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FAMILY SIZE SOLAR STILLS

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Introduction

For many years there has been much popular interest in equipment for desalting sea or brackish water for family or home uses. Several American firms have invested considerable sums of money in developing domestic desalting units, but unfortunately there is nothing yet on the market which fully satisfies customer requirements.(1) Many businessmen have believed, intuitively, that home desalting units, like washing machines, should command a large and growing market that up to now has failed to materialize. There are many reasons for this and perhaps the most important is the estimated high cost for a desalter. For example, one manufacturer estimated that a home desalting unit would have to sell for about $1,200 as a limited production item, and at a cost of perhaps $750 as a mass produced item. Surveys indicate that there is perhaps only a limited market available, and that such unit costs cited above are too high for the average home owner. In spite of these seeming obstacles, interest in small or family-sized desalting devices persists especially for arid or semi-arid countries and countless islands throughout the world.

The need for limited quantities of potable water in many of the developing nations has directed the attention of scientists and engineers to the possibilities of using solar stills. The technology of these stills is simple and small units can be built and operated by non-technical personnel. Electrical or mechanical power is not essential. The small solar still is compact and can be built out of locally available materials except for specialty items, such as plastics. Material costs are within the reach of many in the developing nations.

The development and tests of small or family-sized solar stills have been carried on by individuals working independently or as "side projects" in government and university laboratories. There are now several designs which appear practical for general use and component parts might be sold in kits. Sketches and instructions could also be made available for a "do-it-yourself" project. A summary on the development of small size solar stills is presented.

(1) There is a review on the development of domestic desalination units by E. A. Cadwallader, Industrial & Engineering Chemistry Vol 55 - March 1962

THE SURVIVAL STILL

A supply of water for emergency needs can be obtained in desert areas by a simple technique which requires only a piece of plastic film. The U.S. Water Conservation Laboratory in Phoenix, Arizona[2] tested several designs of a "survival still." This unit utilizes solar energy to distill water from desert soils or desert plants. The still is made by cover g a large hole in the ground with a plastic film and weighting the film at the center with a rock. The rock forms a "V" in the film from which water drips into a suitable container. To obtain water from desert plants, the plant is cut into pieces and placed beneath the plastic film. After a few hours water is extracted from the plant and is collected by the plastic film.

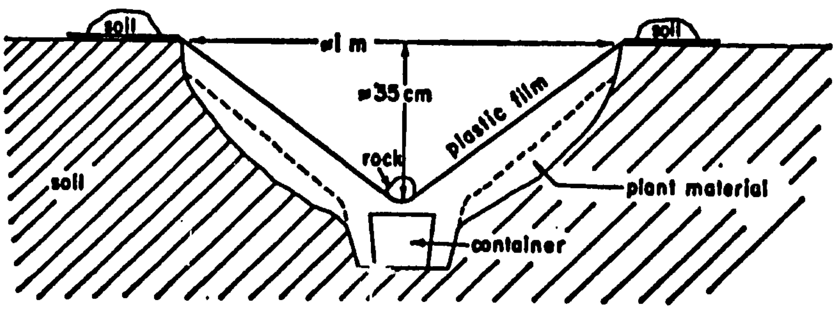

Fig. 1. Diagram of "survival still."

A sketch and dimensions of the survival still are shown in figure 1.

(2) R. D. Jackson and C.H.M. Van Bavel, Science Vol. 149 No. 3690 - Sep 17, 1965

Performance data from field tests are presented in tables 1 and 2.

Table 1. Daily yield of water, in milliliters, from five survival stills located near Phoenix, Arizona. Stills 1 and 2 were in a loam soil with an initial water content of about 18 percent, and stills 3, 4, and 5 were in a desert sand containing 2 to 8 percent water at the time of installation. Rainfall, measured in Phoenix, was 34.3 mm during 1–12 April and 4.0 mm on 12 May 1965.

Date	Loam soil		Desert sand		
	Still 1	Still 2	Still 3*	Still 4*	Still 5†
21 April	1340	900	710	470	180
22 April	208C	1670	1310	1350	260
23 April	1560	1360	1160	800	125
24 April	1900	1675	1180	1000	190
25 April	1685	1430	1030	790	120
26 April	1800	1520	220	550	50
27 April		1460	770	475	120
28 April	2100	1400	690	410	110
29 April	1960	1300	485	260	65
30 April	1830	1130	365	190	30
26 May	1000	840			
23 June	490	465			

* Located in a wash or depression where water would collect during a rain. † Purposely constructed in an unfavorable site—a coarse sand in which rain water rapidly drained away, leaving little water stored in the sand.

