SOLAR STILLS OF INCLINED EVAPORATING CLOTH

by

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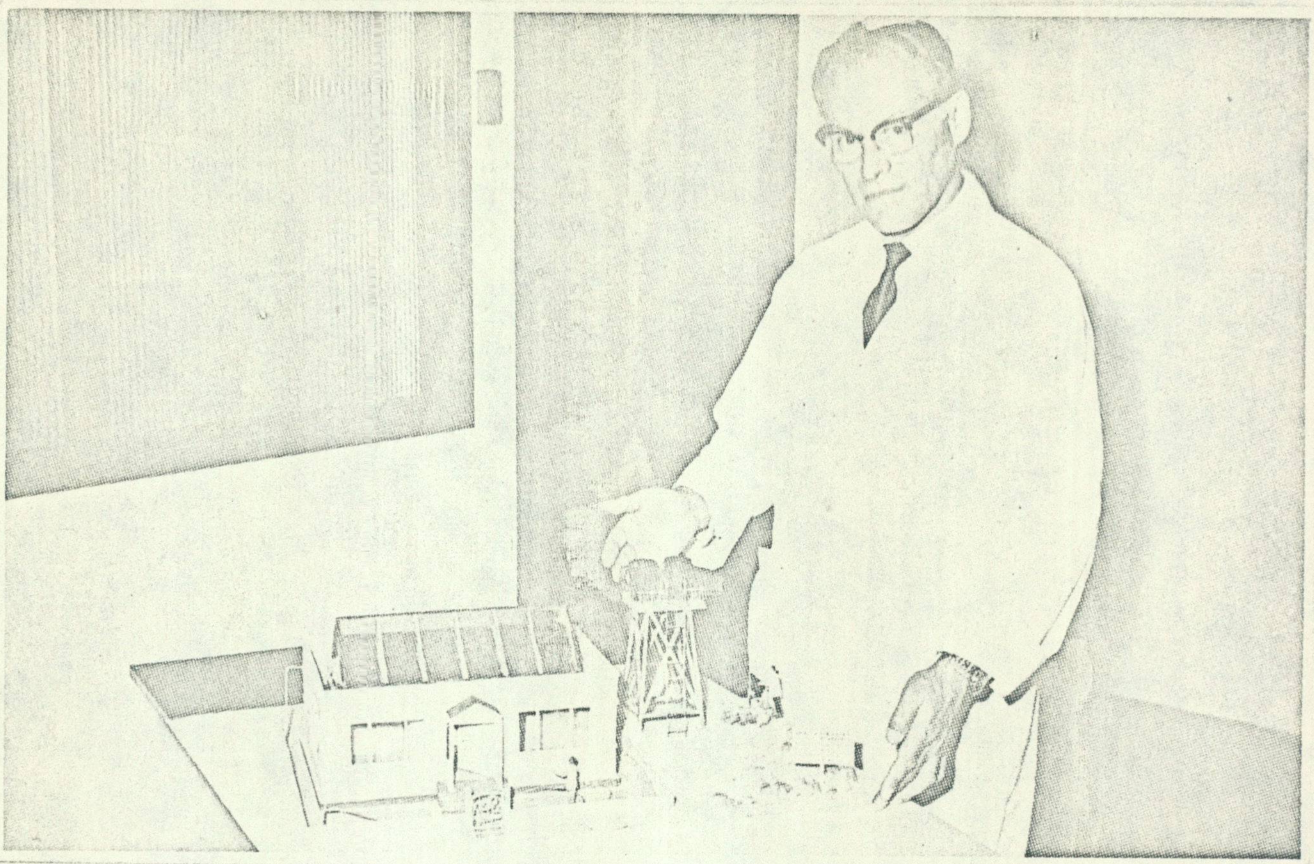
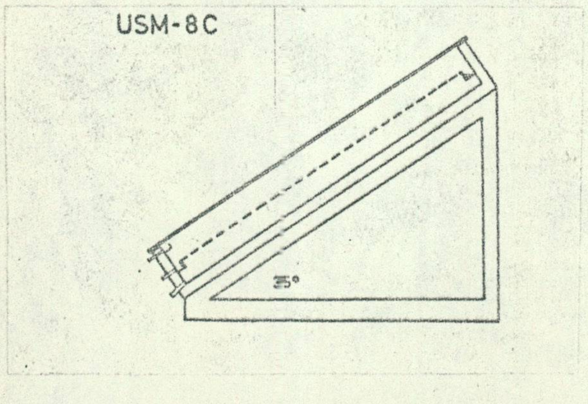


J. von Sommerfelds'

MAQUETA: CASA OBRERO CON SU DESTILADOR SOLAR

In 1963, J, von Sommerfelds' commenced his investigations in solar stills with evaporating cloth, in the Universidad Tecnica Federico Santa Maria, developing a model which, through difeffrent variations, has brought us to the present design of stills of 40, 34, 30, and 20 m2 respectively that will be installed this year on the roofs of workmens' at the Port of Pisagua, 440 km north of Antofagasta.

