Identifying Alcohol Losses using a Counter Top Water Dispenser for Essential Oil Distillation

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Background:

Consumer counter top water dispensers have been designed for a particular purpose – boiling and re-condensing water. These devices have become popular for distilling Essential oils and Cannabis oils. A typical process entails soaking the cannabis plant material in alcohol to extract the oils and then boiling off the alcohol leaving the residual oils called FECO (Full Extracted Cannabis Oil) or RSO (Rick Simpson Oil). A big benefit of this unit's design is re-condensing and saving the alcohol for later reuse resulting in a cost effective easy-to-use solution. But at what cost? There are huge losses of alcohol during the distillation. This paper runs multiple experiment to explain these losses and propose a fix.

Conclusion:

The tests show the result of five distillations and their volume of re-condensed liquid. The conclusion made here is that the condenser design is engineered to remove enough BTUs (British Thermal Units, see References below) to lower the temperature of water steam vapors enough for condensation. It is not engineered to remove enough heat energy for lower boiling point fluids, IE., alcohol, resulting in losses of up to 40% of the original alcohol volume, escaping as vapors. By adding a secondary (although amateurish) condenser in line with the first, the fourth test shows enough heat was dissipated to allow this lower boiling point fluid to be re-condensed at nearly100%.

The Fix:

The heating element and/or condenser must be engineered to match a wider range of boiling points. So there are two possible solutions. First, use a variable wattage heating element to match the required BTU output. Secondly, an alternative fix would add additional condenser cooling capacity to remove more BTUs.

Simple DIY Home Based Fix:

Here's a home made condenser that will add enough BTU capture to re-condense alcohol to almost 100% of the original volume. Starting with a broad funnel, add 36 inches of coiled Stainless Steel Flexible Conduit so there is a top vertical input and bottom sideways output. Insert silicone tubing on both ends for flexibility in attaching to the distiller and the collection jar. Add ice to the top of the funnel when in use. You will have to reload a lot of ice during the distillation so best to let the ice water drain through the bottom of the funnel.

Methods:

Consumer counter top water dispensers share a common design. Here the typical capacity holds 1 gallon of water, has a 750 watt heating element and a fan blown coiled condenser built in the head. Temperature shutoff is provided by an internal thermostat. Some units provide user control over the thermal shutoff point. The re-condensed fluid is deposited in a small reservoir typically holding an activated carbon filter. Once the fluid passes through the carbon filter, it runs out the exit tube and hopefully into a waiting storage tank.

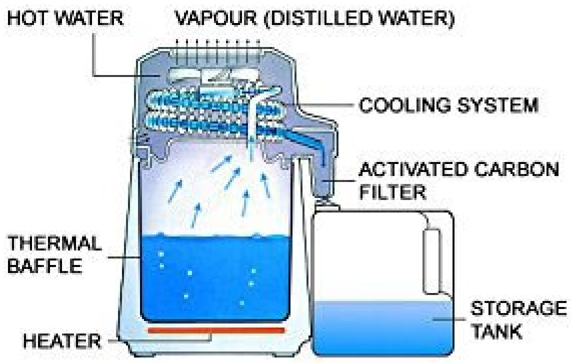

Photo credit: WaterFilterMag.com

Tests:

These units were designed for distilling water which has a boiling temperature of 100ºc (212ºf). Alcohol, in particular et ethanol has a boiling point of 78ºc (173ºf). This lower temperature guarantees these units can handle the distilling of cannabis extracts. "Real World" reporting has said there is a 20-30% loss of alcohol in the process. Why is that? Water is distilled with almost 100% recovery. There should be no loss in alcohol, but there is.

Why?