Table 1.

Table 2. Yield of water, in milliliters, from six survival stills with plant materials and soil as water sources. The initial water content of the soil was 3 percent. Before cutting, the saguaro and barrel cacti were about 40 cm high and 20 cm in diameter. The amount of cholla, prickly pear, and creosote bush was just enough to fill the volume indicated for plant materials in Fig. 1

Date	Soil and cholla cactus	Soil and saguaro cactus	Soil and creosote bush	Soil and prickly pear cactus	Soil only	Soil and barrel cactus
26 May*	485	865	325	575	115	430
27 May	650	1570	370	2165	330	1955
28 May	460	1430	210	1965	215	1850
29 May	265	1150	110	1515	120	1565
30 May	170	965	45	1205	70	1450
31 May	185	805	90	980	100	1475
1 June	55	715	125	775	120	1375

* The yields given in the first row were from time of installation on 25 May to 8:00 a.m., 26 May. Subsequent data are for 24-hour periods. Installation times were 12:45, 1:15, 1:30, 4:00, 4:20, and 5:00 p.m., respectively.

Table 2.

It is evident that this unit will produce only small amounts of potable water and could not be employed to satisfy the daily family water requirements. From table 1 it can be seen that production varies with types of soil and the soil moisture content. Nevertheless a daily production rate of approximately one quart (1,136 milliliters) was obtained in a moist soil while a little more than a pint was obtained in the drier soils (desert sands). The yields of water from desert plants were much greater, being almost 3 pints with the combined soil and barrel cactus plant as water sources.

Figure 2.

In figure 2 a technician from the Water Conservation Laboratory has installed the simple solar still in the Arizona desert. Note the method of sealing by using loose soil and also a rock to form the "V" from which the pure water drips into a receiver.

In another test chopped cactus plants were inserted in the hole and an even greater supply of water was obtained.

↑ Why did they not simply mash the cactus for its juice?

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PLASTIC TENT SOLAR STILL

There has been much interest in a plastic tent solar still, a model of which is shown in figure 3.

