Proc. Indian natn. Sci. Acad. Vol. 44, Part B, No 6, pp. 381-388 (1978)

SOLAR DESALINATION IN RAJASTHAN DESERT

by N. SARKAR, J. P. GUPTA, V. S. DAVE, R. C. VAIDYA, N. BOHRA *and* K. K. SULA
Defence Laboratory, Jodhpur

The paper discusses solar stills developed by Defence Laboratory, Jodhpur for desalination of brackish water for the arid areas of Rajasthan, which suffer from acute shortage of drinking water. The solar stills described are of low roof glass and V-shaped plastic types. The former consists of a glass roof in wooden structure with metal or black plastic troughs, whereas the latter consists of V-shaped trench dug in the ground, lined with a black coarse fabric and covered with a plastic sheet. Output for the solar stills varies from 2.5 to 4.5 litres/M^2/day during February to May 1970.

INTRODUCTION

The arid areas of Rajasthan suffer from acute shortage of fresh water which is vitally needed for human population and livestock husbandry in these regions.

A large degree of salinity exists in the underground water and in many places this water is undrinkable and harmful to health. No development of the Rajasthan desert can be thought of unless fresh water in adequate quantities be made available to these regions.

The survey of a few villages in the Jodhpur District revealed a stringent requirement of fresh water in these areas. It has been found that due to remoteness of these villages, both from the point of view of electric supply and inadequate road facilities, the device for providing water should be such that it is self sufficient, does not require much maintenance and can be easily looked after by the villagers.

Desalination plants working on solar energy can be satisfactory devices from these points of view. Desert climate is characterised by high incidence of solar radiation and long hours of sunshine. This can be seen from the data for Jodhpur (Ramdas & Yegnanarayanan, 1956) as shown in Fig. 1. During our survey, it has been found that there are one or two wells in each village where brackish water is available and this can be utilised for feeding solar stills which can convert this brackish water into potable water. This will meet to some extent, even though not completely in some cases, the requirement of the villages.

Defence Laboratory, Jodhpur, has already carried out some work on development of solar stills for conversion of brackish water into potable water. Two types of solar stills have so far been developed. These are described below.

LOW ROOF TYPE SOLAR STILL

Description (Fig. 2): The low roof type solar still is a glass and wooden construction with an aluminium bottom. The design of this still is now more or less a standard

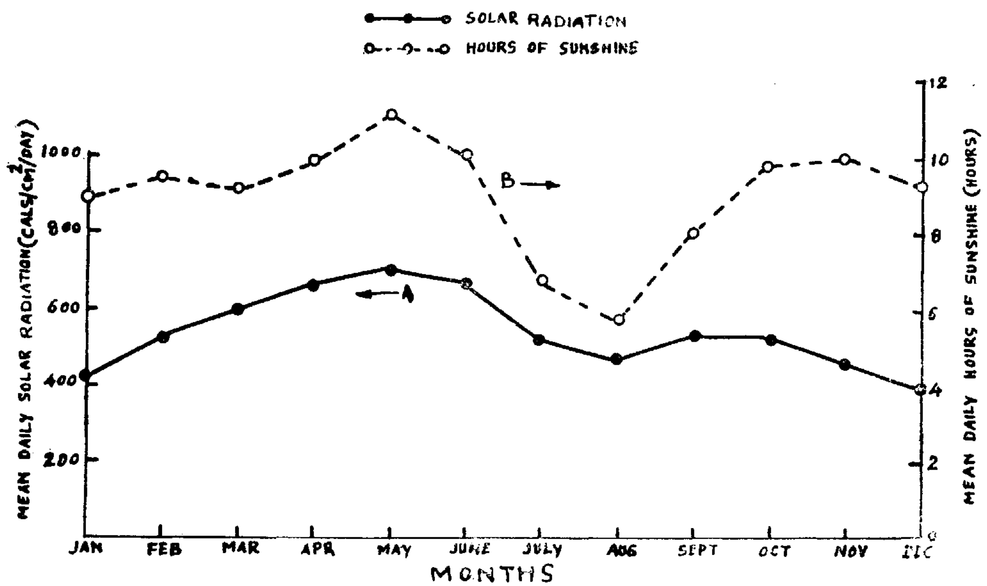

FIG. 1. Mean daily solar radiation and hours of sunshine at Jodhpur.

