# What Condenser Do I Need...

**A Brief Foreword:**

By the end of this paper, the beginner should have a solid understanding of what a certain design in condenser is, be able to set apart their pros/cons for a particular setup and be able to build the simpler designs available for these magic pipes, using the diagrams/illustrations provided in this paper along with the many step-by-step instructions and tutorials available on homedistiller.org...

The following list is based on the most common condensers used for home distillation and is not exhaustive. There are many types of condenser available to the hobbyist and in this paper we will look at condensers that are within the limited skill-base of the average beginner, as well as examine some of the more advanced designs for the ambitious among us. Some are harder to build than others, while a couple are so easy to make, they don't even warrant description...

I enjoyed writing and illustrating this, my first article for the New Distillers Reading Lounge, in the hope that the new hobbyist starting out along this road, may find it easier to understand just what a condenser is and by studying the numerous illustrations, have a greater understanding of its function and necessity within a certain still design.

Good luck on your way forward, have fun with the hobby, but above all else, Please be Safe...

So you need a condenser...?

Here is a fairly detailed list of the most popular condensers, their uses, efficiencies and make-up...
Most of the diagrams are in section view to enable the new distiller to have a peek inside...
We will start with the most useful to get the beginner up and running...

What is a Condenser...?

A condenser is:
a. an apparatus for reducing gases or vapour to their liquid or solid form by the abstraction of heat.
b. a device for abstracting heat, as in a refrigeration unit.

It is the magic component that turns the wash you have vapourised in your boiler back into a liquid form known, in our circles, as distillate or condensate. The distillate can be either directed back into the path of the upcoming vapour known as refluxation or it can be rerouted to a takeoff pipe and collected. There are stills such as the VM (Vapour Management), plated columns (see Olddogs Magic Flute and Kentucky Shinners Kentucky Flute), ect; that take the vapour directly to the takeoff condenser, but both those systems also use refluxation as part of the still designed to purify and clean the product of volatiles before product is taken...

A Brief Introduction to a Reflux Column:

A reflux column may be used to ensure that higher boiling point components are returned to the boiler via the packing, while lighter elements are passed out to a product vessel, as is the case with LM (Liquid Management) sytems, or to a secondary condenser as is the case with VM (Vapour Management) systems. This is useful in producing high quality alcoholic beverages, while ensuring that less desirable components (such as fusel alcohols) are returned to the boiler. It should be noted that the hobbyist who is looking to produce a high quality neutral spirit (such as vodka), causes a reflux coil to become in-valuable. The distillate is returned centrally to the top of the packing within the column to cause a process of mini-multiple distillations within the column, this is called refluxation and can be monitored and adjusted after equilibrium has been attained within the stills fractionating column. If proper attention is made to the correct amount of distillate being refluxed back to the column, afforded to the amount of distillate being taken as product, a very pure 96.5% abv, with virtually no trace to its original fermentational ingredients, can be achieved. Charcoal filtering may be applied to further refine the product more, but IMO, I have never had to charcoal filter any neutral made with this method. The more reflux provided to the top of the packing within a reflux column, the better is the column's separation of lower boiling compounds from higher boiling compounds. Conversely, for a given desired separation, the more reflux is that is provided, the fewer times a VM still needs to be adjusted. This can also be said for Liquid Management sytems, where, if equilibrium is allowed to stabilise and stack compounds within the column, only fine adjustments to the needle valve will produce a distillate on par with the VM...

What is and How many types are there...?
To answer this we must address the second question first.
As mentioned above, there are two type of condenser available to the home distiller. A reflux condenser and a Product condenser.

The Product Condenser:
This condenser does one thing and one thing only. It condenses the vapour that the reflux condenser has purified, back into liquid. There are many product condenser designs available, flake stand and worm, single and triple walled Liebigs, Grahams, Shotguns, ect. Most are water cooled but can be ice, snow, air cooled as well. This paper will give a breakdown of each one in the hope that the beginner can select a design, in condenser, reflux or product, that would be beneficial to the still design chosen, after consultation in the threads of HD if need be. They are also made from copper or stainless steel and can be as complex as a triple walled and coiled Liebig or as simple as a worm in a bucket...

