The Solar Still

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1. Introduction

Lack of good drinking water kills more children (especially in the Third World) than almost anything else. Microoganisms in a water supply can cause dysentery, which can lead to diarrhea and fatal dehydration. Recently, many health workers throughout the world have developed inexpensive solar-powered distillation units, or stills, and pasteurization ponds that provide people with all the fresh water they need.

Most illnesses from water come from bacteria and other microorganisms that can be killed by pasteurization. Pastuerization is heating the fluid (water, in this case) to a temperature of about 175 deg F and holding it for a half-hour. If your health problems can be solved by this method, you can build a pasteurization pond that will provide safe water for a large group.

Distillation is different. Distilling water actually turns it into a vapor by heating it, and the water vapor (which has left behind all the organisms as well as any other impurities in the water) is condensed (turned back into liquid water) and collected. Distilled water is more pure and safer than pasteurized water, and no longer contains any dissolved solids like calcium carbonate. Also, distilled water should be used in batteries, electric irons, and anyplace else where you don't want dissolved solids to clog up the appliance.

2. How this Article is Structured

This paper shows how you can build a solar (sun)-powered still. It will take in impure water, turn it to water vapor (steam), condense it back to distilled water, and collect it. Section 3 explains the principles of operation, Section 4 contains detailed construction instructions, and Section 5 overviews operations and maintenance.

One document that is not included is a BOM (bill of materials). Since you can build this still in a wide range of dimensions, each BOM will be unique to your own sizing. The most expensive and hard-to-find item, of course, is the tempered glass face. I would suggest you get the best deal you can on a pane of tempered glass over three by three feet, and size the still from that.

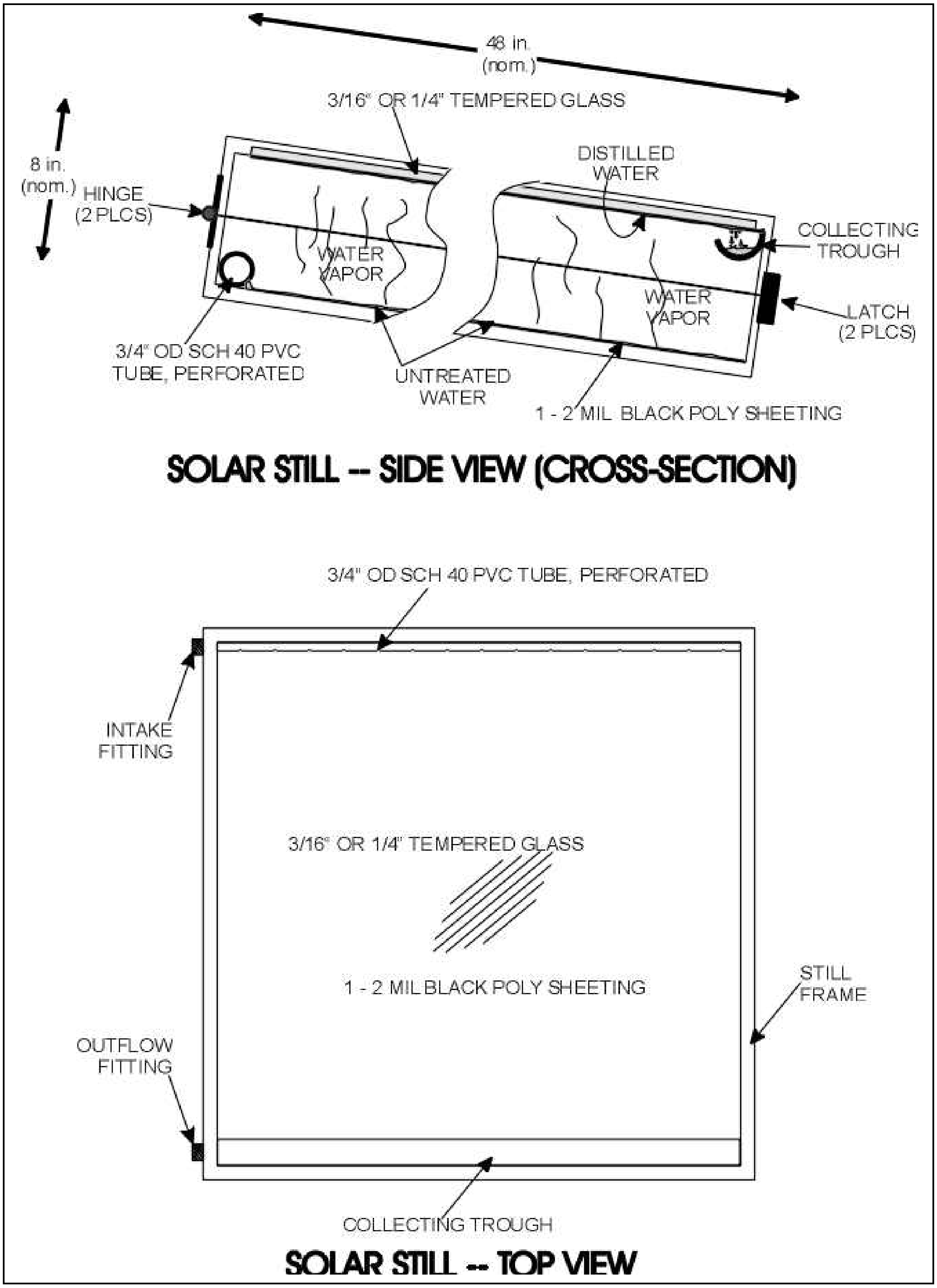
3. How the Solar Still Works

The still is a flat box, hinged so that the top and the bottom are the same size. The box is tilted about five degrees from horizontal; this is the "high end". The top of the box is made of tempered glass, and the bottom is lined with black plastic. At the high end of the box is a polyvinyl chloride (PVC) pipe with holes drilled in it. This pipe is connected to a hose that brings in the impure water. When the hose is turned on, the water pressure is set so that the water dribbles slowly out of the holes in the PVC pipe and down the bottom of the still (the part covered with black plastic). Gravity pulls the water down to the low end of the still, and covers the black plastic.