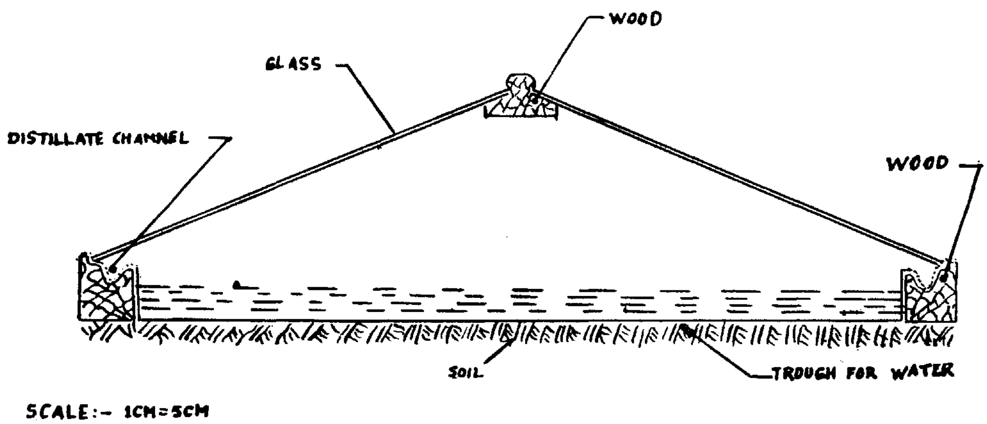

FIG. 2. Low roof type solar still-schematic diagram.

one. The inclination of the glass has been kept at about 20° to the horizontal from the point of view of maximum incident solar radiation and easy flow of the distillate as found from earlier literature (Ahmad *et al.*, 1968) and our own experience. The one described has an evaporating area of 1.5 M^2. The solar still was kept at a slightly inclined level to enable easy flow of the distillate and its collections (Plate 1).

Results : The data on output of the solar stills are shown in Fig. 3 for different periods. The productivity, on an average, is of the order of 3.6 litres/M^2/day during Feb–Apr. The concentration of the input saline water was approx. 10,000 ppm. Further, experiments were carried out with different values of water thickness and the