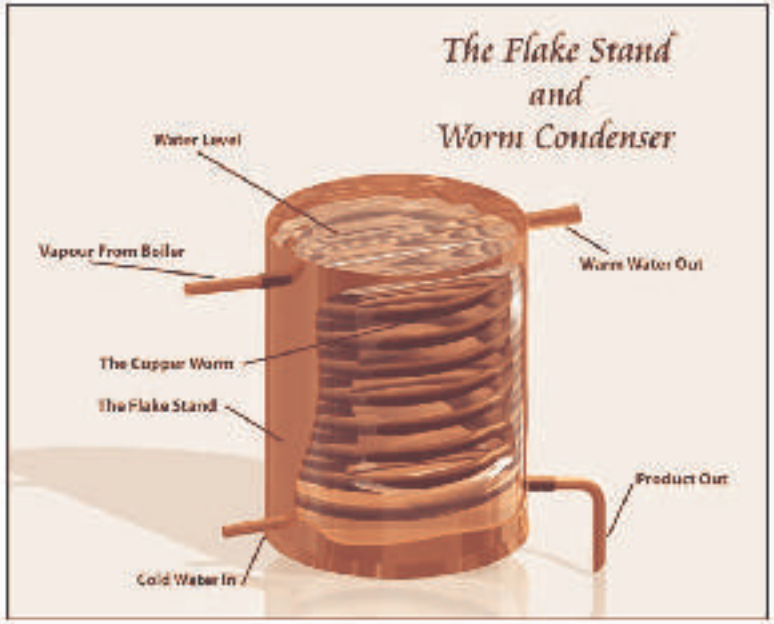
The Reflux Condenser:
A Reflux condenser is simply a coil or other cooling device that directs its output back into the path of the upcoming vapour. This happens over and over again causing the still's column to go into a state of stabilisation known as equilibrium. At this stage the volatile chemicals, that are not wanted, are stacked at the top of the packing and are allowed to escape to the product condenser first. The reflux condenser can also manage both operations on a still, reflux and takeoff. In the case of an LM (Liquid Management), such as the Bokakob Slant Plate, Nixon Stone Offset, etc; the product can be collected by the clever use of plates and traps. The reflux coil in these operations have not only purified the distillate, but sent it on its way to the bottle, not even knowing it had been duped. They are usually single, double or even triple wound coils, cross-flows, shotguns or dephlegmaters, ect; we will have a look at each one. They are either made from copper or stainless steel and come in many shapes and forms...

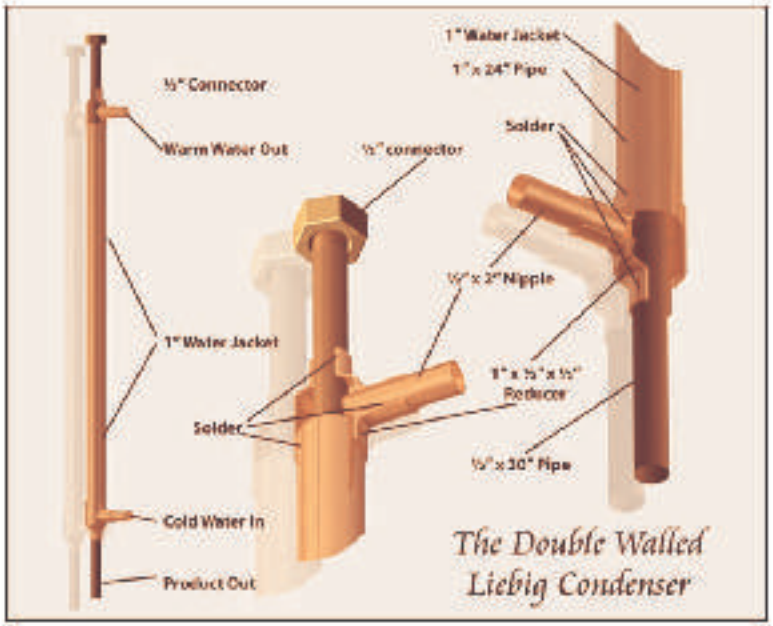
What's Condensers are Not included:
Air-cooled, fan-assisted, triple-walled, etc; Some condensers are not included in this article in the hope that the new distiller will not feel bogged down by the vast array of designs available to him/her. The condensers depicted are, IMO, the ones commonly used by home distillers today and to expand this article further would only serve to confuse the novice defeating the principle for a condenser article to begin with.
This article will be updated as the need arises both in HD's New Distillers Reading Lounge and electronically.

The Flake Stand and Worm:
This form of apparatus is the grand-pappy of condensers. Used predominantly by shiners all over the world, it has stood the test of time with is simple yet effective design. The flake stand is the bucket, it can be made from any material you have to hand. Plastic, wood, metal or any other material that can hold water or ice will do the job perfectly. It is filled with water after the copper coil (worm) has been put in place. The vapour travels from your boiler/thumper and is fed into the cold copper worm to be condensed back into liquid. This coil (worm) should only ever be made from copper or stainless steel, though copper is the preferred material. The old moonshiners used their worms inside an old wooden barrel to great effect. Since heat rises, the water at the bottom of the flake stand is always cold and sometimes replenished by a new supply of cold water. It is still very popular today and used by many pot stiller's all over the world. For a pot stiller, its hard to beat... I have shown the flake stand in copper, as they do look great, but as stated, nearly anything that can hold water could be used...

Pros:
- Inexpensive to build...
- Simple to make...
- Effective...

Cons:
- Water in flake stand could get warm over time if a new supply is not fed to the bottom...

