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The Manual for the Home and Farm Production of Alcohol Fuel

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Ten Speed Press

Out of print

Chapter 17

PUTTING IT ALL TOGETHER

LARGE AND SMALL SYSTEMS

VERY SMALL

The author has alcohol/water injection systems installed on his 1978 Honda and 1975 Ford pick-up truck. The injection systems, purchased from Spearco Performance Products, Inc. (address in appendix), are designed for water injection. Consequently, they were modified to (approximately) double the flow rate to the carburetor under peak load conditions. This enables maximum efficiency from a 120 proof alcohol/water injection mixture. Under average driving conditions, the gasoline saving amounts to 25-30%. The alcohol injection mixture is prepared from miscellaneous vegetable matter, damaged fruit, and garbage that is collected (free) from a number of sources. It is fermented directly in two 44-gallon plastic trash cans and distilled in a solar still as described in Chapter 15. The entire set-up, including the injection systems, cost less than $150.00 (in 1978) and the labor requirement is only an hour or two per week. Family gasoline consumption has been cut from an average of 50 gallons per week to about 35. The whole investment was paid back in less than 4 months, and all current savings are pure profit!

SMALL

A nearby farmer, who is semi-retired, processes a variety of agricultural surplus in a 500 gallon cooker that also serves as a fermenter and still pot. One run a week produces about 400 gallons of beer that yields, on an average, 35 gallons of 190 proof alcohol. The alcohol is used in a tractor, the family car, and a one-ton truck. The entire "plant" was built (in 1978) for about $1,000.00. The batch still and column (4" diameter) only produce 2 to 3 gallons per hour (at 190 proof), and the total labor requirement is about 20 hours.

MEDIUM

Another farmer in the area has a somewhat larger operation. He processes artichoke culls in a 4,000 gallon cooker that also serves as a fermenter. However, distillation is done in a 10 inch continuous column that produces 20 gallons of 180 proof alcohol per hour. Working intermittently when feed stock material is available, 2 batches are cooked and fermented each week. The resulting 6,000 gallons of beer are distilled in about 24 hours. Since the still is fully automated, total labor to produce 500 gallons of fuel is about 20 hours. The still was built in the farm machine shop from a design worked out by the author and the Alcohol Technology Corporation at a cost of about $10,000.00. Of this amount, about $4,000.00 was spent on automatic controls and instrumentation. A comparable distillation unit, purchased commercially, would cost between $25-50,000.00! In addition, the cooker/fermenter was built for about $4,000.00 and miscellaneous plumbing cost another $1,000.00, all at 1979 prices. The planned addition of two 5,000 gallon fermenters will cost another $7-8,000.00. The desired capacity is to produce 15-20,000 gallons of fuel alcohol each fall when the surplus crops are available.

LARGE

An even larger fuel alcohol production facility is currently being constructed by a Mid-West dairy farmer. This facility will process corn. Each 70 pounds of unshelled corn will yield a bushel (56 pounds) of shelled corn and 14 pounds of corn cobbs. The shelled corn, when processed, will yield about 2.5 to 2.7 gallons of alcohol. The corn cobbs, when dried and burned in a boiler, will produce 91,000 Btu which is enough to completely fuel the cooking and distillation operations. The facility centers on a steam batch cooker, several fermenters, and a 12 inch continuous, fully automated, still. Initial production will be in excess of 50,000 gallons per year, although the facility is capable of several times this amount. The stillage is to be fed to a resident dairy herd as a high-protein supplement. The possibility of using manure from the cattle to generate methane is also being considered. The entire system is being professionally engineered and purchased commercially at a cost of about $250,000.00.

The foregoing examples illustrate a number of points. First, that alcohol production is possible on all levels, from the author's modest system to a fairly large "on-farm" plant. Secondly, all of the systems described fill a need, all of them are cost efficient, and all will pay back the entire plant cost in a relatively short time. Finally, all of the systems provide a certain degree of independence from petroleum fuels, and all are operated totally from renewable resources.

CONSIDERATIONS

The main areas of cost in setting up and operating an alcohol plant are: (1) the cost of the physical plant; (2) the cost of raw materials or feedstock; (3) the cost of fuel to run the plant; and (4) the amount of labor involved.

You can begin producing alcohol with a modest capital investment or you can spend a great deal of money. A farm or cooperative might find an alcohol facility a bargain at almost any price. Not only can the installation eliminate the use of petroleum, it can provide independence or "crop insurance" in these perilous times. As for very small systems, they pay for themselves and, if everyone produced even a small percentage of his own motor fuel, there would be no immediate fuel crisis.

Farmers have the advantage of available surplus and damaged crops that might otherwise go to waste. They also have the advantage of combined operations whereby stillage is fed to animals (saving feed costs) and manure is used to generate methane to run the alcohol facility. Others are not quite so fortunate. Nevertheless, alcohol feedstocks are available for very little cost if time is spent to locate them. City dwellers, for example, can purchase damaged materials from wholesale food distributors.

Fuel to run the still and cooking operation is another important cost consideration. The fuel must be cheap and available. Wood, straw, corncobbs and the like are hard to handle but are good sources of heat. Coal might be considered in certain areas as might electricity. Whatever the fuel, though, it should be from a renewable source.