This type of solar still, U S M 2, is shown in fig. 2 The lower and lateral parts are made of zinc sheet iron of 1.1 mm The transparent cover



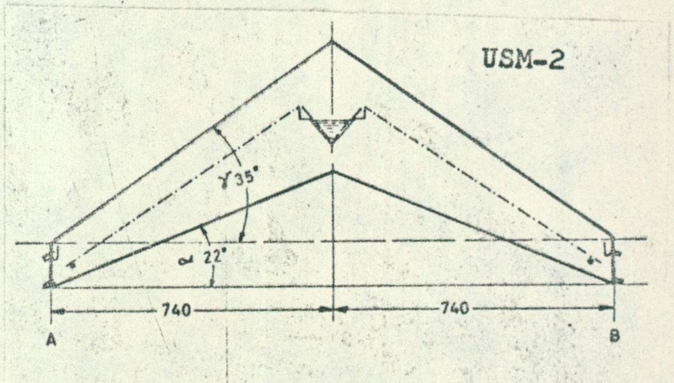


Fig. 2

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can be a special plastic one with a great resistance to ageing, or a window glass 3 mm thick. It is oriented with the top directed towards the geographic North. The salt water is taken from a trough by dipping into it a fibre cloth. On both sides of the trough, the cloth runs parallel to the cover until it reaches the bottom of the salt water collecting channels situated at both sides as is shown in Fig. 2. There are two condensate collection Channels situated directly under the glasses at both sides of the still (Ref. 3).

It is an obvious economical advantage to place thermal isolation in the inferior and lateral parts of the outside of the still, with exception of the one oriented to the North. Also the same kind of stills have been experimented on with the inferior and lateral parts made of plastic materials (acrylic "cristal"), but this solution has not been succesful as it is more expensive.

2. The Plastic Cover

The biggest problem is to find or develop a transparent cover with a durability of many years, without an impairment of its mechanical conditions and a transparency to solar rays. Concerning the plastics used as covers, we can briefly inform on the following points taken from our experiences:

a) Polyvinyl PVC (used for packing in stores). It is very transparent, and the one we had was too thin (0,020 mm). It distills very well, is of very poor mechanical conditions; durability only 30 days.

b) Polyethylene "oro T" (Implatex Factory, Chile). Plastic sheet 1.0 mm thick, made by Implatex under indications from J. von Sommerfeld. It is very transparent and is flexible at a temperature above 50 °C. It shrinks with the cold. As a cover in solar stills it works very well during the first two months, but after 3 or 4 months it takes on a dark colour, it cracks and decomposes. The price is cheap, but because of its unstableness under working conditions, it has to be rejected.

c) Polyesterene "violaceo" (Implatex, Chile). Made especially so that it can absorb the ultraviolet rays and avoid decomposition when exposed to the solar rays. It is very resistant to steam at 100 °C. It worked very well during 6 months, but due to the atmospheric agents (burned gases), small spots appeared where the material was weakened.

d) Metacrylic polyester "burdeos", 1.5 mm thick, made by Implatex for use in these experiences, given the fact that it is not marketable. It is of great mechanical resistance, very transparent (with a light purple colour). It doesen't suffer perceptible deformations with temperature variations. It doesn't reject water as much as other plastic do, so that the fine drops of condensation reflect the solar light far less than the normal plastics; this lends itself for a higher efficiency because more solar light penetrates into the interior of the still. After a year of complete satisfactory work, we think that it will be possible to use it for a good few years more in satisfactory conditions.

3. The evaporating cloth

Another important problem is to find a texture that will keep in good conditions as an evaporating surface for many years. The most difficult point is the conservation of a high absorption coefficient to the solar rays (maintenance of good black colour).

