,
Subcommittee on Department Investigations, Oversight,
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References.
Language: ENGLISH
Descriptors: Alcohol as fuel; Loans; United States; Government
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92 NAL Call. No.: No Call No. (ENR)
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Doering, O.C. III
Purdue University, Cooperative Extension Service.
Energy in agriculture collection - Michigan State University,
Department of Agricultural Engineering (59): 8 p.; Feb 1980.
Language: ENGLISH
Descriptors: Organic; Alcohol; Ethanol; Fermentation;
Economics;
033

93 NAL Call. No.: 100 C12CAG
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California). Meo, M.; Sachs, S.
Berkeley, Calif., The Station; July 1982.

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Language: English
Descriptors: California

94 NAL Call. No.:S27.A3
On-farm alcohol production potential.
Rider, A.R.; Shelton, D.P.
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Manhattan, Kan., Kansas State University; 1980.
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Language: English
Descriptors: Sunflowers; Fuel; Oils; Models; Cash flow; Energy; Costs; On-farm

Abstract: Extract: Small scale on-farm production of sunflower oil as a diesel fuel substitute and grain alcohol as a gasoline substitute are both technically feasible. This research compares the technical feasibilities of these two technologies, estimates the cost of producing these fuels at three different scales and examines the impact of the available subsidies for ethanol production on the economic ranking of these technologies. The ethanol plants are based on technologies modeled in previous studies. The sunflower oil plants were designed as a part of this thesis on the basi of available oil presses and relatively simple oil refining equipment. As modeled in this study, sunflower oil is screened, filtered, degummed, neutralized, transesterified, washed and dried in order to produce transesterified, refined sunflower oil (TRSO).

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Language: English
Descriptors: Biomass; Ethanol; Energy conversion; Farm enterprises; Feasibility studies; Production possibilities

97 NAL Call. No.: FICHE S-72
On-farm ethanol pilot plant design and operation (Production of fuels from biomass).
Dodd, R.B.; Roberts, D.L.
St. Joseph, Mich. : The Society; 1981.
Paper - American Society of Agricultural Engineers (Microfiche collection) (fiche no. 81-3568): 1 microfiche : ill; 1981. Paper presented at the 1981 Winter Meeting of the American Society of Agricultural Engineers. Available for purchase from:
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Language: English

98 NAL Call. No.:TJ163.5.A37E5
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Language: English

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100 NAL Call. No.: 100 SO8T
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Technical bulletin - South Carolina Agricultural Experiment Station (1097): 16 p.; 1988 Dec. Literature review. Includes references.
Language: English
Descriptors: South Carolina; Ethanol; On farm processing; Energy conservation; Fermentation; Fuel crops; Case studies; Crop residues; Nutritional value

101 NAL Call. No.: FICHE S-72
Plant biomass production for energy in eastern New Mexico (Small and medium sized alcohol plants, best crop is grain sorghum).
Morin, G.C.A.; Finkner, R.E.; Fuehring, H.D.
St. Joseph, Mich. : The Society; 1982.
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Language: English
Descriptors: New Mexico

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Geng, S.; Hills, F.J.; Johnson, S.S.; Sah, R.N.
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Language: English
Descriptors: California; Zea mays; Sorghum bicolor; Beta vulgaris; Yield components; Carbohydrates; Ethanol; Hexoses; Cost analysis; Farm results; Irrigation; Nitrogen fertilizers

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Language: ENGLISH
Descriptors: Organic; Alcohol; Ethanol; Design; Technology Assessment; 033

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Language: ENGLISH
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Gibbons, W.R.; Westby, C.A.
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Biomass v. 15 (1): p. 25-43; 1988. Includes references.
Language: English
Descriptors: U.S.A.; Cereals; Whey; Distillers' residues; Fuel crops; Fermentation; Ethanol; Energy consumption;
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Production costs

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Descriptors: Alcohol; Potatoes; Industrial applications

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The productivity of a farm size still (Production of fuel alcohol from crop biomass).
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Chicago, Ill., Institute of Gas Technology; Apr 1981.
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Language: English

109 NAL Call. No.: 100 K13S (4)
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Language: English

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I.A.A.E. occasional paper - International Association of Agricultural Economists (2): p. 104-108; 1981. This paper was presented at the "17th International Conference of Agricultural Economists," 1979, Banff, Canada.
Language: English
Descriptors: Brazil; Energy cost of production; Energy conservation; Biomass; Fuel resources; Marketing; Investment;

Terms of trade
Abstract: Extract: “The purpose of this paper is to report initial results of a farm level regional analysis of the Brazilian alcohol plan. Alcohol production from energy crops is presently not competitive with world oil prices. However, within Brazil, a price regulated energy market insures a competitive price for alcohol. The analysis examines both the regulated market and a free market for energy. The free market analysis is conducted to measure the anticipated response to rising energy prices."