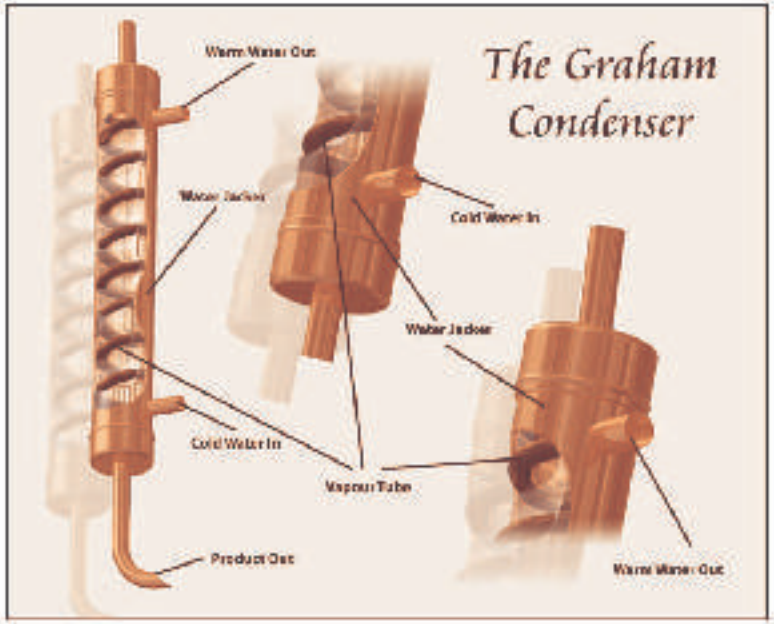



The Double Walled Liebig Condenser:
The Double Walled Liebig condenser is one of a very basic design. The inner-tube is straight (usually 6"-8" longer than the outer), making it cheaper to manufacture. Popularised by Justus Baron Von Liebig, he cannot be given credit for its invention as it had been in use for some time before him. However, it is named after him because of his popularisation with it. The device relies on its length to be efficient and a good starting length for this condenser would be 24" (600mm), although I've seen some at (40"+). Additionally, stainless steel or copper 'wool/mesh' can be loosely placed in the inner tube (the vapour path) of a Liebig condenser, substantially increasing turbulence inside the tube to create more of a reflux effect, and hence, the overall efficiency of the distillation. The cooling water should flow from the bottom to the top of the device, as that also increases the efficiency of this type of condenser. Some soldering skills are needed with this design, but is well within the beginners skill base... BTW, it's called double walled because the vapour is surrounded by a jacket of cool water that is held between two walls, the OD of the inner tube and the ID of the outer...

Pros:
- Inexpensive to build...
- Simple to make...
- Effective...

Cons:
- Prone to (Huffing). (can remedy with a little copper/SS mesh inside inner tube)...




The Graham Condenser:

A Graham condenser has a spiral coil running the length of the water jacket surrounding it. There are three possible outlines for the Graham condenser. The spiral can either contain the coolant, which would cause the condensation to take place on the outside of the spiral. Or, the coolant can be fed within a water jacket encompassing the spiral (helix), with the condensation taking place inside the coil. The third would entail triple-walling the condenser with the coolant being passed through the internal coil and an outer water jacket. This would leave the vapour to be placed between the coil and outer water jacket, very efficient, but difficult to build. The first is said to maximise flow capacity since vapours can flow over and around the spiral. The second ensures that all the vapours flow through the entire length of the spiral, thus having prolonged contact with the coolant and the third is a combination of both. As a side note, somewhat similar to the graham condenser is the Dimroth condenser, named after Otto Dimroth. It has an internal double spiral with the cooling medium inside the coil so that both the coolant inlet and outlet is at the top, as is the same case with a reflux coil. The vapours travel through the jacket from bottom to top. Dimroth condensers are more effective than conventional coil condensers. They are often found in large commercial evaporators. We will be concentrating on a single spiral Graham. The making of the graham condenser confirms that you can make a loose coil, about 6 to 8 wraps, from 3/8" copper, (½" copper, if you can work it, would be better). The design of the Graham condenser ensures that the unit must remain vertical at all times. This guarantees that the vapour, once condensed to liquid, has a clear path to your collecting jar... This is normal practice for all Graham condensers...

Pros:

- Very Effective...
- Not too Difficult to Build...

Cons:

- Must always be used in a vertical position to stop liquid locks...
- Soldering is a little more difficult with the Graham Condenser...

The Single Wound Reflux Condenser:

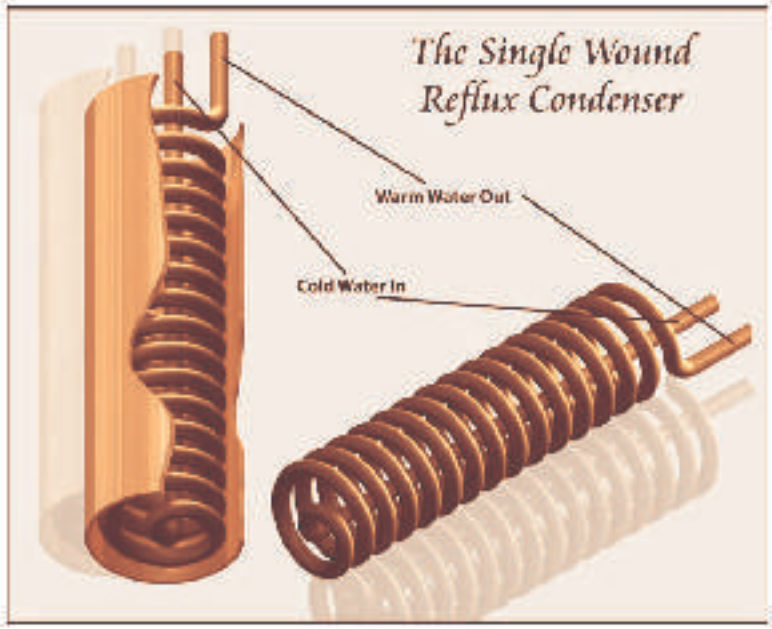
The single wound reflux condenser coil is by far the simplest to make but is controlled the same way as all reflux coils. By controlling the flow of coolant (water) going through the coil, it is important to note that this will have the effect of being able to control the temperature of the condenser and hence control the output and quality of the distillate. In its simplest form, a reflux coil is just a length of 1/4" copper tube wound on a mandrill to a height of between 6 to 8 inches. For a single would coil, the first wind is started at the bottom of the helix with a tail of approximately 300mm running up the inside of the mandrill. A space equalling the diameter of the material, in this case 1/4", is left between each subsequent wind to ensure that maximum surface area of the material is utilised by the upcoming vapour from the column. In home distillation circles, they are best used in small diameter columns like 1 1/2" or 1 3/4".