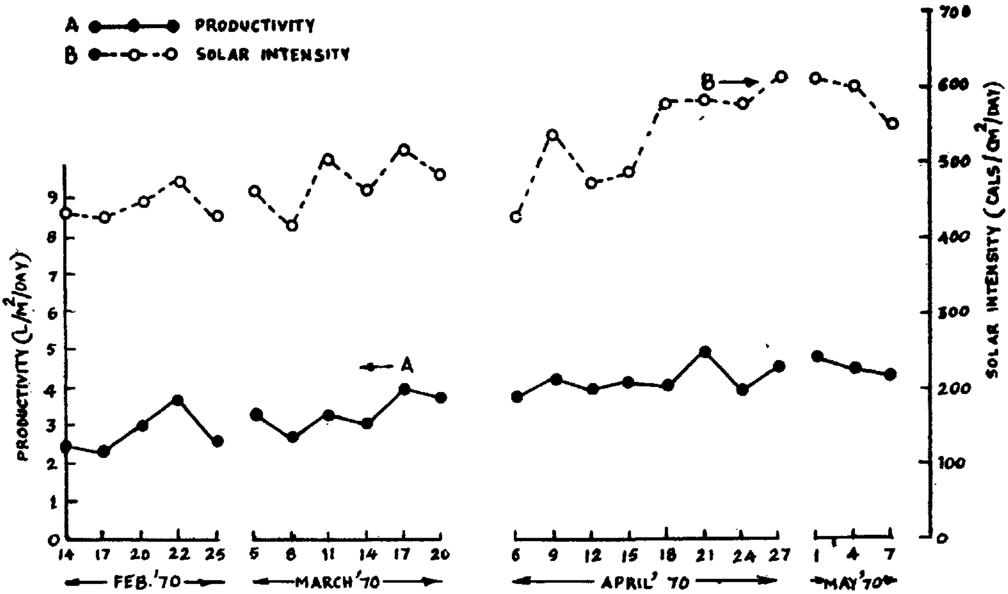

Fig. 3. Productivity of low roof type solar still over a period.

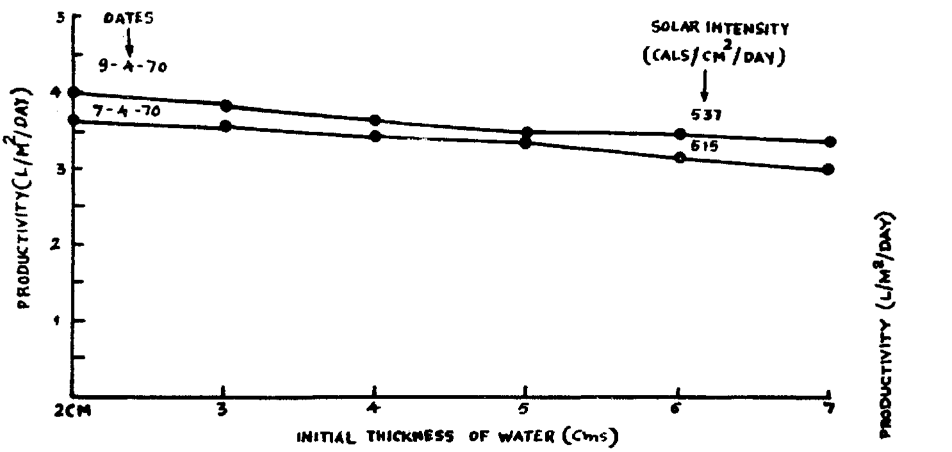

Fig. 4. Productivity of low roof type solar still with different values of thickness.

productivity is found to be maximum for minimum thickness of about 2 cm as shown in Fig. 4. It is not possible to reduce the thickness any further as the level of the water has to be maintained over the entire area to avoid the possibility of the solar still going dry. The productivity of this solar still has been found to increase with increasing solar radiation for the same value of ambient temperature (Fig. 5). Since these data are for different days, it may happen that mean ambient temperature varies from 25°C to 35°C even though solar radiation may be the same. However, the productivity, in general, tends to decrease gradually with time even though the