Recently I distilled a gallon of Ethanol in a consumer water distiller to raise the Alcohol By Volume (ABV) only to find out, I lost approximately 30% of the entire volume. Why? During the distillation, I put my face in the exhaust fans output and was nearly overcome with alcohol vapors. This led me to believe my unit was broken. Upon further investigation, I discovered the unit's condenser deposits its liquid, not into my collection jar, but dumps it into a small cup in the condenser's plastic housing. The liquid is poured over a small fabric bag containing activated charcoal to filter out any remaining impurities. These finding lead me to believe this is a design problem by depositing hot ethanol into the path of fan's suction, causing evaporation before reaching the collection jar. I had an idea - Remove the capture cup and carbon filter, then add a silicon tube from the condenser drain directly into the collection jar.

Update: After running the first two tests, recaptured alcohol showed marginal improvement, so an additional two tests were performed to further remove heat, thus allowing the vapors to re-condense. The fifth test was added to distillation of one gallon of water as a baseline of performance.

All pictures are presented, one per page, at the end of the paper to show a greater degree of detail.

A commercial denatured ethanol was used for the test supply -

This product contains 100% alcohol, a mix of both Ethanol and Methanol, the actual percentages are a trade secret. Given this is 100% alcohol it is an acceptable material. Methanol has a boiling point of 64ºc (148ºf) and Ethanol's boiling point is 78ºc (173ºf). The Safety Data Sheet is available in the references.

For each test, 1750ml alcohol was poured into the distiller reservoir, the condenser top mounted, power applied and temperature set for 85ºc (185ºf). Each test terminated when the unit's overheat protection circuit turned off the power. This works because alcohol is an azeotrope (See references below). As long as there is high percentage of alcohol in the water, the boiling point won't rise above approximately 85ºc (185ºf) degrees. Once the alcohol percentage falls, the temperature will rise and the unit shut down.

Test #1 – Original Equipment Configuration

The picture shows the entire assembly. The condenser drain tube protrudes out of the condenser into a small cup holding a fabric ball containing activated carbon (not shown). The fluid passes through this carbon filter, then drains through the pipe in the base of the cup. The housing body wraps around the condenser's drain tube and exposes this area to the radiator and fan. The carbon filter was removed so as not to absorb any fluid.

The first test used the manufacture's original configuration. The condenser will drain into the cup, then drain into the original 64oz jar. A silicon tube was attached to the base drain to feed it to the collection jar. A 4-inch bronze tube was inserted inline to help cool and deliver the liquid to the jar. 1000ml was recaptured, approximately 750ml lost. Here is a picture of the end of the run.	

Test #2 – Filter Cup Removed

The condenser's outlet cup & filter are removed and a silicon tube attached directly to the drain spout. The silicon tube attaches to a 4-inch bronze tube, that in turn will deposit fluid in the 64oz jar. Approximately 1125ml was recaptured, approximately 625ml lost. Here are pictures of condenser setup and the end of the run.		

Test #3 Add a 2-foot Copper Tube to Cool the Vapors.

This test replaced the 4-inch bronze tube with a 2-foot copper tube with the intent of adding heat dissipation, thus helping the condensation. Approximately 1125ml was recaptured, approximately 625ml lost. No significant change from test #2. Here is a picture of the end of the run.

Test #4 Full Supplementary (homebrew) Condenser Added.

A length of tubing and small radiator was added to the end of the 2-foot copper drainage tube. After passing vapors through the radiator, fluid then drained into the collection jar. Hand held ice and a spritzing spray bottle was used to cool the copper pipe during the run. Approximate 1700ml was recaptured. Losses were a scant 50ml. Here are pictures of the setup and manual cooling with addition pictures of the radiator and 64oz jar.

Test #5 Distilling 1 Gallon of Water in the Original Configuration

The unit's reservoir was filled with 1 gallon of water up to the FULL marker, then the unit was run till the overheat protection shut it down. The water was poured back in the reservoir to measure the recaptured water and it came up to the original marker.

Almost 100% of the distilled water was recaptured in the collection jar.

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Klean Strip
Fuel


Ball
1500
1000


IRWIN


Comfort Zone