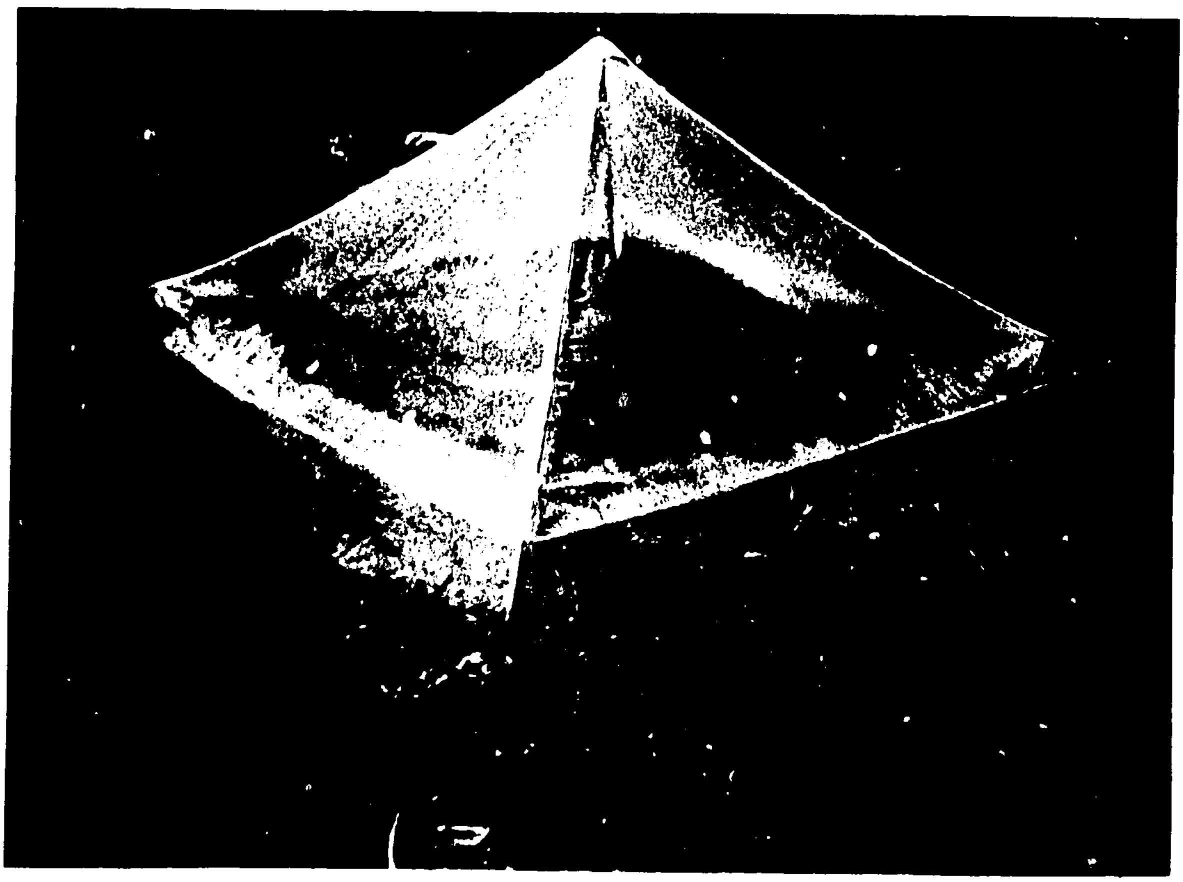


Figure 3.

Several of these units were obtained from a foreign manufacturer at a factory cost of $16 each, and tested under field conditions by some of the A.I.D. bureaus. The plastic tent solar still is not a typical solar still. It produces water by collecting and condensing the water vapor arising from the ground during the night hours rather than extracting water from a pond or reservoir of salt water. The tent may be more aptly called a "dew" collector. The plastic tent solar still cannot really be considered a satisfactory means for producing potable water for family uses. Even under the best of conditions it will produce only a few pints of water daily, hardly enough for the drinking requirements of a small family. Thus, it may be more properly classed with an emergency unit described previously.

Field tests with the plastic tent have shown several defects. For example, the collection system, a plastic trough formed by a flap at the base of the still, adhered to the sides of the tent and partially prevented the product water from flowing to the reservoir bottle. Also there were numerous problems in preventing rips and tears to the plastic material. Proper sealing of the tent was difficult and in some cases it was found that rodents would burrow into the unit to get at the water.

Results from the field evaluations indicate that the plastic tent solar still is not suitable for providing water for family uses, but it could be used to obtain small amounts of water for emergency uses.

DANIELS SOLAR STILL

Dr. Farrington Daniels, working in the Solar Energy Laboratory at the University of Wisconsin, has experimented for several years on a family size solar still. Models have been tested in Wisconsin, Florida, Arizona, and the South Pacific.

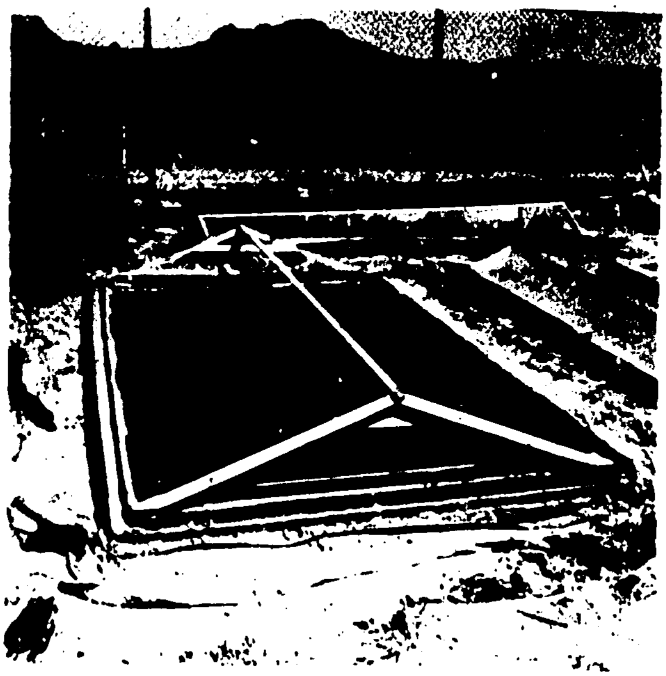


Figure 4.