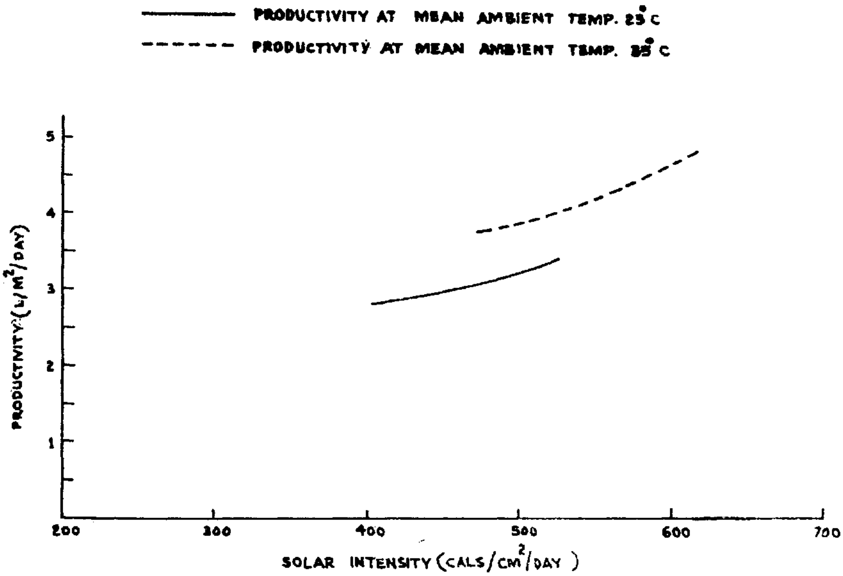

FIG. 5. Productivity of low roof type solar still vs solar intensity.

solar radiation and ambient temperature may remain the same. This is probably due to factors like development of leakage in the glass cover etc. The average efficiency of this type of solar still has been found to be of the order of 40% on a clear sunshine day during Feb. – April.

A low roof type solar still without any bottom and having an evaporating area of 10 sq. m was fabricated by this laboratory and installed at Pachbadra Salt Works, over the brine bed. The saline concentration was as much as 1,70,000 ppm and the report as obtained from the Pachbadra Salt Works showed an average output of 10 litres per day during the summer season.

Further, experiments are under way to evaluate the performance of black polythene/PVC sheets put at the bottom for holding brackish water.

V-SHAPED SOLAR STILL

Description (Fig. 6 A): V-shaped trench of length 10 metres is dug in the ground in the east west direction, to a depth of 40 cm including a rectangular channel in the centre, the depth and the width of the rectangular channel being 8 and 10 cm respectively. The aperture width of the V-shaped trench is 75 cm.

Next, the trench is lined with a plastic sheet covering the central channel and also the slanting surfaces. Two coarse black fabrics are laid on either side of the slanting surfaces over the plastic linings already laid. The central channel is filled with brackish water (concentration approx. 10,000 ppm) and one end of the black cloth dips in brackish water, the other end being held along with the plastic lining at the top on the ground with stone pieces or plastic bags filled with sand. A plastic cover is laid over the trench in the form of a 'V', held in shape, with thin iron rods placed over

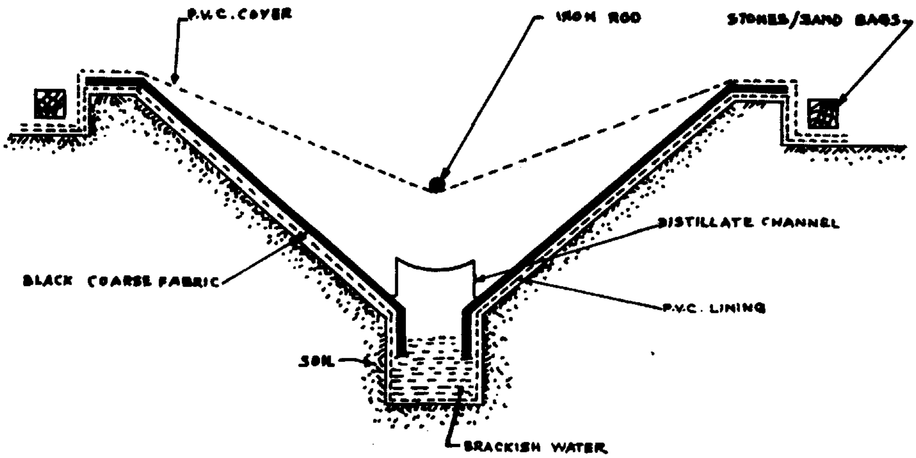

FIG. 6. V-shaped plastic solar still-schematic diagram.

the cover along the centre. The ends of the plastic cover are also held over the ground along with black cloth and inner plastic linings with stone pieces or plastic bags filled with sand. A plastic channel is placed below the plastic cover and above the brackish water channel for collection of distilled water. This plastic channel is held with clips on GI wire stand.