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Descriptors: Michigan

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United States. Congress. House. Committee on Agriculture. Subcommittee on Forests, Family Farms, and Energy;
United States, Congress, House, Committee on Agriculture, Subcommittee on Wheat, Soybeans, and Feed Grains,
United States, Congress, House, Committee on Energy

and Commerce, Subcommittee on Energy and Power
Washington [D.C.] : U.S. G.P.O. : For sale by the Supt. of Docs., Congressional Sales Office, U.S. G.P.O.,; 1988; Y 4.Ag 8/1:100-80. v, 156 p. : ill. ; 24 cm. Distributed to some depository libraries in microfiche. Serial no. 100-80 (Committee on Agriculture). Serial no. 100-127 (Committee on Energy and Commerce).

Language: English; English

Descriptors: Agricultural wastes as fuel; United States; Energy crops; United States; Alcohol; Fuel; United States

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Descriptors: USA; Synthetics; Fuel; Technology; On-farm; Efficiency; Alternatives

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Chambers, R.S.
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Language: ENGLISH
Descriptors: Organic; Alcohol; Economics; Distillation; Ethanol;
117 NAL Call. No.:TP358.G35
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Language: English

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120 NAL Call. No.:S27.A3
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Andrew, F.W.
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Language: English
Descriptors: Maize meal; Cooking; Steam; Ethanol; Production; Maize starch

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Descriptors: Factory and trade waste; Alcohol as fuel

123 NAL Call. No.: FICHE S-25
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Descriptors: Organic; Ethanol; Renewable Energy; 033

124 NAL Call. No.:916937(AGE)
Small-scale ethanol production: economics and issues.
Braden, J.B.
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Illinois agricultural economics staff paper, series E agricultural economics -Dept. of Agricultural Economics, University of Illinois (E-133): 16 p.; Sept 1980. 8 ref.
Descriptors: Energy; Synthetics; Fuel; Production; Costs; Prices; Economic feasibility

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The small-scale ethanol production enterprise: arrangement and economics. Leiner, F.T.; Braden, J.B.
Urbana, Ill., The Department; Sept 1981.
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Language: English
Descriptors: Petroleum; Models; Prices

Abstract: Extract: The purpose of this paper is to examine, within an economic framework, the optimal arrangement of small-scale ethanol production. The first is on-farm production. Most observers believe that on-farm production will not be undertaken widely due to technical disadvantages, low product yields, and significant demands on the time of farm operators. The second option is a small specialized production unit which though not actually part of a farm operation, has direct ties to the local economy for its inputs and outputs. Local grain feedstocks would be used. Protein-rich by-products could be fed to livestock in a feedlot associated with the plant or on nearby farms. Finally, the alcohol produced might be used locally. It is this small specialized production unit which serves as the basis for our analysis.

126 NAL Call. No.: FICHE S-72
A small-scale ethanol production facility design and performance (Production of fuels from biomass).
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Paper - American Society of Agricultural Engineers (Microfiche collection) (fiche no. 81-3567): 1 microfiche : ill; 1981. Paper presented at the 1981 Winter Meeting of the American Society of Agricultural Engineers. Available for purchase from:
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Order Dept., 2950 Niles Road,
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429-0300 for information and prices. Includes references.
Language: English

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feedstocks (for fuel). Coble, C.G.; Hiler, E.A.; Sweeten, J.M.;
O'Neal, H.P.; Reidenbach, V.G.; LePori, W.A.; Aldred, W.H.;
Schelling, G.T.; Kay, R.D.
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Language: English

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243 p. in various pagings : ill. ; 26 cm. Prepared with the
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Language: ENGLISH
Descriptors: Alcohol as fuel; Synthetic fuels; United States