A unit shown in figure 4 without the plastic cover has an area of 60 ft^2 (5'x12'), and it produced about 5 gallons of fresh water on a hot, sunny day in Phoenix, Arizona. About 2 man-days of labor are required to construct the still. The floor and the sides of the unit are concrete. The frame supporting the cover is wood and the cover is polyvinyl chloride plastic. The floor is covered with crushed charcoal briquettes which serve as a heat absorber. It is important that the unit be completely sealed if high efficiency and good production of water are to be achieved. When properly built, sealing is not difficult. Cost of the unit in the United States would be about $15. The still is expected to have a life of several years except for the plastic cover that will require changing at least each year. Other plastics have longer life but they are now more expensive.

Operation of the still requires daily attention. Fresh water and an equal quantity of residual brine are removed manually after each day, and the still is recharged to the initial volume. The salt water is added to the still by means of a plastic tube through the side and the fresh water is drained from the lowest point into a suitable container. The salt water can be admitted to the still by means of a pump but this increases the overall cost. The unit should be cleaned once a week to prevent a buildup of solid residues, usually precipitated salts and sediment. The product water is free of salt and micro-organisms.

Dr. Daniels is also developing a small portable type that will produce 3 to 5 gallons of fresh water daily. The design is similar to the unit described above. Materials of construction are wood and plastic, and the unit weighs about 25 pounds. The cost of a single unit has not yet been determined, although it is not expected to exceed $25.

The Daniels stills could easily be packaged and shipped in a kit form. But, if units were to be built in some of the developing nations using locally available materials, the plastics might have to be shipped from the U.S. Generally speaking, the Daniels solar still appears ready for commercialization.

HOWE SOLAR STILL
(University of California)

The Sea Water Conversion Laboratory, University of California, has developed a family-size, glass-covered still which can easily be constructed in many of the developing countries.

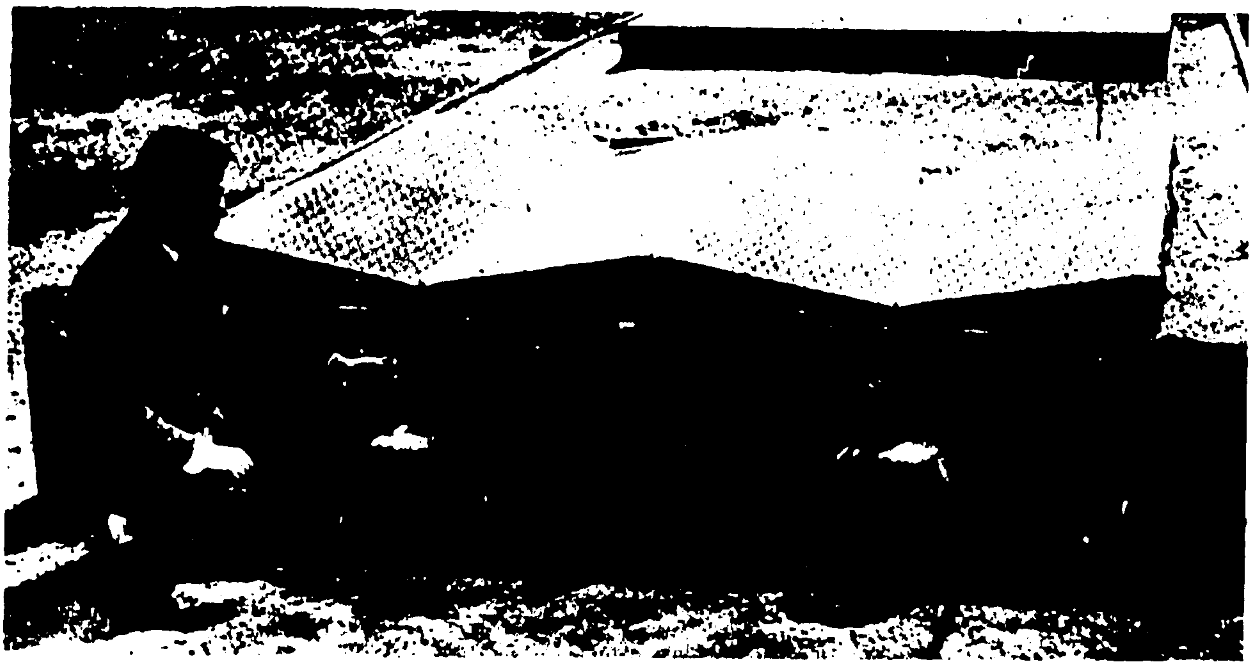


Figure 5.