In its operation, the black coarse fabric draws brackish water by capillary action. It appears that black fabric for drawing brackish water by capillary action has been used for the first time only in this work. However black fabric had also been used by Dr. M. Telkes in inclined solar stills wherein the brackish water was fed from the top (Telkes, 1955). The vapours produced after heating of the coarse fabric by solar radiation condense on the inside of the top plastic cover and the distillate is collected in the plastic channel placed below the top cover. The output is automatically drained out through a PVC tube and is collected in a bottle kept outside the trench.

This type of solar still has an advantage that it does not require any workshop fabrication like the low roof type. The solar still can be made on the spot and does not need the help of skilled personnel. The total weight of the kit for a solar still of 6 square meters area is of the order of 15 kg (Plate 2).

Results: Experiments have been carried out with varying dimensions of the solar stills viz., 1 M^2, 2 M^2, 4 M^2, and 6.1 M^2. The data shown in Fig. 7 are for 6.1 M^2 still. The productivity, on an average, is of the order of 4 litres/M^2/day, during Apr. – May.

Experiments have also been carried out to investigate into the variation of productivity with increasing concentration of saline water. Fig. 8 shows the performance of such a solar still of area 1M^2 with different saline water concentration on successive days. The productivity decreases with increasing concentration. Decrease in productivity is also partly due to decline in solar radiation. In order to eliminate the effect of variation of solar radiation on successive days, simultaneous experiments have also

PLATE 1. Low glass roof type solar stills in operation.

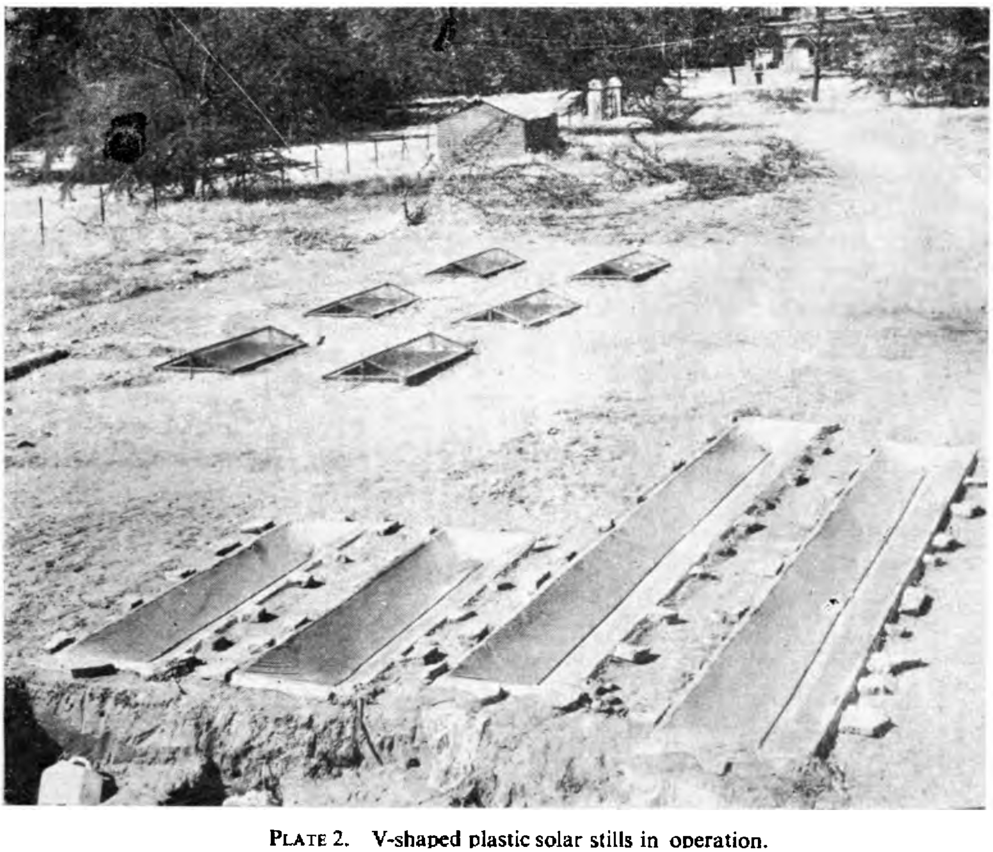

PLATE 2. V-shaped plastic solar stills in operation.