Pros:

- Very easy to fabricate...
- Excellent for small bore reflux columns...

Cons:

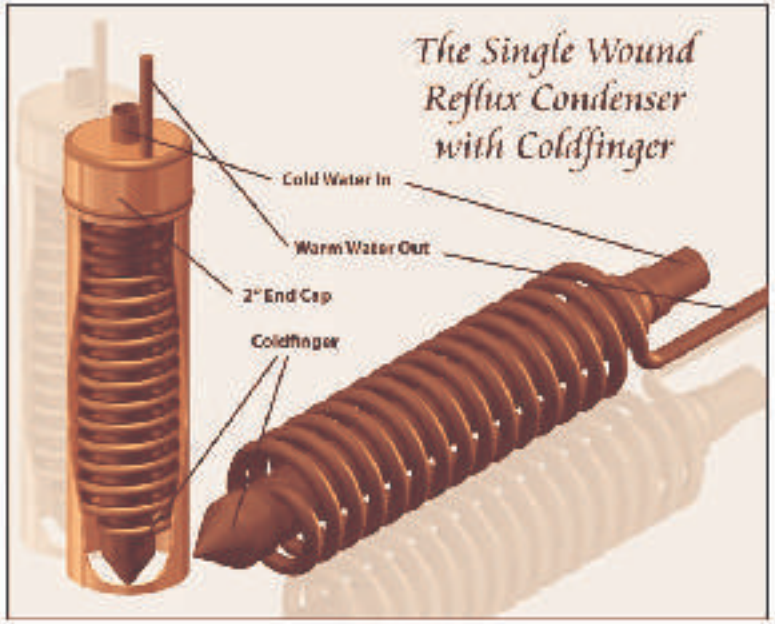
- Really only useful for small bore columns...
- Would need to be longer depending on the diameter of the column...
- Not as efficient as its big brother (Double Wound Reflux Coil)...



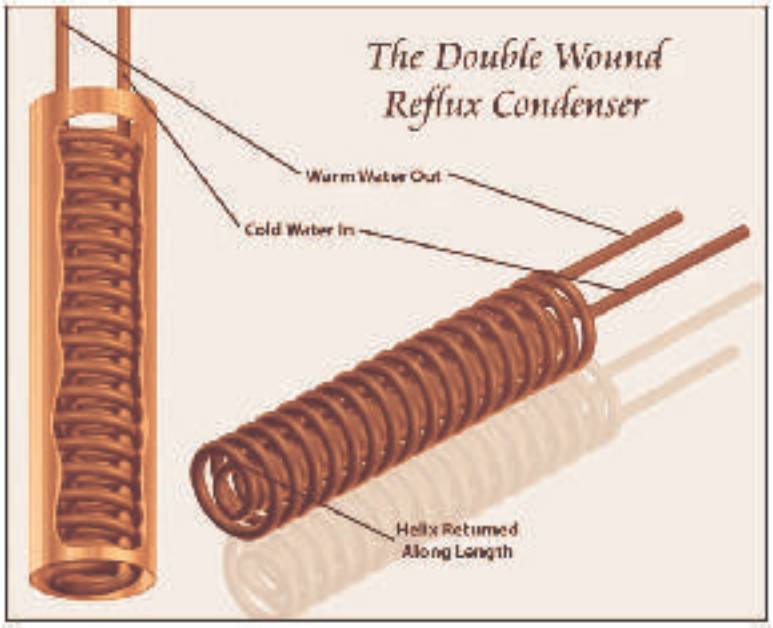
The Single Wound Reflux Condenser + Cold Finger:
Also known as a Gloved Coldfinger, The Single Wound Reflux Condenser is just as easy to make as a single wound reflux (helix) condenser is to construct. The only difference being a connection to a central pipe at the bottom of the coil. Again, because of the surface area connected to this type of coil, they are best suited inside smaller bore pipes, (1½" - 1¾"). That is not to say the gloved single wound condenser could not be used inside a 2" column for instance, that would entirely depend on a few variables, the coil/coldfinger diameter, the length of the condenser, the number of wraps, the space between wraps, ect;, and ofcoarse the ammount of power being delivered from your boiler. That said, the single wound gloved condenser is way more efficient than a plain old single wound helix.

Pros:
- Excellent for small bore columns
- Easy to fabricate...

