SOLAR WATER DISTILATION PLANT

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ABSTRACT

The paper describes the development of an effective and economical solar water distillation plant to produce, in commercial quality, distilled water of high purity as is required by pharmaceutical, chemical, food industries, etc. The plate is currently undergoing a series of performance tests. Initial results show that the improved unit can produce larger quantities (up to 30 litres per day) of high quality distilled water. The process can also be adapted to supply potable water to rural areas where the water available is not suitable for drinking.

INTRODUCTION

The objective of this project is the development of a small scale solar distillation plant to produce economically pure water of the high quality required for different purposes in various industries such as pharmaceutical, chemistry and food industries and for motor batteries, laboratories and hospitals. Solar water distillation can be very economical if well designed especially in countries such as Nigeria with abundant sunshine all the year round.

HISTORICAL BACKGROUND

In 1982 two experimental solar stills of galvanised mild steel body and glass pane covers were constructed at Kaduna Polytechnic, Kaduna. Each unit had a tray area of $2.1 m^2$ for heating water by solar radiation and produced on average 8.6 litres of distilled water per day or about 4.1 litres per m^2. The production gradually declined to 2.5 litres per m^2 per day in April 1984.

In laboratory analysis of samples of distilled water collected in January 1982, the pH was 7.0, electrical conductivity was 17 micro mhos and traces of calcium, magnesium and sodium were within international standards. The maximum temperature of water in the tray reached 68°C with an ambient temperature of 39°C and corresponding output of 12 litres on 6th April 1982. During the two years operation, the units were overhauled twice and during the second overhaul it was discovered that one of the units had corroded badly with many pit holes in the base plate.

Initially the units were not lagged and hence lost a lot of heat energy to the surrounding atmosphere. Scales forming on the base of the tray covered the black coating and considerably reduced the thermal efficiency and the daily production.

AN IMPROVED UNIT

Based on the experience described above it was decided to design an entirely new solar water distillation process plant (Jimoh and Gupta 1984). This process incorporates pre-treatment of the water by sedimentation and filteration, preheating of the filtered water using a solar collector, and multi-stage distillation by a serial arrangement of stills (Figure 1).

The still is 1.75m x 1.22m and made of stainless steel. It has a copper sheet base, a glass pane cover and is insulated with 50mm thick polyurathane foam enclosed in plastic coated steel sheets. The inclination of the glass pane is 12° to the East-West horizontal plane to allow condensed droplets to run along the glass pane to the V-shaped channels leading to the plastic tubes carrying the distillate to the storage plastic container.

Water is supplied automatically through a float valve to the filter tank fitted with four filter elements mounted directly on the supply tank. The filter water is supplied through a plastic hose pipe and a level control float valve to the still. Preheating of the solar collector was rejected as this had very little effect especially with the introduction of a water level control float valve which only released the supply water as droplets into the still.

The entire process functions automatically and requires only one attendant to dust the glass panes daily and to collect the distillate.

OBSERVATIONS

Performance tests are still being carried out on the new installation which went into operation in December 1984. The following preliminary observations have been made:

1. The average daily quantity of distilled water produced for the month of December 1984 was about 30 litres at average ambient temperature of 30°C making about 14.3 litres per m^2.

2. The maximum water temperature of 68°C was recorded on 22nd February 1985 with ambient temperature of 38°C.

3. The first analysis of the distillate, carried out on 6th December 1984 by the soil laboratory of the Department of Irrigation/Agriculture Mechanisation gave the following results:

pH	=	6.8
EC x 10^6	=	4.35 micro ohm/cm at 25°C
CO_3	=	None
HCO_3	=	0.3 meg/l
CA^{++}	=	2.4 ppm
MG^{++}	=	None
Cl^-	=	None
Ma^{++}	=	None
K^+	=	None

Water colourless and odourless.

The water is being collected temporarily in plastic containers and the permanent distillate tank is to be installed later.

CONCLUSION

The 400% increase in average daily production from 4.5 litres per m^2 to about 143 litres per m^2 in the improved solar still is still being investigated, but can be attributed to:

1. the initial pretreatment of the supply reducing the sediment considerably;

2. the automatic level control float valve maintaining a constant water level (presently about 25mm high in the tray);

3. the use of a copper tray which increases the rate of energy absorbed by the water;

4. the insulation of polyurathane foam which prevents heat loss to the surrounding atmosphere.

Further experiments are being planned.

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FIGURE 1: Solar water distillation process diagram