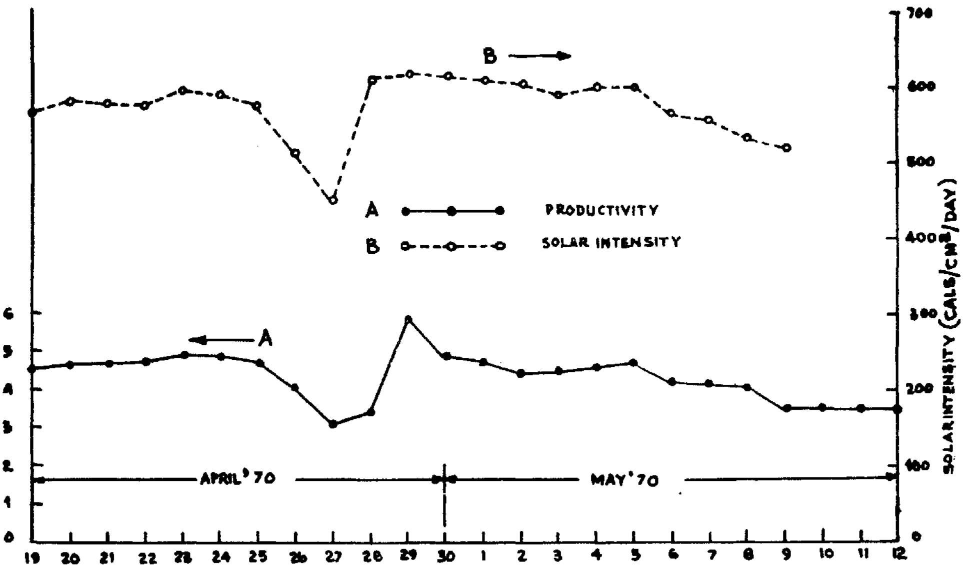

FIG. 7. Productivity of V-shaped plastic solar still over a period

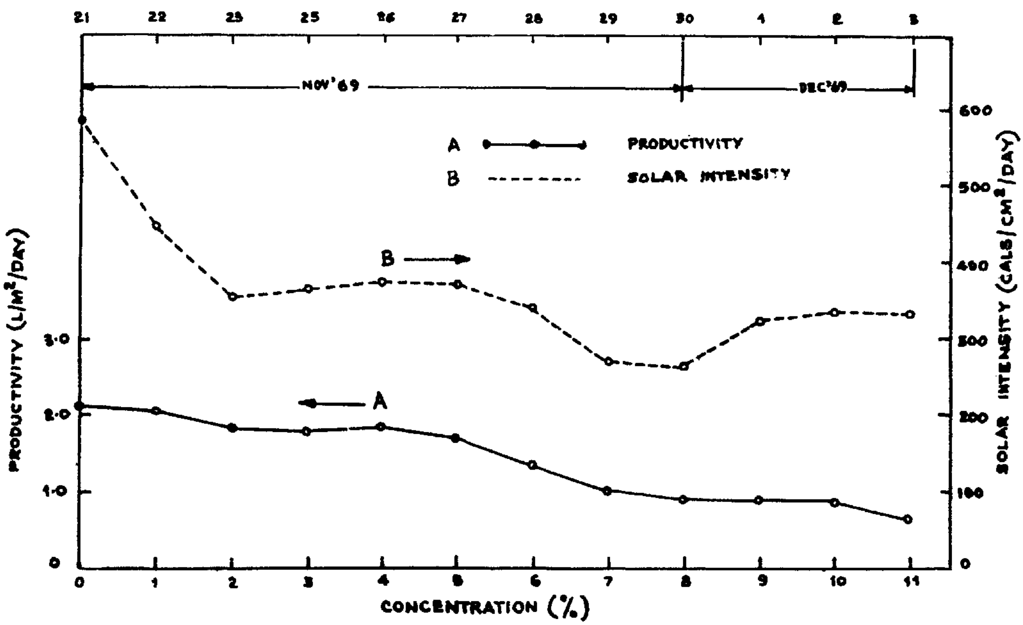

FIG. 8. Productivity of V-shaped plastic solar still Vs saline water concentration

been carried out on four solar stills with saline water concetrations as 0.2%, 1% 2%, 3% respectively. The data are shown in Fig. 9. A low value of productivity during January at Jodhpur (approx, 0.9 litre/M²/day) even for fresh water, is not

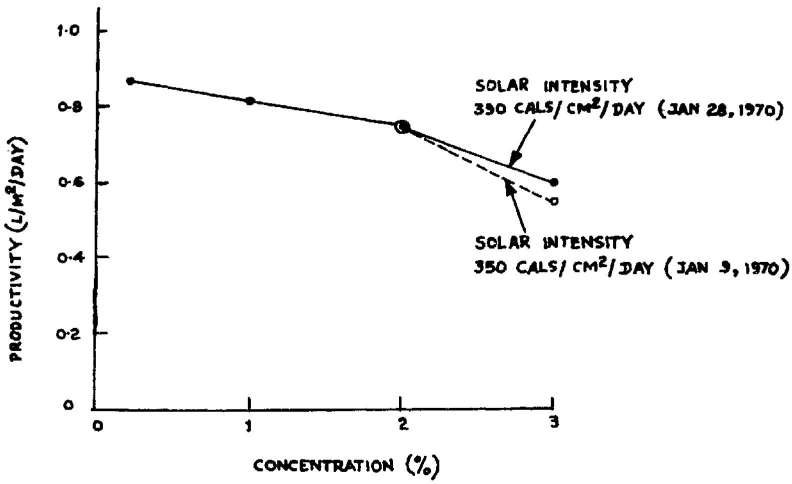

FIG. 9. Productivity of V-shaped plastic solar stills vs saline water concentration with simultaneous observation on four stills.

only due to low value of solar radiation, but also due to large shadow effect in winter which is the characteristic of V-shaped solar stills. This effect will be further examined and reported in future. The productivity tends to decrease substantially when concentration exceeds 2%. Average efficiency of V-shaped plastic solar still has been found to be of the order of 45% on a clear sunshine day during Apr. — May.

Large Scale Solar Desalination Plant

Our laboratory has also carried out some design work on large scale solar desalination plant, specially for application in villages of Rajasthan. We have designed a 1000 gallons per day output which can be used for a village like Ghantiali in Jodhpur district which has a stringent requirement of potable water but the nearest source of sweet water and electricity is at Phalodi which is about 45 miles away. It has been found that installing a solar desalination plant using a black PVC sheet as the bed will be cheaper than transportation of water by trucks or by laying water pipelines.

Acknowledgements

The authors wish to express their thanks to Dr B.N. Singh, Director, Defence Laboratory, Jodhpur, for taking keen interest and offering valuable suggestions towards the project from time to time.

References

Ahmed, S.Y., *et al.* (1968) Scope and development of solar stills for water desalination in India. *Desalination*, 5, 64-74.

Ramdas, L.A. & Yegnanarayanan, S. (1956). Solar Energy in India. *In: Proceedings of the Unesco Symposium on Wind and Solar Energy, New Delhi*, pp. 188.

T elkes, M. (1955) Solar stills. *Proceedings of the World Symposium on Applied Solar Energy*, Phoenix, Arizona, pp. 73-79.