The experiences carried out during many years in the Solar Energy Lab. of the Universidad Técnica Federico Santa María, with solar stills provided with evaporating cloth, have carried us to suggest that the evaporating cloth for these stills must comply with the following conditions:

a) Good capillary ascension of water in the cloth (static ascension > 15 cm).

b) Sufficient water flux due to capillarity (with 5 cm of ascension and 10 cm of descent, water must drain through the cloth at the rate of 20 to 40 cm^3/minute per meter with of cloth.

c) Good impregnation with a dark tincture (Absorption coefficient $>85\%$ in a new wet cloth.

d) Good endurance of impregnation (decrease of the coeficient of absorption $<15\%$/year under conditions of permanent draining of water through the cloth, and $<15\%$/month under conditions of alternating dry conditions one day and wet conditions the next day).

e) Good mechanical resistance (>500 Kp/m for the cloth when it is new; >200 Kp/m after 5 years of permanent work of the cloth inside a solar still).

After many tests with different types of fibres, we found that two types of fibres fulfill the above given conditions:

1st. Yute, or gunny (Corchorus Capsularis). It is used in sacks for the transport of salt. It is a fibre taken from the stems of a woody plant that grows in India.

2nd. "Malva Blanca" (Malvacha Yuraco Cuzquensi). It is used in very strong textures and also for cables. It is taken from the bark of the stem of a woody plant that grows in the Cuzco Valley in Perú, at an altitude of 3.100 meters above sea level.

The yute fibres have a maximum length of 1.80 meters and are composed of fine capillary tubes of 1 to 4 mm in length and 17 to 23 μm in diameter. The fracture length is of 30 to 34 km. The mallow fibres ("malva") are from 4 to 7 meters long and are composed, similary of those of the yute, of small tubes of 1 to 3 mm in length. The rupture length is of 60 to 120 km.

4. Long Term Experiences

We shall only mention the one of the solar stills with an evaporating cloth of 1.20 m^2, experimented by J. von Sommerfeld, which worked from the 12th. of April 1963 to the 28th of February 1971 with the same evaporating cloth. In December 1963 the maximum daily production of distilled water was of 4.4 dm^3/m^2 per day, with an efficiency of 46% without thermal isolation at the base or the sides. Last summer, the cloth being very discoloured, it produced 3.8 dm^3/m^2 per day, with an efficiency of 40%, but placing thermal isolation at the base and the sides of the solar still. Without isolation, in the same conditions as in 1963, the efficiency was around 32%.

The above figures indicate that the still, after working for 8 years, suffered a decrease of 30% in its efficiency, due to the discoloration of the cloth, given the fact that the plastic cover was replaced by another similar in the transmission of solar rays.

5. The Cost of the Distilled Water

A solar still, similar to the one in Fig. 2, placed on the roof of a house, has the following costs per m^2:

	US \$/m^2	T years	f	US \$/m^2 year
Zinked iron base, sides and trough	4.70	20	0.19	0.890
Plastic cover	0.75	4	0.39	0.292
Tinctured cloth (yute)	0.20	4	0.39	0.078
Improvement of the impermeability of house roof	0.80	20	0.19	0.152
Joints, painting, others	0.12	2	0.64	0.077
Tanks, pipes, fittings	0.50	20	0.19	0.095
Wood base	0.50	20	0.19	0.095
	7.57			1.679

T = replacing period of the materials;   With
i = 0.06/ year = capital interest;
m = 0.08/ year = maintenance cost; the investment capital factor, f, is taken as

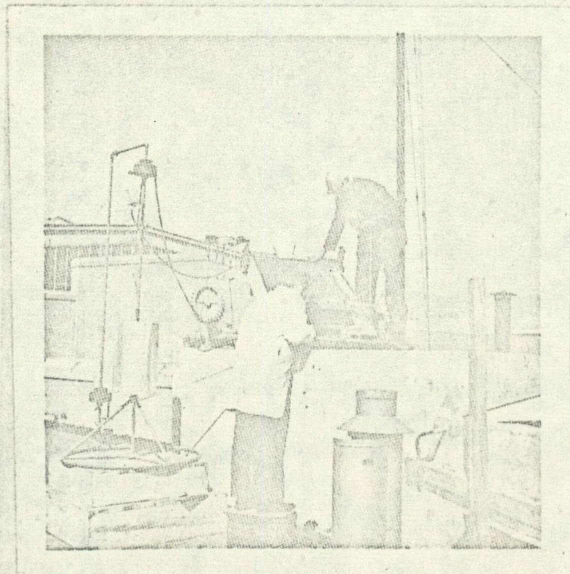
$$f = \frac{1}{T} + i + m$$

We estimate that at the Port of Pisagua the still will give a yearly average of 3.0 dm^3/m^2 day = 1.10 m^3/m^2 year. Given these figures, the cost of distilled water is

$$\frac{1.68}{1.10} = \underline{\underline{1.53 \text{ US \$}/m^3}}$$

6. Conclusions

In accordance with our laboratory experiences, we find that the solar stills with an inclined plane evaporating cloth could be the most economical solution for providing drinking wafer in certain localities. We are in hopes that the installation of 4 stills of this type at the Port of Pisagua, with more than 100 m^2 of evaporating surface, will confirm aour aims.