Cons:
- Would benefit from being longer depending on the ID of the column...
- Not as efficient as a (Double Wound Gloved Reflux Coil)...




The Double Wound Reflux Condenser:
And here we come to the most popular reflux condenser for the home distiller, The Double Wound Reflux Condenser. This magic component just works so well inside a hobby still and lends itself to any of the reflux designs available, VM, Bokakob, Nixon/Stone, ect; Simple in its construction, it consists of a length of 6mm (¼") copper tube wound on a small mandril (16mm) to make the internal column. It is the returned onto itself at an angle of approx 10°-15° and wound on an external mandrill of 32mm for a 2" column. Once wound to the top, the tail is positioned in such a way that they can be connected to a water supply. The coil only needs a length of 4"-6" to be efficient inside the column, it is oh so easy to make the longer 8"-10", but the surface area of the ¼" tube cases the overall length of the condenser to drop dramatically. The beginner winding his/her first coil produces a very steep learning curve indeed and home distillers have been known to fill them with all manner of things to stop them kinking especially during the initial wind of the central helix. Salt, sugar, water, sand, ice, to name but a few. It can of-coarse be wound without the need to fill the tube and I produce two such ways at the end of the paper, one method by, 'DixieDrifter' and another by 'Hookline'. Prepare to render your first attempt useless as you come to terms with annealed and hardened copper. None the less, it is very rewarding when you finally get your first coil rolled perfectly, effectively giving you the means to make a coil that will give many liters of neutral and last a lifetime. As stated the double wound reflux coil is one of the most popular condensers and one, in my opinion, that should be in every hobbyists arsenal...



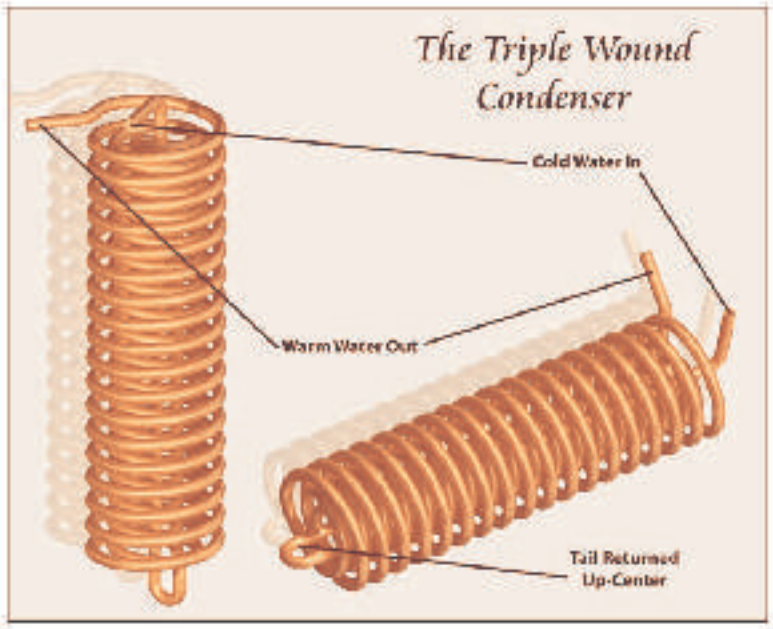

Pros:
- Very very efficient in use...
- Does not have to be as long as the Single Wound Reflux Coil...

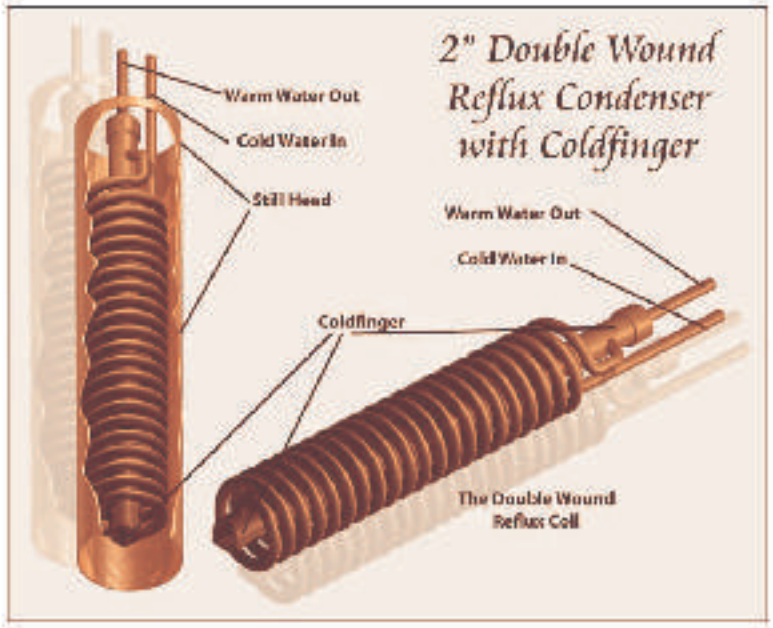
Cons:
- Steep learning curve in winding your first ever coil...
- May need packed with SS or Copper packing, depending on the ID of the column...

