Solar Distillation:

A Simple Solution to a Global Problem

By Michael Culver

Summary: Solar distillation is a natural process that has become a mature technology in recent years. This article discusses the method of harnessing the sun's energy to produce pure water, a viable, economical solution that could easily help solve a global water problem—or at least offer a sense of assurance that your customer will have a continued source of potable water through crises such as the Y2K computer bug.

Evidence of the effectiveness of solar distillation is as old as our planet. The concept is simple— water is vaporized by the heat of the sun, it condenses in the atmosphere and falls to the ground as rain, mist, fog, snow, sleet or hail. We've counted on this natural water cycle to provide us all with a sustainable level of potable water.

Efforts to harness the cycle, so as not to be dependent on where or when the rain will fall, have resulted in development of the solar distillation panel or "solar still/' These panels are ideal for passive desalination of sea-water or brackish water as well as eliminating or greatly reducing dissolved solids, heavy minerals, pesticides and nitrates.

A history of distillers

Though the practice of solar distillation has been in existence for a long time, Arab alchemists who observed the phenomenon take place in hand blown glass vessels— arranged adjacent to concave mirrors—first published its theory in 1551. The first conventional solar still apparatus was designed in 1872 to provide potable drinking water for the workers for a nitrate mining camp near Las Salinas, Chile, where it was in operation for 40 years.

In this century, much research has been done by universities around the world exploring the nuances of solar distillation. Notable accomplishments include those of Maria Telkes, who, in 1945, developed an inflatable still for emergency life-rafts used by the U.S. Navy and later by the U.S. Air Force; and Horace McCracken, a research team member at the Uni versi ty of California Sea Water Conversion Laboratory who developed commercially acceptable models adaptable for both residential and commercial use.

How it works

A basic solar still is essentially a panel that's capable of containing a shallow pool of water. It's capped with a glass or transparent top, which allows the sun to shine through and heat the water. Once the water is heated sufficiently it vaporizes and rises, condensing on the underside of the glass. The condensed droplets then roll along the angled glass top to a collection tray and are dispensed into a reservoir, where the product water may be consumed or stored.

The design and construction of the solar still's pan plays a large role in its successful operation. The pan must be water tight, capable of containing hot concentrated saline water and tolerable to UV light and air exposure. For the designs described in this article, research has shown a pure silicon membrane is ideal for this purpose. The glass top of the still is 3/16-inch tempered glass, which is commonly available. The two most common models are the basin-type distiller, which sits level and has an angled top; and the tilted solar still (TSS), which holds the water in trays and for which the panel can be angled to gain a better advantage in terms of relative position to the sun.

The efficiency of the solar still is calculated by dividing the heat of condensation of the distillate by the heat incident on the glass over the pan. Theoretically, the limit of efficiency is around 62 percent. A single panel measuring 36-inches by 78-inches can produce an optimal average of 2-to-3 gallons or more per day, depending on the climate and weather conditions where the still is operating. Panels can be connected in tandem to exponentially increase the yield.

The tilted still has 26 trays and there are two water lines in each tray to provide adequate flushing, keeping scaling to a minimum. Soaking the trays with a mild muriatic solution as you would your swimming pool and rinsing it thoroughly will remove a majority of the scale.

Left: A basin-type solar distiller array with tzvo storage tanks in Kona, Hawaii. Right: A tilted solar still with panels measuring 36-x78-inches; each are connected in tandem to increase product water yield at a Tucson, Ariz., community college.

Applications

Solar stills have found a niche in a variety of markets. Principal of these includes:

- Personal use in remote areas such as beaches or island homes,
- Residential use in urban, suburban or rural areas, operating on a tap feed,
- Commercial business applications,
- Laboratories and health clinics, or
- Community desalting plants.

Despite the variety of applications, the water supplied by a solar still is of top quality, with total dissolved solids (TDS) typically tested at 1 part per million (ppm). They're convenient to use and can be fully automated to fill and flush the panel, essentially making them self-cleaning systems. Maintenance of a solar desalination plant requires little skilled labor.

The average water quality and operation of a solar still can be affected by the quality of the feed source as well as the storage of the water produced by the still. For example, if your feed source comes from a well or municipal water supply, pretreatment is not always necessary (depending on your water analysis, in the case of a well, or preference, in terms of municipal water).

If, however, you want to desalinate seawater, river, marsh or lake water, it's recommended that feedwater be pretreated by either pumping it from a shallow inland well or a settling tank, as opposed to pumping it directly from the ocean. This "pretreatment" assures organic matter and debris are not pumped directly into your still. Post-treatment of distilled water stored in reservoirs isn't usually necessary, though it may include ultraviolet light to prevent bacterial growth and simple carbon block filtration to remove any remaining volatile organic contaminants (VOCs) or flavors that may have leached from the storage container into the water.

Limitations

Solar distillation is a passive process subject to some limitations that should be taken into consideration:

Climate—The productivity of a still is a direct function of the amount of solar radiation received on a horizontal surface. If skies are generally clear, a solar still is feasible.

Quantity—Solar distillation is suited to water requirements on a relatively small scale. According to one United Nations study, this means less than 50,000 gallons per day. Quantities beyond this are not necessarily cost-efficient when compared to modern desalination methods.

Location—The site for a single panel or a whole desalination plant must be unobscured to allow maximum solar radiation, and relatively close to the water user. Also important is the close proximity of the feed water entering the still.

Capital outlay costs—As with all solar products, the initial capital costs need to be considered and compared to the current cost of drinking water in a particular area.

On the plus side, a solar distillation panel is competitive economically. Depending on the price of drinking water in the area, a solar distillation unit can recuperate its initial investment in less than two years and has an average life expectancy of 20 years or more.

For example, if a person purchases a solar still averaging 2 gallons per day for $750, it will produce 730 gallons of pure distilled water annually. With water averaging a cost of $1.10 per gallon, the payback will be in just over one year. Of course, with peripheral equipment for full automation, the amortization will increase as the relative costs increase.

Gaining perspective

Solar distiller pioneer and inventor Horace McCracken points out: "You can burn a pound of fossil fuel and gain a couple of hundred pounds of purified water—and both the water and the fuel are gone the next day. If, however, we build a solar still with the energy and / or materials from a pound of oil, we get back maybe 20 or 30 times that amount of water over the life of the still.

This concept helps us realize that with the limited supply of fossil fuels, we can't afford to ignore solar distillation as a viable option for millions of people.

In his new book, *Tapped Out,* former U.S. Senator Paul Simon, D-Ill., points out that by the year 2050 our global population will be close to having doubled while nearly half the world will have insufficient water. Water purification requires energy and typically this energy is in the form of fossil fuels. Not so with solar distillation.

Conclusion

Solar distillation is a mature technology. The research and long history of cost-effectiveness are evident. Solar energy is free and the technology to own and operate a solar still is relatively simple. The quality of solar distilled water is excellent and the market potential is vast.

It is apparent that when the water industry understands the concept of distillation, it will begin to embrace it as a viable, affordable option for their customers. And, as a result, the world will benefit from this age-old purification process. □

References

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About the author

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