Solar still

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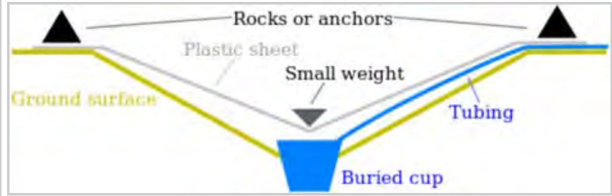
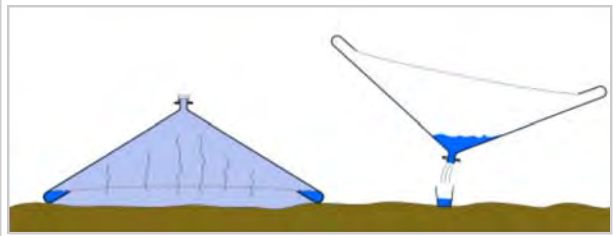
A **solar still** distills water, using the heat of the Sun to evaporate, cool then collect the water. There are many types of solar still, including large scale concentrated solar stills, and **condensation traps** (better known as **moisture traps** amongst survivalists). In a solar still, impure water is contained outside the collector, where it is evaporated by sunlight shining through clear plastic or glass. The pure water vapor condenses on the cool inside surface and drips down, where it is collected and removed.



Solar still built into a pit in the ground


Solar still "Watercone"

Distillation replicates the way nature makes rain. The sun's energy heats water to the point of evaporation. As the water evaporates, water vapor rises, condensing into water again as it cools and can then be collected. This process leaves behind impurities, such as salts and heavy metals, and eliminates microbiological organisms. The end result is pure distilled water.

Contents

History

Condensation traps have been in use since the pre-Incan peoples inhabited the Andes.

Today a method for gathering water in moisture traps is still taught within the Argentinian Army for use by specialist units expected to conduct extended patrols of more than a weeks' duration in the arid border areas of the Andes.

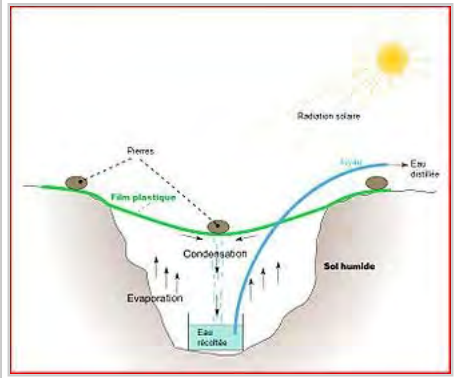
Uses

Solar stills are used in cases where rain, piped, or well water is impractical, such as in remote homes or during power outages.[1] In subtropical hurricane target areas that can lose power for days, solar distillation can provide an alternative source of clean water.

Methods

Several methods of trapping condensation exist:

First method



Solar Well

This method was first used by the peoples of the Andes. A pit is dug into the earth, at the bottom of which is placed the receptacle that will be used to catch the condensed water. Small branches are placed with one of their ends end inside the receptacle and their other ends up over the edge of the pit, forming a funnel to direct the condensed water into the receptacle. A lid is then built over this funnel, using more small branches, leaves, grasses, etc. The completed trap is left overnight, and moisture can be collected from the receptacle in the morning.

This method relies on the formation of dew or frost on the receptacle, funnel, and lid. Forming dew collects on and runs down the outside of the funnel and into the receptacle. This water would typically evaporate with the morning sun and thus vanish, but the lid traps the evaporating water and raises the humidity within the trap, reducing the amount of water that is lost. The shade produced by the lid also reduces the temperature within the trap, which further reduces the rate of water loss to evaporation.

Modern method

Today, with the advent of plastic sheeting, the moisture trap has become more efficient.

The method is very similar to that described above, but a single sheet of plastic is used instead of branches and leaves. The greater efficiency of this type of trap arises from the waterproof nature of the plastic, which doesn't let any water vapour pass through it (some water vapour escapes through the leaves and branches of the first method). This efficiency requires a certain amount of diligence of the part of the user, in that the plastic sheet must be firmly attached to the ground on all sides; this is often accomplished by using stones to weight the sheet down and/or covering the edges of the plastic sheet with earth (such as that dug out to make the hole in which the trap sits). Weighting the centre of the plastic sheet down with a stone forms the funnel via which the condensed water will run into the receptacle.