The Double Wound Reflux Condenser + Cold Finger:
The Double Wound Reflux Condenser is also known as a Gloved Coldfinger for the very same reasons as the single wound gloved condenser. This condenser is a little more difficult to build in as much as an inner coil must be wound then fixed to a central ½" coldfinger running the length of the condenser. The outer coil is then wound on a larger mandrill and attached , usually 180° from the inner coil, to the central ½" coldfinger. The use of various fittings makes the process a bit easier to mate the inner and outer coil to the coldfinger, as special care must be paid to the angles that the coils enter the coldfinger to avoid kinking. Although the extra surface area afforded to the addition of the central tube marginally makes it more efficient than its predecessor, the double wound reflux condenser, the gloved double wound reflux condenser is seldom made by the distiller, who opt for either the double wound condenser or, if headroom is a problem, Harry's cross-flow condenser. However, the single and double gloved reflux coils do come with one build in advantage, they both deliver the condensate back centrally to the column to be refluxed...

Pros:
- Very very efficient in use...
- Can be 150mm to 200mm in length..

Cons:
- Steep learning curve in learning to windthe coil and insert ends into the coldfinger...



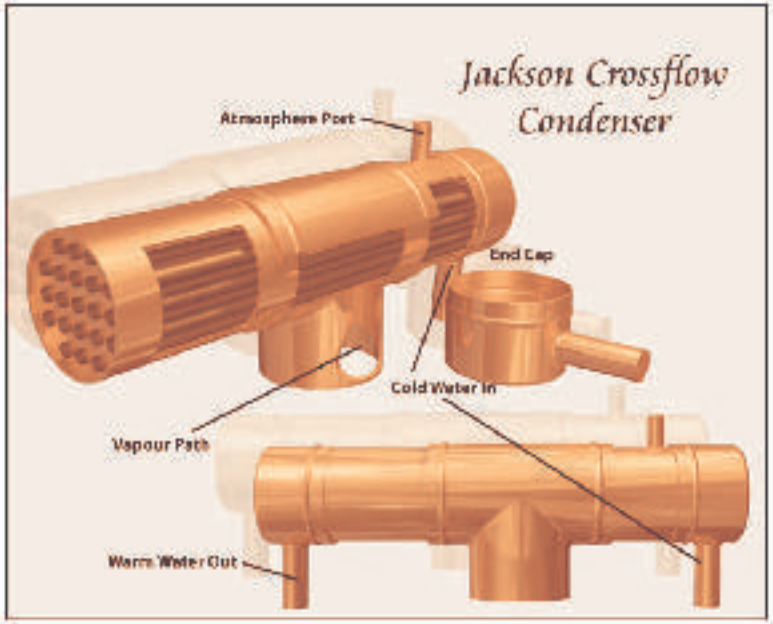

The Triple Wound Reflux Condenser:
Large bore, 3" - 4", make the Triple Wound Reflux Condenser invaluable when dephlegmaters and shotguns are not in use. Three formers are needed to wind a triple coil, a small, middle and large mandrill, all of varying relevant diameters in relation to the column diameter being used for the still. Essentially, it is 3 coils stacked inside one another at varying degrees in diameter. The central coil (helix) is wound on the smallest mandrill of the three. It is then returned back on itself and wound onto the middle sized mandrill, before being returned and wound in the direction of the innermost coil, but this time on the largest mandrill. What is achieved is a triple condensing coil where coolant flows into the bottom, exchanges the heat to the upcoming vapour causing it to condense back to liquid and sends it back on its way to be refluxed. The spent warm coolant exits the top of the coil as fresh cold coolant enters the bottom and so the loop continues. The triple wound reflux condenser has been superseded by the use of dephlegmaters, shotguns and cross-flows, making it an expensive comparison to the materials needed to make any of the fore-mentioned. That said, it is included here for its direct usefulness in being able to handle large bore columns, its large surface area which causes all vapour passing, to be condensed and sent back through the system. Most home distillers would now favour the shotgun or cross-flow condensers, but as with all condensers, its all about surface area...

Pros:
- Very efficient in use..
- Ideal for a larger bore column upto 3" - 4" maximum...

Cons:
- Steep learning curve in winding your first triple helix...

The Jackson Crossflow Condenser:

Named after its designer, Howard (Harry) Jackson, the Jackson Crossflow condenser really is one of the most sought after condensers by home distiller distilling on a kitchen stove or where headroom is at a minimum. It clears a minimum of approx 300mm (12") of headroom and makes way for a longer column to be attached beneath. Besides its height benefits, the 21 ¼" tubes arranged in a horizontal manner inside a 8" x 2" copper pipe with a an equal 2" Tee at its center, not only makes it simplistic in design but very efficient in its execution... Fabrication of the unit can be a bit daunting for the novice distiller wanting to make the crossflow. Silver solder is used to attach the 21 pipes to the end-plate and the end-plate to the 2" vapour jacket. The end-plate, carrying the 21 water tubes can be soldered with soft lead free solder and a clear silicon can be used to attach the end-caps to either side of the crossflow since the silicon never comes into contact with high-alcohol vapours which are extremely corrosive. Rubber bands can also be used to act as a water gasket when attaching the end-caps to the head if silicon is not available. A screw must be placed into the center of the end-cap to avoid them working loose should the water pressure be a tad high. If soldering the end-caps into position with soft solder, then silver solder must be used exclusively inside the water chamber as this melts as a much higher temperature than soft lead free and so avoids any leaks due to the liquification of any soft solder placed used in the making of the water chamber... IMO, The Jackson Crossflow is a great condenser to have in any distillers arsenal. There maybe a learning curve in building one, but once over this hurdle, the efficiency and practicality of the condenser will make all the work building it worthwhile...