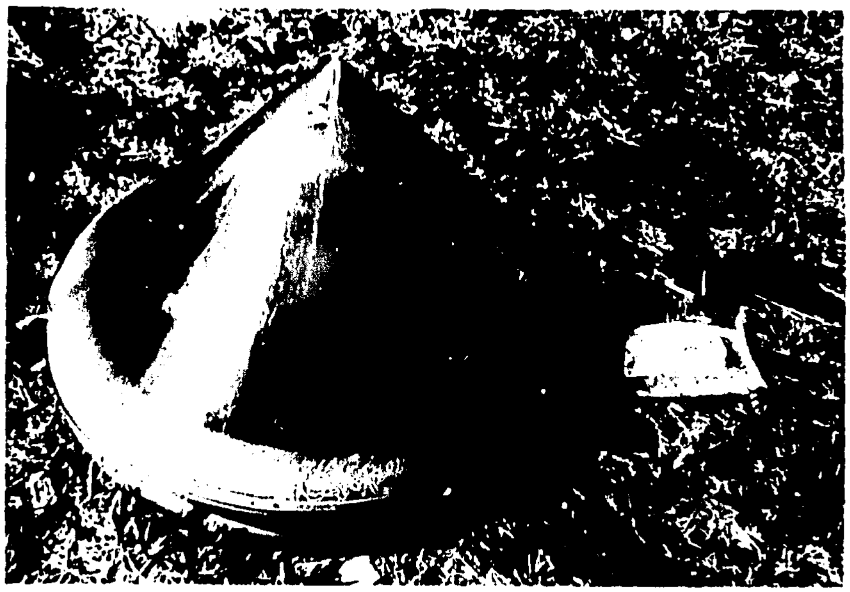
The model shown in figure 5 covers an area of 48 ft^2. It has a plastic film bottom over a sand base. A plywood frame confines the salt water and supports the glass cover. The frame is isolated from the salt water by the plastic film base which extends up the sides of the still. Loss of heat through the sand bottom is not excessive although a layer of insulating sawdust might be beneficial.

The use of crushed charcoal, as in the Daniels still, may increase production. The unit of figure 5 is located at the University of California (Berkeley) and has produced .02 gal/ft^2/day (approximately 1 gallon) during December, and 0.12 gal/ft^2/day (5.7 gallons) for July. Cost of materials for this unit should not exceed $20 in the U.S.

Construction of the still is simple. The base of the still should be as nearly level as possible with final adjustment by arrangement of the sand bed. The height of the bed inside the frame depends upon the depth of the salt water to be charged to the still. Depth of the water layer depends upon the frequency with which the still is to be refilled. For example, the estimated maximum production rate lowers the water level by nearly 1/2 inch per day. Thus, if the unit is serviced every three days during the summer months, the initial depth of the water in the still should be about 2½ to 3 inches at each recharge. The salt water is added to the still by means of a plastic tube through the side and the fresh water is drained from the lowest point into a suitable container. The salt water can be admitted to the still by means of a pump but this increases the overall cost. Care should be taken not to allow the water to evaporate completely; otherwise salts in the water would precipitate out and would present cleaning problems. With normal care this unit should provide good quality water for family uses for several years. During rainy weather, the design permits collection of rainwater for family use. Drawings and a list of materiels for this still are available for a "do-it-yourself" project. A kit containing the essential materials could be prepared, but most of the components should be available throughout the world.

THE DELANO STILL

Mr. Richard P. Delano of Long Island, N.Y., has developed a small solar still which produces approximately 2 quarts of water daily from salt water.



This unit (figure 6) is assembled by mounting a plastic cone over a child's small wading pool. The cone is supported internally by a plastic rod and is attached to the pool by a plastic zipper. As fresh water condenses on the cone, it runs down to the outer rim of the pool. By a slight tilt of the still, the fresh water will flow into the plastic bag at the right in the photograph. Efficiency of the still can be increased by adding a thin layer of charcoal or carbon black to the bottom of the pool. The salt water may be fed manually or by means of a self-feeding reservoir*

why not black plastic Bottom.

This still may also be converted to a survival-type unit described previously by cutting out the bottom of the pool and carefully and completely sealing the bottom of the still with earth.

The still covers 4.6 ft^2, weighs about 4 pounds, and is estimated to cost $6.

***When not in use, or for carrying, the still is collapsable into a small package.**