Transpiration Method

Water can be obtained by placing clear plastic bags over the leafy branch of a *non-poisonous* tree and tightly closing the bag's open end around the branch. Any holes in the bag must be sealed to prevent the loss of water vapour.

During photosynthesis plants lose water through a process called transpiration. A clear plastic bag sealed around a branch allows photosynthesis to continue, but traps the evaporating water causing the vapor pressure of water to rise to a point where it begins to condense on the surface of the plastic bag. Gravity then causes the water to run to the lowest part of the bag. Water is collected by tapping the bag and then resealing it. The leaves will continue to produce water as the roots draw it from the ground and photosynthesis occurs.

The vapor pressure of water in the sealed bag can rise so high that the leaves can no longer transpire, consequently when using this method, the water should be drained off every two hours and stored. Tests indicate that if this is not done the leaves stop producing water.

If there are no large trees in the area, clumps of grass or small bushes can be placed inside the bag. If this is done the foliage will have to be replaced at regular intervals when water production is reduced, particularly if the foliage must be uprooted to place it in the bag.

Efficiency is greatest when the bag receives maximum sunshine at all times. Exposed roots are tested for water content. Soft, pulpy roots will yield the greatest amount of liquid for the least amount of effort.

Condensation Trap Efficiency

Condensation traps are not in themselves a sustainable source of water; they are sources for extending or supplementing existing water sources or supplies, and should not be relied on to provide a person's daily requirement for water, since a trap measuring 40 cm (16 inches) in diameter by 30 cm (12 inches) deep will only yield around 100 to 150 ml per day.

One method to increase the water output is to urinate into the pit before placing the receptacle in. This increases the moisture content of the earth, reducing the amount of water vapour that the earth can subsequently absorb.

Materials

A simple basin-type solar still can be constructed with 2-4 stones, plastic film or transparent glass, a central weight to make a point and a container for the condensate. A cubic hole in moist ground is created of about 30 cm (12 inches) on each side. Into the centre of this hole, a collection container is placed. Then a sheet of plastic film is stretched over the hole. Stills made from water bottles or plastic bags.[2]

Variations

Transpiration bag

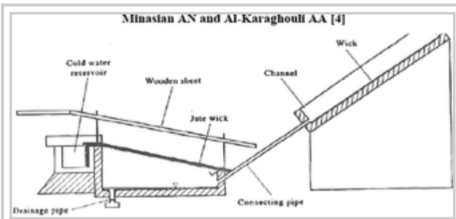
An alternative method of the solar still is called the transpiration bag.[3][4] The bag is a simple plastic bag and it folds over a stemmed plant with a corner pointing down to allow the condensate to pool. From there a person can remove the water by taking the bag off and pouring the water out or one can make a tiny incision into the corner to drip water into a cup. Its advantage over the basin type solar still mentioned before is that it only requires a bag like one can get at the grocery store. It doesn’t need to be completely transparent. A disadvantage of the transpiration bag is the requirement for a plant in direct sunlight or heat to take the condensate.

In a study performed in 2009, variations to the angle of plastic and increasing the internal temperature of the hole versus the outside temperature made for better water production. Other methods used included using a brine to absorb water from and adding dyes to the brine to change the amount of solar radiation absorbed into the system. During the adjusted tilt angle experiment, the different angles used by the different researchers created different results and it was difficult for any of them to get a definite answer. In the graph, a bell curve is observed with the maximum water output being at 30 degrees angle adjustment. Each brine depth created a different amount of water and it is noted on the graph that about an inch is optimal with a decreasing trend if more is used.[5]

Wick still

The “wick” type solar still is a glass-topped box constructed and held at angle to allow sunlight in.[6] Salt water poured in from the top is heated by sunlight, evaporating the water. It condenses on the underside of the glass and drips to the bottom. A pool of brine in the still attached to the wicks which separates the water into banks to increase surface area for heating. The distilled water comes out of the bottom and depending on the quality of construction most of the salt has been purged from the water. The more wicks, the more heat can be transferred to the salt water and more product can be made. A plastic net can also catch salt water before it falls into the container and give it more time to heat up and separate into brine and water. The wick type solar still is made vapor tight, as in the vapor does not escape to the atmosphere. To aid in absorbing more heat, some wicks are blackened to take in more heat. Glass’s absorption of heat is negligible compared to plastic at higher temperatures. A problem, depending on application, with glass is that it is not flexible if the solar still is not a standard shape.