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Small-scale fuel alcohol production from corn: economic
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Brookings, S.D. : The Station; 1983 Jun.
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Descriptors: South Dakota; Fuels; Production; Maize; Ethanol; Marketing; Costs; Transport; Economic evaluation

130 NAL Call. No.: TEXAS A&M TP358.A28
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La Turner, R.E.
West Lafayette, Ind. : Agricultural Engineering Dept., Purdue University, 1981; 1981.
Alcohol and vegetable oil as alternative fuels : proceedings of regional workshops. p. 107-110; 1981. Available on microfiche for a fee from Microfilming Corp. of America. 1982. Energy and Agriculture: BIO 373. Also available from: Interlibrary Loan Service Div., Texas A&M Library, College Station, TX 77843.
Language: English

131 NAL Call. No.:SB249.N6
Substituting diesaveg fuel for diesel fuel.
Fryar, E.
Memphis, Tenn. : National Cotton Council and The Cotton Foundation; 1981 Jan04.
Proceedings - Beltwide Cotton Production Research Conferences. P. 226-230; 1981 Jan04. 1981 Proceedings Beltwide Cotton Production
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Language: English

Descriptors: Diesel oil; Vegetable oils; On farm consumption; Mechanical methods; Ethanol; Economic analysis; Energy resources; Energy cost of activities

132 NAL Call. No.: FICHE S-72
Systems analysis of economics of on-farm energy

production. Atwood, J.A.; Schulte, D.D.; Helmers, G.A.
St. Joseph, Mich. : The Society; 1986.
American Society of Agricultural Engineers (Microfiche collection) (fiche no. 86-4070): 22 p.; 1986. Paper presented at the 1986 Summer Meeting of the American Society of Agricultural Engineers. Available for purchase from: The American Society of Agricultural Engineers, Order Dept., 2950 Niles Road, St. Joseph, Michigan 49085. Telephone the Order Dept. at (616) 429-0300 for information and prices. Includes references.
Language: English
Descriptors: Linear programming; Systems analysis; Economics; Farms; Methane production; Ethanol

133 NAL Call. No.:QR151.S542
Thermophilic microbes in ethanol production.
Slapack, Gary E.,; Russell, Inge,_1947-; Stewart, Graham G.,
Boca Raton, Fla. : CRC Press,; 1987.
186 p. : ill. ; 26 cm. Includes index. Bibliography: p. 137-177.
Language: English
Descriptors: Fermentation; Bacteria, Thermophilic; Microorganisms, Thermophilic; Alcohol; Synthesis; Cellulose; Metabolism; Biomass energy

134 NAL Call. No.:aHD1401.A2U52
Why gasohol can’t pass the farm income cost-benefit test.
Washington, D.C. : The Service; 1987 Feb.
Farmline - United States Dept. of Agriculture, Economic Research Service v. 8 (2): p. 10-12. ill; 1987 Feb.
Language: English

Descriptors: U.S.A.; Ethanol; Fuels; Farm income; Economic depression; Tax incentives

135 NAL Call. No.: 166.2 N47
Will alcohol fuels offer new opportunity for farmers.
Lee, B.W.; Prevan, S.D.
Washington, D.C., The Service; Oct 1980.
Farmer cooperatives - United States Agricultural Cooperative Service v. 47 (7): p. 4-6; Oct 1980.
Descriptors: Synthetics; Fuel; Production; Costs; Plant; Size

Glossary

Acidity - The measure of how much acid a solution contains.

Air Lock - A device for keeping the air out of a fermenting brew. Can be made by attaching a tube to the top of the fermentation vessel and immersing the other end of the tube in a container of water. The carbon dioxide gas bubbles out through the water, but air cannot en ter the fermentation container. A one-way vent valve may be used for the same purpose.

Alkalinity - The measure of alkali in a solution. The word "base" is a chemical term meaning alkali.

Alcohol - The family name of a group of organic compounds. In cludes methanol, ethanol, isopropyl alcohol and others. In this book, the word "alcohol" generally refers to ethanol.

Anaerobic - Without air. All fermentation is anaerobic.

Anhydrous - Literally, without water. Anhydrous alcohol refers to 197 proof or above.

Azeotrope - The chemical term for two liquids that, at a certain con centration, boil at the same temperature. Alcohol and water cannot be separated more than 194.4 proof because at this concentration, alcohol and water form an azeotrope and vaporize together.

