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GIORGIO NEBBIA

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THE DEMINERALIZATION OF SALINE WATER WITH SOLAR ENERGY

GIORGIO NEBBIA
Istiuuto di Merceologia, Università - Bari

The future of man in under-developed areas of the world depends in part on the availability of fresh water. This term will be used here to indicate water containing less than 1000 p.p.m. of dissolved salts. There are however many different conditions and needs: for this reason the study of the ways of obtaining fresh water for arid zones requires many different approaches.

In order to satisfy the needs of an industrial area or of a large community it is necessary either to build hydraulic networks or, if only saline water is available, to use demineralization processes requiring cheap fuels or nuclear energy. This can be done in large plants, and techniques are available which allow to foresee the future developments.

On the other hand, there is a large number of little communities or isolated country houses with availability only of water containing more than 1000 p.p.m. of salts and in this case the use of solar distillation may prove succesful in obtaining little amounts of water for drinking or domestic uses. The problem of the manufacture of efficient and simple solar stills has been studied in many laboratories for at least ten years [1]. It is now possible to summarize such results.

First of all it is necessary to point out that, at present, solar stills cannot be used in large plants for fresh water production in amounts of the order of thousands cubic meters per day. In fact, in the single-effect solar stills, water production in favourable conditions is of the order of 4 l/m^2 per day, with a yearly average of 1 $m^3/m.^2$ In these conditions the production of 1 cubic meter of distilled water per day requires a collecting surface of about 250 m^2. If multiple-effect stills were developed — at the expense of simplicity and cost — this figure might be reduced to 50 m^3/m^2 per day.

So far but few attempts have been made to build large scale solar stills; one of these has been designed and built by Löf [2-4]; the second is a project of a solar still with a production of about 1 thousand t per day, now still in the laboratory scale, developed in the University of Arizona at Tucson [5]. On the contrary, there is an immediate field of application of small solar stills for giving water to families or little communities in arid zones. Solar stills for these communities should be manufactured locally, using local materials, following the design lines which have been tested in the past years by various laboratories. The dimensions of such stills may range between 1 and 100 m^2 of collecting surface.

The success of solar stills depends largely on their simplicity in design and low cost, also at the expense of the water yield. An increase of water yield does not pay if obtained with sacrifice of simplicity, through introduction of auxiliary equipments or of more costly materials. In fact the great advantage of solar stills is the minimum maintenance they require, derived from the fact that there is no movable part or mechanism. Also, the life of the stills seems of secondary importance if they can be manufactured « in loco » with local materials. Anyway, a minimum availability of mechanical shops and facilities and of building materials is necessary.

For the manufacture of single-effect solar stills essentially few elements are necessary. Such elements can be assembled in many different ways [6] and can be made with many different materials. The still must essentially contain:

⟨*a*⟩ One cover, transparent to solar radiation and opaque to infrared radiation, which is generally used also as a heat exchanger and condensing surface: this condensing surface is surrounded by a little channel for the collection of the distilled water;

⟨*b*⟩ One tray or pad exposed to solar radiation and containing the saline water to be distilled: it must be blackened to increase solar energy absorption;

⟨*c*⟩ One insulation under the tray or pad, for reduction of heat losses; such insulation may also be given by a layer of still air.

Because of the large number of practical solutions which can be given to the assembling of a solar still, the development of such stills must be considered, at the present, as a technological, rather than a scientific problem.

There is still one area of scientific interest, namely the study of the thermodynamics of the solar distillation. There are at least three different approaches to this treatment, one by TELKES [7-9], a second by BAUM [10] and the third by the Georgia Institute of Technology [11].

Scientific studies and experimental work so far available have indicated the lines for the economic and efficient manufactures of solar stills and some designs are now available. The manufacture of solar stills and their field use depend on the cost and availability of materials, labor, shop facilities, etc. It seems reasonable to foresee that the manufacture near the installation site will be preferred to the manufacture in industrialized areas and the shipment to users.

Solar stills can be manufactured mainly following two designs:

⟨*a*⟩ The type of solar stills shown in Fig. 1 can be assembled in units of about 1 or 2 m^2 of collecting area, is very simple and requires a minimum of

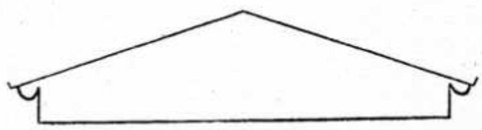

FIG. 1 – Simple model of solar still.

work and facilities. This design has been tested in various forms by many laboratories [12-15] and has been found satisfactory. In our Institute, we are building such little units (solar still model No. 8) in order to collect accurate data on the cost and life of the still.

