The Manual for the Home and Farm Production of Alcohol Fuel

by S.W. Mathewson
Ten Speed Press

Out of print

Chapter 12

DRYING THE ALCOHOL

GENERAL DESCRIPTION

As stated earlier, if the alcohol you produce is going to be burned in an engine modified to burn "pure" alcohol, water content of 5, 10 or even 15% is not objectionable. However, if the alcohol is going to be mixed with gasoline, the water will either have to be removed or "neutralized".

Drying the alcohol is a separate manufacturing step requiring additional labor, energy and/or expense. It would be wise to consider all factors before deciding whether this procedure is necessary.

ABSORPTION METHODS

If you are able to obtain alcohol from your still that is close to 190 proof (95%), the easiest method of producing "gasohol" is to mix sufficient benzene (benzol) with the alcohol to keep the water from separating. Usually, benzene in a ratio of about 2-3 times the amount of water in the alcohol is sufficient. For example, to prepare 100 gallons of 10% gasohol, mix 10 gallons of 95% alcohol with 2 gallons of benzene. Then add 88 gallons of gasoline. Note that water percentages greater than 5% require the addition of much larger amounts of benzene. It is suggested that experiments on a small scale be done before attempting to mix large quantities of gasohol. Prepare a mixture according to the above proportions and see if it separates. You may want to put a sample in the refrigerator to test cold weather tolerance. At any rate, if the mixture separates, more benzene is needed.

A second method takes advantage of the fact that water will dissolve in most salts, but ethanol will not. Therefore, water can be removed (although not entirely) by filtering the alcohol/water through dry salt. Almost any “hygroscopic" (water absorbing) material such as calcium salt, various sulphates, phosphates and similar materials will work. However, common rocksalt, such as used in water softeners is cheap and available. An apparatus such as described in Chapter 7 for sprouting malt can be used. Fill the drum or container with rocksalt. The alcohol/water is poured in at the top and filters down through the salt. Relatively water-free alcohol is

collected through holes or a valve at the bottom of the container. Remember that the salt must be dry. After absorbing water from a certain amount of alcohol, the salt must be re-dried either in an oven or by spreading it out in the sun.

A good system might be to use both of the methods described above. First, most of the water in the alcohol is removed by the salt method, and then the blend is prepared with benzene. The more water that can be removed from the alcohol, the less benzene will be needed. Benzene will have to be purchased (the cheapest technical grade is fine) and can be used only once. The rocksalt can be dried and used many times.

DRYING WITH LIME

The oldest method of drying alcohol is dehydration with lime. This process is still used on a laboratory scale. It is similar to the salt absorption method just described except that, with this method, water is removed by a chemical reaction. Ordinary lime (calcium oxide, formula CaO) reacts with water to form calcium hydroxide (formula Ca(OH)2). The process is simple. The water-containing alcohol is mixed with lime at a ratio of about 35 pounds (or more) of lime for each gallon of water to be removed (as determined with a hydrometer) and allowed to “slake" for 12-24 hours with occasional stirring . The lime reacts with the water to form calcium hydroxide. The calcium hydroxide is insoluble in the alcohol and so the relatively pure (99.5%) alcohol goes to the top of the container and the calcium hydroxide settles to the bottom.

The usual method of separating the lime and calcium hydroxide from the alcohol is by distillation. Alternately, but less desirable, the alcohol can be carefully drawn off (decanted) and filtered to remove any suspended particles that give it a milky appearance.

An apparatus based on a 55-gallon drum (similar to that in Figure 13-1) can be built. A still head with thermometer (no reflux column is needed) and condenser should be added to allow simple distillation. Also, a small gate valve located 6-8 inches from the bottom (above the level of the lime) will allow the alcohol to be decanted, if desired.

After slaking in the apparatus, the alcohol should be distilled off through the simple still head and condenser. During distillation, the temperature should remain exactly at the boiling point of pure alcohol. Remaining after the pure alcohol has been distilled or decanted is wet calcium hydroxide and lime.

Some alcohol will also be trapped in the residue. To recover it, continue the distillation. The still head temperature will rise above 173 degrees F indicating that water is coming over with the remaining alcohol. When the still head reaches 208-212 degrees F all of the alcohol has been removed. The water/alcohol distillate should be added to the beer for the next run in the reflux distillation apparatus.

The calcium hydroxide may be converted back into calcium oxide and re-used. However, the temperatures required are quite high unless a vacuum drying oven is used. Since lime is relatively cheap, this process is not recommended.

AZETROPIC METHODS

Commercial alcohol distilleries usually use an "azetropic" drying system. The fact that water and alcohol form a binary (two-part) azetrope, or constant boiling mixture, was described earlier. If a hydrocarbon solvent such as benzene, trichlorethylene, or even gasoline is added to the water/alcohol mixture, a ternary (three part) azetrope is formed.

Typically, trichlorethylene is mixed as a vapor with the 190 proof alcohol/water vapors coming from the rectifying column. These vapors are passed to another column. The water/ trichlorethylene/alcohol azetrope boils at about 153 degrees F which is lower than the boiling point of pure alcohol. Therefore, the water, trichlorethylene, and some alcohol will vaporize first and exit the top of the column while pure anhydrous alcohol will exit the bottom. The water and trichlorethylene will separate into two layers upon standing in much the same way that water and gasoline will separate. Because of this separation, the trichlorethylene can be recovered and reused. The water (recovered from the trichlorethylene) contains some alcohol and is passed back into the main apparatus and redistilled. Systems using benzene and gasoline work in exactly the same way except that the boiling points are slightly different. If gasoline is used as the solvent, gasohol is produced automatically!

It is possible to mix benzene or gasoline in a reflux batch still, as described in Chapter 14, and boil off the water/solvent through the rectifying column leaving pure, dry alcohol behind. However, in doing this you would be boiling a highly flammable mixture of solvent and alcohol. This could be extremely dangerous, especially if an open fire were used to heat the still. Please do not attempt this procedure unless you are absolutely sure you know what you are doing and the equipment is properly designed.

Biofuels
Biofuels Library
Biofuels supplies and suppliers

Biodiesel
Make your own biodiesel
Mike Pelly's recipe
Two-stage biodiesel process
FOOLPROOF biodiesel process
Biodiesel processors
Biodiesel in Hong Kong
Nitrogen Oxide emissions
Glycerine
Biodiesel resources on the Web
Do diesels have a future?
Vegetable oil yields and characteristics
Washing
Biodiesel and your vehicle
Food or fuel?
Straight vegetable oil as diesel fuel

Ethanol
Ethanol resources on the Web
Is ethanol energy-efficient?