Pros:

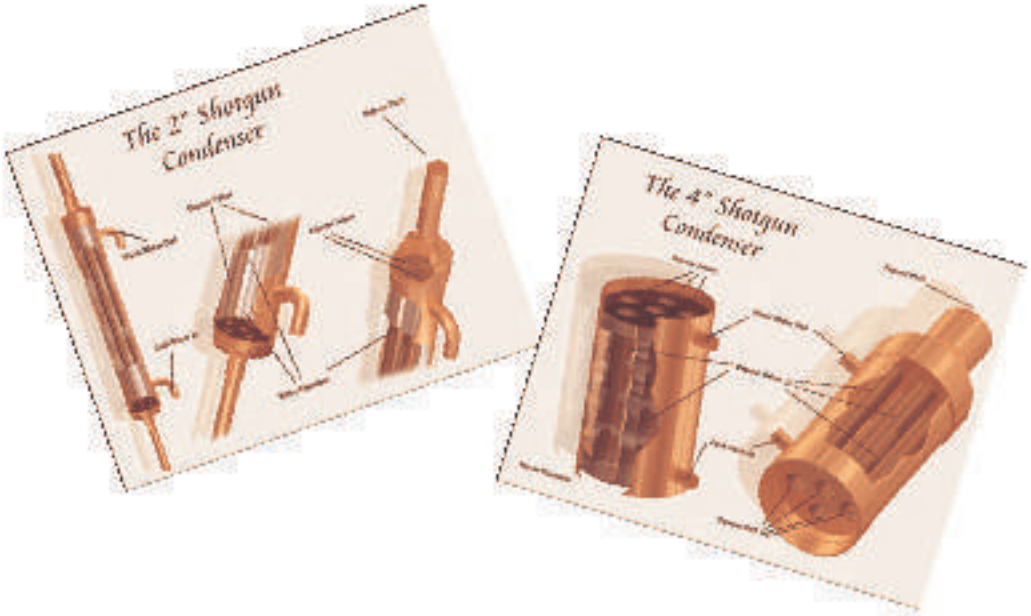
- Very Efficient...
- Allows for greater headroom for the reflux column...

Cons:

- Can be a bit daunting for the new distiller to fabricate...

The Shotgun Condenser:

The Shotgun Condenser has been around for a while... So called, Shotgun, because of it's vapour tubes, (barrels)... It can be installed horizontally with the coolant going through the tubes, or vertically, with the coolant going outside and around the tubes. Kentucky Shinner has made this modification vertically on Olddogs original, 'Magic Flute Design', called, "The Rainmaker', it is 4" high with 4 1" tubes on a 4" plated column. See the bottom on this post for a link to both. The Shotgun is a little more complex to build for the novice. Hard (silver) solder must be used to connect the vapour pipes to the end-plates and soft (lead free) solder used to connect the end-plates to the external water jacket. Hard solder melts at a higher temperature (450°C - 650°C depending on the amount of silver in the solder), whilst soft solder melts at a much lower temperature, typically, (180°C - 190°C (360 - 370 °F). Once you have a condenser like the Shotgun, you have something that should, given the amount of heat you throw at your boiler, knock down anything you have to throw at it. This of-coarse, depends on the size and width of the Shotgun condensers design...




Shown to the right are illustrations of both the 2" and 4" Shotgun Condensers:

Pros:

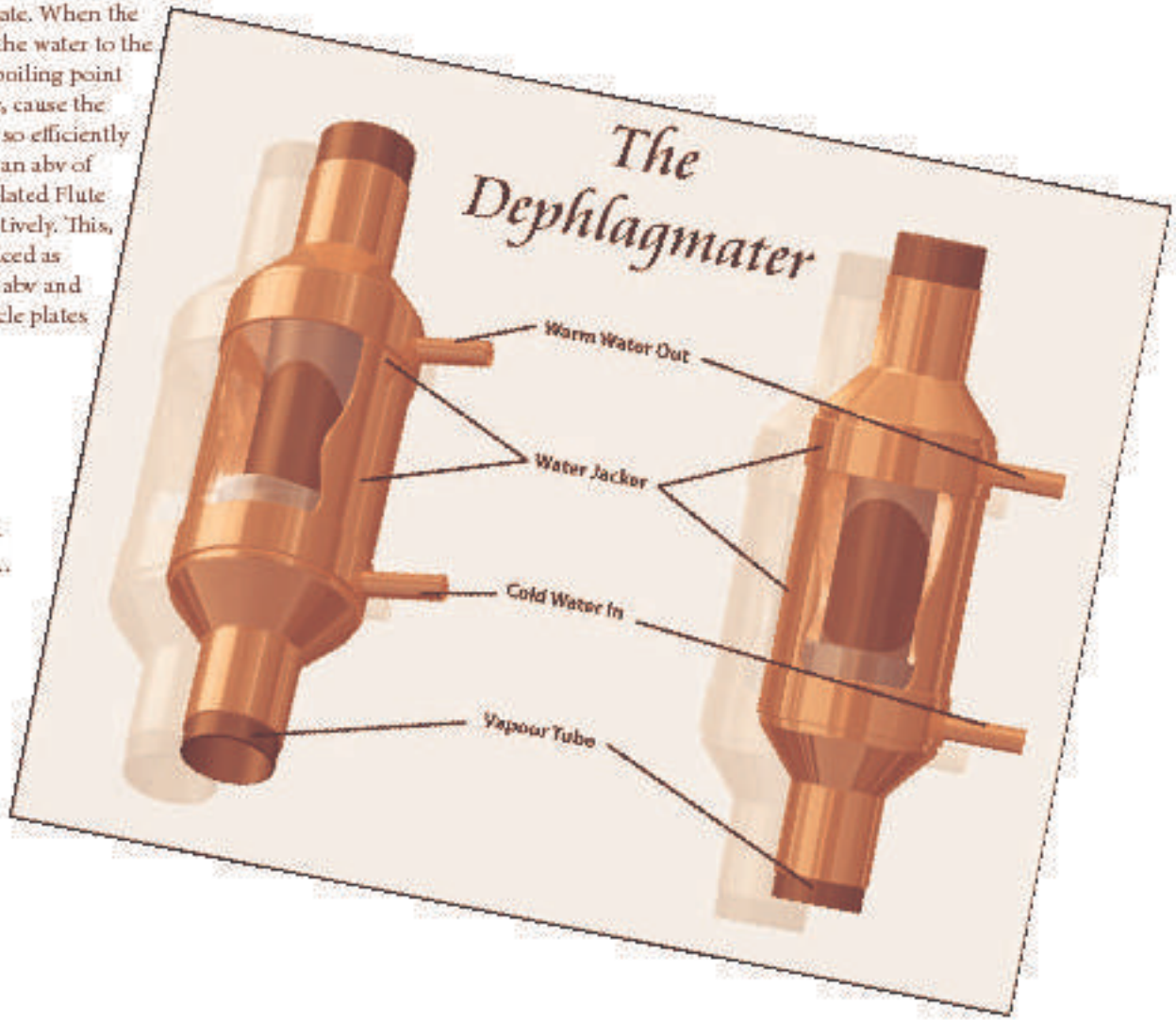
- Very very efficient...
- Not too expensive to build...

Cons:

- Can be a bit tricky to build for the novice since silver(hard) and soft(lead free) are used...

The Dephlegmater:

And so to the Dephlegmator. It is a device surmounting the rectifying column of a still whose function is to condense portions of the vapours rich in high boiling point constituents and return the condensate to the column as reflux. Used very efficiently in commercial installations at a much larger size than the hobby model pictured here, it has been, successfully I might add, scaled down in size to meet the needs of the home distiller. Olddog's Magic Flute uses a dephlegmator at the top of his plated 4" column and is essentially one of the main elements that make this design work together with the perforated/bubble-cap plates below it, in perfect harmony. The dephlag, for short, is so simple in design yet so effective in execution. It is an outside water chamber with an internal vapour pipe, that when initially cold will put the still into full reflux of the condensate. When the distiller is ready to take off his product, he half closes the valve controlling the water to the dephlag, the dephlag warms up in temperature to allow the vapours lower boiling point compounds to pass through to the product condenser and at the same time, cause the higher boiling point compounds, h20, ect, to fall back as reflux. It does this so efficiently that reports have indicated a full flavoured whisky/rum, can be achieved at an abv of 90% from a straight low alcohol wash. Truly amazing. Kentucky Shinners Plated Flute uses a 4" shotgun in place of the dephlag called, "The Rainmaker', very effectively. This, in-turn, causes the number of fittings required for the flute build to be reduced as 4" pipe fitting can become very expensive. It should be noted that this high abv and full flavoured distillate, can only be produced if the deplag and the theoreticle plates below, work together on that particular design.




Pros:

- Very Very Effective...
- Causes the abv of single run flavoured washes to be high on a single run...

Cons:

- Depending on where you are, fittings can be very very expensive...


# LINKS

Click Title to Link to Page...

Here are some useful links to condenser tutorials and great design builds. It is by no means exhaustive and to find more fantastic builds on www.homedistiller.org, the main menu and search function should be used.

Special thanks go to a great selection of experts from HD that are too many to mention and to Admins/Mods and Mentors, past and present, that keep the HD wheels turning behind the scenes, delivering a resource that is second to none....

Thanks Guys...

**Winding a Double Helix Condenser**...
*Excellent step by step tutorial by Hookline...*

**How to Wind a Perfect Coil**...
*Another great tutorial by Divedrifter...*

**Olddog's Flute Build Thread**...
*Read the original Flute thread as Olddog and others brainstorm the design and break boundary's along the way...*

**Kentucky Shinners Flute Build**...
*For a slight variation on the Flute build have a look at Kentucky's Still...*

**Rad's Small Scale Apartment Still**...
*Pushed for space? Don't worry, rad14701 uses a small bore column/condenser combo to full effect...*

The HD Management Team. - www.homedistiller.org