⟨*b*⟩ The concrete type of solar still, designed to be placed on the roof of country houses as structural element of the house itself (Fig. 2). One experimental still of this design (solar still model No. 5) was tested in our Institute years ago [1, 16]. According to this design the saline water is pumped in the trays and the distilled water flows by gravity in a tank into the house. For the field application of this model it is necessary to solve some constructive problems. The water in the tray, in fact, reaches a temperature as high as 70-75 °C and the concrete layer easily breaks and water losses occur; difficulties are also encountered in the blackening and insulation of the concrete layer of the tray. Probably it will be easier to manufacture structural elements of moulded black plastic material. Fig. 3 shows an example of the section of such elements. They might be placed on a layer of insulating material, on the roof of the building.

For the various parts of both types of solar stills various building materials can be used but attention must be directed to the most easily available, materials local and also cheapest, iron sheets, glass, wood, black paints. Galvanic treatments to blacken the iron sheets must be preferred but they seem hardly applicable in the field. There are many interesting designs based on the use of plastic materials, with the advantage of rather low cost and weight, but, they require

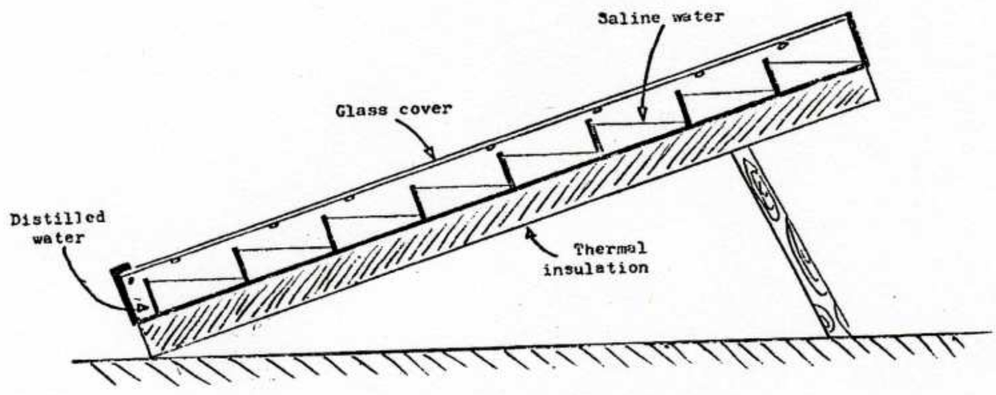

FIG. 2 – Tilted solar still with metal tray.

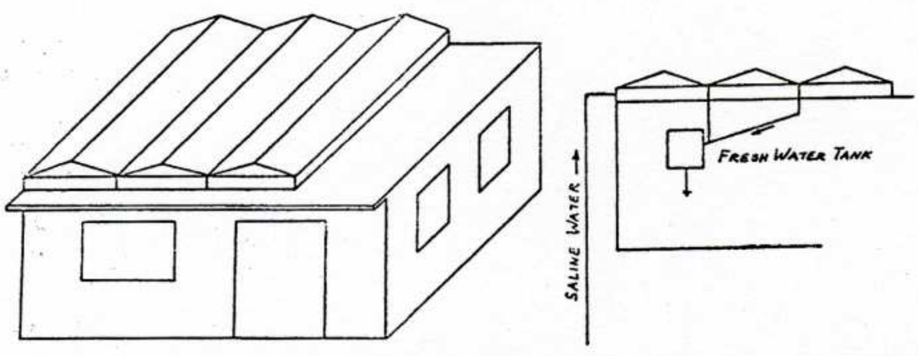

FIG. 3 – Design of a concrete solar still to be placed on the roof of houses in arid zones.

mechanical complications or auxiliary equipments which are too troublesome for an immediate field application. They probably will be successful after further developments and new inventions.

The success of solar stills depends in a large part from the efforts in order to educate users to their best use; distilled water is unpleasant to drink and it is generally necessary to readjust its taste with salts and gases.

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SUMMARY

The demineralization of saline water with solar energy.

The use of solar stills seems confined to giving little amounts of fresh water to isolated families or little communities for domestic uses.

The present status of the scientific knowledge and experiments indicates that some good designs are available and that solar stills can be assembled according to such designs and depending on the availability of materials, mechanical facilities, and so on.

It seems better that the stills be assembled near the field with local materials and labor, and the task of the laboratories seems presently the spreading of the experience so far gained in order to let users build their own stills.

Problems yet to be solved are indicated.