G. Frick and J. Hirschmann testing a solar still

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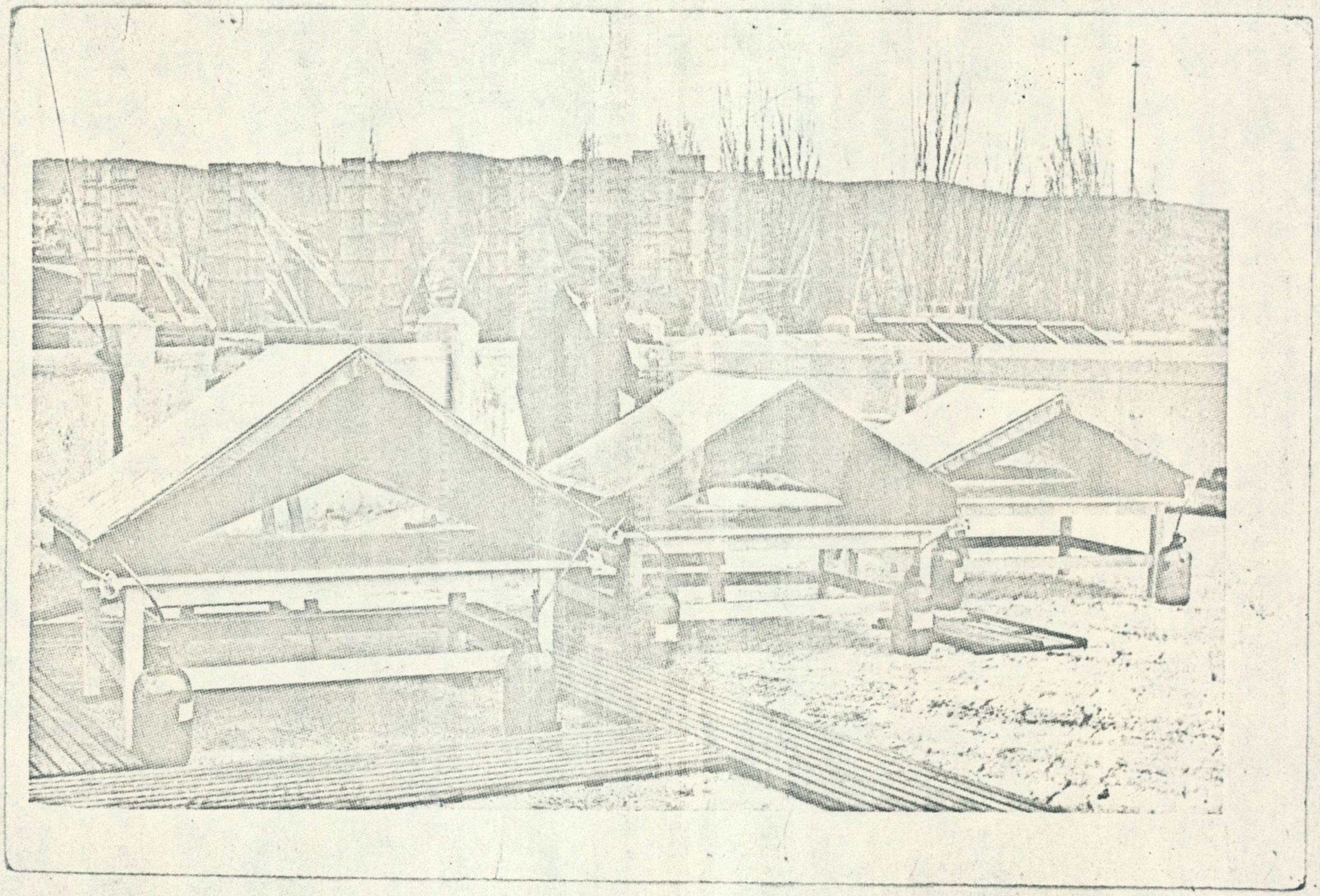

J. von Sommerfelds' solar stills