Labor is a consideration closely related to plant cost and the degree of automation. Small batch equipment requires a disproportionate amount of labor for the alcohol produced. The "small" operation previously described requires 20 hours labor for less than 40 gallons of fuel. The "medium" operation produces over ten times the amount of alcohol for the same amount of work. The difference is in the size of the equipment. In the long run, larger equipment often pays for itself in terms of labor and economic operation.

Those considering purchasing or building larger facilities should obtain as much information as possible before making a commitment. The number of manufacturers and suppliers of alcohol fuel equipment seems to be increasing at an almost exponential rate. Some offer good, reasonably priced equipment and services. However, many offer designs that are totally incompetent or, at best, hopelessly old fashioned. An excellent source of "state of the art" information in relation to the above is "Gasohol" magazine, whose address is listed in the appendix.

Chapter 18

THE FUTURE

PRESENT TECHNOLOGY

Almost all of the technology currently used in the production of fuel alcohol was developed 30-40 years ago. During the Great Depression, much research was done concerning the use of crop surplus for the production of fuel alcohol . The research was never put into practice partly because of pressure from the oil lobby. Interest in alcohol fuel again arose during the Second World War when oil was in short supply. It is no secret that much of Europe, and the entire Third Reich, ran on alcohol fuel from about 1943 on. After the war, interest in alcohol again declined, partly because gasoline was cheap and available, and partly because of the oil lobby. Today, with a new crisis upon us, this existing fuel alcohol technology is being rediscovered.

It is amusing to note that a lot of the "new" advances being claimed are not new at all. A manufacturer of distillation equipment, for example, claims the discovery of a process of using gasoline as an alcohol drying agent in the direct production of gasohol. In fact, U. S. Patents 1,490,520 (1924), 1,699,355 (1929), 1,744,504 (1930), 2,371,010 (1945), and 2,591,672 (1952) cover the subject quite well! Soon, automobile manufacturers (after much research and the resulting tax writeoffs), will "discover" that alcohol can be used in internal combustion engines, and tractor manufacturers will "remember" that they have been exporting alcohol fueled farm equipment to many foreign countries, principally in South America, for the past 50 years.

The point is that most of the solution of the energy problem regarding alcohol fuel is already in existence, waiting to be rediscovered and put to use.

NEW TECHNOLOGY

The current (and hopefully continuing) interest in alcohol fuel is generating new research and many promising developments are at hand. The following is a small portion of what is being done.

IMMOBILIZED ENZYMES

One of the most important areas of current research concerns the enzymes used to convert starch to sugar. Enzymes are expensive and are a major expense in starch conversion. Using present technology, enzymes can only be used once. They go into solution in the mash and are all but impossible to recover for reuse. The current research (begun in the 1950s) involves immobilizing the enzymes. Instead of being allowed to go into solution, the enzymes are fastened or "immobilized" on an inert substrate. The mash is then passed over a bed of these immobilized enzymes. The end result is that the enzymes do not go into solution and they may be reused many times at a considerable saving. This technology is not yet fully developed for starch conversion, but should be available in the near future.

CELLULOSE CONVERSION

Cellulose is the most plentiful and cheapest potential source of fuel alcohol. Attempts are being made to develop new enzymes to economically convert cellulose to glucose. The problem, as mentioned earlier, is freeing the cellulose from the lignin. Strains of organisms, such as those that cause dry rot in wood, are being studied. The object is not only to extract the cellulose, but to allow easy recovery of the lignin. Lignin, in turn, makes an excellent fuel with which to run a still.

ALTERNATIVES TO DISTILLATION

The entire distillation process is also under scrutiny. The research is in three basic areas. First is the development of large, efficient solar distillation apparatus. The approach is either to develop a still that will completely strip the beer and deliver high proof alcohol, or to use solar energy to generate steam to run a conventional still. Another promising area involves elimination of the distillation process altogether. One method is the use of membranes that will selectively pass the alcohol but retain the water and other impurities in the beer. The third area of research involves extraction of the alcohol with solvents. So far, these processes involve the use of heat and a certain amount of redistillation. Hopefully, the perfected system will consume less energy than conventional distillation.

BIOLOGICAL RESEARCH

It is known that plants must first produce sugar in order to make starch or cellulose. If there were some way to pick plants at the peak of sugar production, the manufacture of ethanol could be greatly simplified. In addition, crops with inherently high sugar content could be mutated to produce even more sugar and grown specifically for the production of alcohol.

There are certain bacteria, algae, and fungi that can ferment alcohol directly from cellulose without a conversion step. It is also within the realm of possibility that a plant could be developed to produce alcohol directly. Certain plants, such as mint, already possess the basic biological mechanism! Even the relatively simple development of a yeast strain that is more tolerant to alcohol would allow more concentrated mashes and a significant saving in distillation energy.

CONCLUSION

The full utilization of existing technology and the promise of new developments will make the production of alcohol fuel easier and more economical in the near future. However, as fossil fuel supplies dwindle, it will become increasingly important to utilize every shred of available material and waste in the production of energy. Aside from the large scale production of alcohol fuel, self-contained, automatic appliances that could turn all sorts of waste material into useable fuel would be an important development. Electric vehicles and small, regional hydro-electric plants would also help, as would full utilization of solar, geothermal, and other energy alternatives.

It is important to realize that the energy problem will not solve itself. It is already the "eleventh hour" and nothing short of a concerted, world-wide effort will suffice!

Chapter 18 THE FUTURE

Biofuels

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Biofuels supplies and suppliers

Biodiesel

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Mike Pelly's recipe
Two-stage biodiesel process
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