Beer - The fermented mash, which contains about 10% alcohol.

BTU - British Thermal Unit. The quantity of heat needed to raise one pound of water one degree Fahrenheit.

Boiling Point - The temperature at which a liquid boils. The boiling point varies with the liquid and with the altitude. The greater the altitude, the lower the boiling point.

C - Abbreviation for Celsius temperature.

Calibrated - Marked so that each mark signifies a certain percent, proof, temperature or other measurement. For example, a thermometer is calibrated in degrees F.

Calorie - The amount of heat required to raise one gram of water one degree Celsius.

Carbohydrate - A chemical term describing compounds made up of carbon, hydrogen, and oxygen. Includes all starches and sugars.

Carbon Dioxide - A gas produced as a by-product of fermentation. Chemical formula is C02. Harmless. Can be compressed and used as a refrigerant, used in silos to exclude air and prevent spoilage, or vented to a greenhouse to help plant growth.

Cassava - A starchy root crop used for tapioca. Can be grown on marginal croplands along the southern coast of the US.

Cellulose - A complex carbohydrate that gives plants their rigid structure.

Celsius - A temperature scale commonly used in the sciences. Water freezes at 0 degrees C and boils at 100 degrees C at sea level.

Centigrade - The same as Celsius but now outdated.

Columns - As used in this book, the apparatus for separating water from alcohol through distillation.

Compound - A chemical term denoting a combination of two or more distinct elements.

Condenser - A cooling apparatus designed to change a vapor to a liquid by lowering the temperature.

DDGS - Distillers Dried Grain Solids. The residue left after fermentation and distilling. DDGS from corn contains about 28% protein.

Denaturant - As used in this book, a liquid that makes ethanol unfit for drinking.

Dextrose- The same as glucose. The terms are interchangeable.

Distillate - The end product of distillation. In this book, ethanol.

Distillation - The process of separating two liquids by changing one to a vapor with heat and driving the vapor off the other liquid. The separated vapor is then condensed into another container.

Distillers Grain - The high-protein residue left over after fermen tation. See DDGS.

DSB - Abbreviation for dry starch basis.

Energy Crops - Crops grown for their energy potential, as for alcohol production.

Enzymes - Proteins which act as catalysts to change one chemical compound to another chemical compound. Each chemical reaction requires a different enzyme. The enzymes are not used up, but can be destroyed by high heat, acidity, heavy metals and other chemical poisons.

Ethanol - The same as ethyl alcohol or grain alcohol. Will produce intoxication and can be burned as fuel.

F - Abbreviation for Fahrenheit temperature.

Fahrenheit - A temperature scale. Water freezes at 32 degrees F and boils at 212 degrees F at sea level.

Feedstock - The raw material for fermentation, in this book.

Fermentation - The process where yeast changes sugar to alcohol in the absence of air.

Fines - The fine particles that result from grinding or cracking solids.

Flash Point - The temperature at which a combustible liquid will ignite when a flame is introduced. Anhydrous ethanol will flash at 51 degrees F. 90 proof ethanol will flash at 78 degrees F.

Gasohol - A blend of 10% anhydrous alcohol with 90% unleaded gasoline.

Glucose - A simple sugar that can be fermented to make ethanol.

Hydrometer - A long stemmed glass tube with a weighted bottom. It floats at different levels depending on the relative weight (specific gravity) of the liquid. The specific gravity or other information is read where the calibrated stem emerges from the liquid.

Methanol - The same as methyl alcohol or wood alcohol. Highly poisonous to drink or get on skin. Can be used as fuel.

Methane - A gas that can be produced from the decomposition of organic materials or from the incomplete combustion of wood.

Membrane - As used in this book, a thin layer of a substance that separates liquids by allowing one to pass through, but not the other.

Molecule - The chemical term for the smallest particle of matter that is the same chemically as the whole mass.

Malting - The process of sprouting grains to produce enzymes which break down starch into sugar.

Mash - The mixture prepared for fermentation.

Non-Renewable Energy - Energy produced from sources that cannot be regenerated in a reasonable length of time. Oil, coal, and nuclear energy are non-renewable energy sources.

Polysaccharides - 30 or more molecules of s u*gar joined together.

Proof - A measure of alcohol content. Proof is twice the percentage of alcohol. Thus, 200 proof is 100% alcohol.