When the still is in the sun, the inside temperature rises quickly, and the thin film of water running down the inside begins to evaporate. It rises and condenses on the underside of the glass plate, and runs down to the low side. At the low edge of the glass plate is a trough made of PVC pipe. The distilled water drips into the trough and runs out a hole in the side of the still, through a small tube, and into the container that you are using to store the water.

4. Building the Solar Still

There is no absolute dimensional requirement for the still; the larger you make it the more it will produce (and cost). The still we built was four feet wide, four feet high, and six inches deep. Since that's what the figure shows, too, we'll use those dimensions for purposes of discussion.



1. *Build the lower half.* The base is a piece of 1/2" CDX plywood, four feet on a side. With the C side up, screw four 4" X 2-1/2" sides, also of 1/2" CDX, to the perimeter of the 4 X 4 plywood and to each other. Using a single piece of 2-mil black poly sheeting, line the inside of the box up to about an inch above the bottom. Secure the edges of the poly to the sides of the box with brads. Do not puncture the poly sheeting; if you do, water could leak through and damage the plywood. Set the lined box aside.

2. *Build the upper half.* The base is a wooden frame, four feet on a side, into which the glass is placed and secured as convenient. Screw four 4" X 2-1/2" sides, also of 1/2" CDX, to the perimeter of the frame and to each other. Set aside.

3. *Prepare and install the inflow tube.* Cut a piece of Schedule 40 3/4" ID PVC pipe fifty inches long. Starting about four inches from the end, drill a series of 1/8" holes about three inches apart until you get to within four inches of the other end. Drill a 3/4-inch hole through the side of the lower half of the still as shown in the cross-section view. Carefully cut a hole in the black poly lining and slide in the inflow tube.

   With the inflow tube partly in, cap the end with a PVC end cap. Slide the tube in the rest of the way until the capped end is resting snugly against the side of the box away from the hole. Secure that end. Now twist the tube until the row of holes is facing downward and almost touching the black poly lining, (These are the holes from which the water will come out and flow down the lining.)

   The other end of the inflow tube should be sticking out about an inch and a half from the hole. Using a non-toxic silicone sealant, carefully caulk the inside and outside of the hole, so that there will not be any leakage around the pipe and underneath the black poly lining.

   Glue the appropriate fitting to the protruding end of the inflow tube to attach the garden hose, or whatever tubing you will use to deliver the untreated water.

4 *Prepare and install the collection trough.* Cut a piece of Schedule 40 1-1/2" PVC pipe as long as the inside width of the upper half (about 47 inches). Then cut the pipe lengthwise, ending up with two troughs. (You will only use one; save the other one for a second still if you choose to build it.)

   Place the trough as shown in the cross section view. Attach it, using small brass screws, to the end of the upper half. The trough should be butting against both sides of the upper half. Using a non-toxic silicone sealant, carefully caulk the ends of the trough, so that no water can leak back down into the lower half after it's condensed. Drill a 3/4" hole in the side of the upper end so that it exactly matches the bottom of the trough, and insert a two-inch-long piece of 3/4" Schedule 40 PVC pipe. (This is how the distilled water in the trough will flow out of the still.)

5. *Assemble the still.* Carefully invert the upper half and place it over the lower half. At the inflow end, mark for two hinges and install them. (This will allow you to open up the still to periodically clean it.) Glue a rubber strip along the rim of the lower half where it meets the upper half. (This makes the still watertight, which avoids contamination and increases its thermal efficiency.) At the outflow end, mark for several spring latches (similar to those on a musical instrument case) and install them. (This will keep the still tightly closed unless you want to clean it.)

6 *Set up the still.* Choose an unshaded outside location, and place the still about five degrees from horizontal facing south (if you're north of the equator). Attach the hose from the untreated water container to the inflow tube. Attach the tube from the collecting trough to the container you're using to collect your distilled water. Start the water flow.

Adjust the inflow water volume so that the water dribbles down the black poly lining. Once the still reaches stagnation temperature, adjust the volume so that the water never quite reaches the lower end of the still. As the water evaporates away from the hot black poly lining, you will see droplets form on the underside of the glass surface. As gravity pulls these drops down to the trough, check to make sure the distilled water can flow unimpeded out of the trough, through the discharge tube, and into the collecting and storage container. You may have to tilt the still about one degree to the discharge side so that the trough doesn't overflow.

5. Operations and Maintenance

The amount of distilled water you will get depends primarily on the heat of the interior of the still. During summer in the Sonoran Desert, our 4' X 4' model produced about a liter an hour. This is probably the optimum; a sunny winter day, you'd be lucky to get half that output. Unlike a solar panel, the angle of which you can adjust to face the sun, the solar still must stay at about a five degree from horizontal orientation, or else the water would flow down the black poly lining faster than it would evaporate. However, experimenting with the proper angle and the optimum inflow volume will provide the best results.

If your untreated water is "hard" (i.e., it has dissolved calcium carbonate in it), you will have to open the still up on a regular basis to clean the inflow tube's holes and wash away the deposits from the folds in the black poly lining. Do this carefully; you don't want to accidentally rip the lining – that would decrease distillation efficiency and allow the water to soak into the plywood.

I am not aware of anyone who has used this still to distill seawater, although it can be done. However, if you do so, you will get a much faster buildup of precipitated salts, and will probably have to rinse the inside and clean the inflow tube holes much more often.