Practical considerations



This image shows how a wick basin solar still works.

The system is inefficient for how much work is put into it versus the water output.[7] In desert environments water needs can exceed 1 US gallon (3.8 L) per day for a person at rest, while still production may average 8 US fluid ounces (240 mL) per day.[7][8] Even with tools, digging a hole requires energy and makes a person lose water through perspiration; this means that even several days of water collection may not be equal to the water lost in its construction.[8] Because of this, it is advised to make a solar still to supplement another water source, such as a reverse-osmosis unit or water purification tablets. For long term sustenance multiple stills could provide an abundance of water and would be worth the time and effort invested.

Seawater still

In 1952 the United States military developed a portable solar still for pilots stranded on the ocean, which comprises an inflatable 24-inch plastic ball that floats on the ocean, with a flexible tube coming out the side. A separate plastic bag hangs from attachment points on the outer bag. Seawater is poured into the inner bag from an opening in the ball's neck. Fresh water is taken out by the pilot using the side tube that leads to bottom of the inflatable ball. It was stated in magazine articles that on a good day 2.5 US quarts (2.4 l) of fresh water could be produced. On an overcast day, 1.5 US quarts (1.4 l) was produced.[9] Similar sea water stills are included in some life raft survival kits, though manual reverse osmosis desalinators have mostly replaced them.[10]

Distilling human urine

Using a condensation trap to distill urine will remove the urea and salt, providing one with drinkable water as a result.

In fiction

There are many films and books talking about this technique:

- The 1972 Movie “Family Flight” features a family forced to make an emergency landing in the Mexican desert. The movie shows, in great detail, the method for construction and use of the modern (plastic sheet) condensation trap.
- In the TV PBS show *The Voyage of the Mimi* episode 10 'making dew' 'Water, Water, Everywhere' the build and explain the concept of the solar still.
- In Yann Martel's novel *Life of Pi*, the main character, Piscine Molitor Patel (Pi), survives on a life boat in the Pacific with a Bengal tiger by using twelve solar stills to extract fresh water from saline ocean water.[11]
- In the 2002 horror film *28 Days Later* about a "zombie apocalypse" in Britain, Frank attempts to use this technique after seeing it on television, but is unable to do so properly.
- In the 2013 movie *All Is Lost*, the character played by Robert Redford discovers that his water jug was accidentally contaminated by seawater. Later, after observing condensation in some of the plastic bags he has on his life raft, he constructs a crude solar still using the water container, with one side cut out, a plastic bag that fits over the whole water container, a small collecting can in the middle, and a compass in the middle, so that the condensed water drains into the can.

See also

- Concentrated solar still
- Desalination
- Freshwater
- Solar cooker
- Solar water disinfection
- Watermaker

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3. Munilla, R. Solar Still (http://www.practicalsurvivor.com/solarstill) *Practical Survivor* Retrieved April 22, 2013
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Patents

- US 3337418 (https://worldwide.espacenet.com/textdoc?DB=EPODOC&IDX=US3337418), "Pneumatic solar still"
- US 4235679 (https://worldwide.espacenet.com/textdoc?DB=EPODOC&IDX=US4235679), "High performance solar still"
- US 4966655 (https://worldwide.espacenet.com/textdoc?DB=EPODOC&IDX=US4966655), "Plastic covered solar still"

External links

- Making a solar still (http://www.desertusa.com/mag98/dec/stories/water.html)
- Solar distillation (http://www.theenergylibrary.com/node/11693)
- Solar distillation with solar ovens (http://www.idcook.us/2-solar-cookers)
- Plans for solar distillation (http://solarcooking.org/plans/)

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