Proof Test - Passing a lighted match over the alcohol to see if it ignites. Alcohol will burn at 100 proof or above. It has reached “proof”when itwill first burn. Use test with caution.

pH - A measure of acidity or alkalinity on a scale of 0 to 14. The more acid the solution, the lower the pH number. The more alkaline, the higher the pH. Neutral is pH 7.

Pot Still - The type of simple still used by moonshiners. These have no ref lux columns.

Producer Gas - A low BTU gas containing methane and other gases, produced by incomplete combustion of organic matter.

Pyrolysis- Bring about chemical change by heating.

Rectifying Column - In a two column still, the second column.

Reflux - To return the liquid or vapor to a previous point in the process to be processed again. Part of the alcohol is refluxed through the distillation column.

Renewable Energy - Energy produced from renewable resources, such as the crops grown on America's farms.

Saccharify - To change to sugar.

Sight Gauge - A glass tube parallel to the bottom 2' of the column used to gauge the level of liquid in the column.

Sight Window - The glassed-in portion of the reflux columns that allows visual inspection of the process.

Specific Gravity - The ratio of the weight of any volume of a sub stance to the same volume of water, which is taken as a standard. Water has a specific gravity of 1.000. Different percentages of alcohol and water will have a specific gravity of less than 1.000, depending on the concentration of alcohol.

Starch - A carbohydrate made up of long, tightly coiled chains of glucose molecules.

Starch Test - When iodine is added to a solution, it turns blue if starch is present. If no starch is present, the solution remains colorless or turns red-brown, depending on how much iodine is ad ded.

Stillage - The water and high-protein residue left over from distillation.

Temperature Scale - A scale used for temperature designations. The Fahrenheit scale is used in this book. Another common scale is the Celsius scale, formerly called Centigrade.

Vaporize - To change from a liquid or a solid to a vapor, as in heating water to steam.

Vaporization Temperature of Ethanol - 172.9 degrees F. at sea level. 83

Vaporization Temperature of Water - 212 degrees F. at sea level. Less at higher elevations.

Volatile Liquid - A liquid that is easy to vaporize.

Wood Alcohol - The same as methanol or methyl alcohol. See methanol.

Yeast - A micro organism that is capable of changing sugar to alcohol by fermentation.

Definitions

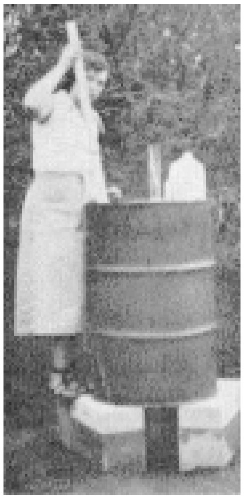
About The Author

Micki Nellis was raised on a small farm in southeastern Oklahoma where the fields were plowed by mules and the cotton was picked by hand. She went to a one-room school with a wood-burning stove and one teacher for eight grades. Sitting around the kerosene lamp at night, her parents would talk to the children about "When you finish college...," and they grew up not doubting but that the impossible dream would happen. When the time came, her parents left the land and her father worke as a common laborer on construction projects to help the kids through college.

Micki graduated with a Phi Beta Kappa key and a B.S. with Distinction from the University of Oklahoma in 1965 with a triple major in microbiology, zoology, and chemistry. She worked 10 years in several fields of science, including in a tuber culosis lab, in microbiological research, oil field chemistry, radioactive tracing of enzymes, industrial production of hospital chemicals, and food microbiology. When she and husband Alden decided to get out of the big city, they bought a farm near Iredell, a tiny town of 316 peo ple, quit their jobs on Friday and moved the next day. In Iredell, they re-discovered the hard economic facts of life in Rural America.

In January of 1976 Micki started the tredell Times, the first newspaper in the town since 1939. Then on Valentine's Day in 1978, she and Alden started the American Agriculture News, which was later endorsed by the American Agriculture Movement. Features about Micki and Alden, who was raised in Haviland, Kansas, appeared on NBC TV, in Texas Monthly, the Dallas Morning News, the Austin American Statesman, and the Texas Press Messenger, and the Dallas Times Herald.

Today she and husband Alden own a computer service company in Cleburne, Texas. Micki does software and publishing, both traditional and e-publishing.



Micki Nellis,
author - in her
youth!

Micki Nellis today - or at least within the last 10 years!