SOLAR STILL FOR ROSE WATER PRODUCTION

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This paper is the outcome of students' project work guided by the author. An attempt has been made to design and develop a solar still for rose water production in India. This unit has the following features : i) possibility of tilt adjustments to suit the different altitudes of Sun, ii) specially designed stepped basin for conveniently keeping the rose petals and water in an inclined position and iii) cover which can be opened to facilitate the cleaning operations. This unit supplied 3.7 litres of rose water in three days during winter in Madras, in India. The sunshine and solar radiation particulars of Botswana are shown to indicate that a better climatic conditions prevail here for a higher production rate.

1. INTRODUCTION

The simplest and widely adopted method for rose water production is the distillation process. In this process, rose petals are boiled with water using thermal energy and the generated steam is condensed as final product. The thermal energy is normally supplied by using kerosene stove, gas burning or by an electric heater. However, increasing cost of fast depleting fossil fuel resources and frequent breakdown of heating filament in electrical appliance are the main factors which resort for an alternative. In this context one has to remember that solar energy is abundant in Botswana and rose plants are cultivated all over and therefore, utilisation of solar energy looks an attractive method for the production of rose water. It is necessary to mention here that rose water is very good for skin care and used as cosmetics. Diluted rose syrup is good for health as cool drinks.

2. SUNSHINE AND SOLAR RADIATION IN BOTSWANA.

The duration of bright sunshine is recorded at all the nine synoptic stations in Botswana, which are equipped with the Campbell-Stokes sunshine recorders. Table 1 shows the highest, lowest and annual mean hours of bright sunshine. The lower figures, in bracket, indicate bright sunshine duration as percentage of the day-length. The day-length is to be taken as the time during which the centre of sun is above the horizon. Table 2, (Bhalotra Y.P.R[3]) shows the calculated average daily total solar radiation on horizontal surfaces. General observation can be made from this table that the values of solar radiation in Botswana, is generally highest in December (23–27 $MJm^{-2}day^{-1}$) and lowest in June (14–17 $MJm^{-2}day^{-1}$) .

We have earlier worked on the design of small and efficient stepped basin type solar still for the production of distilled water for our laboratories at Madras, India (Latitude 13.4°, longitude 83°). In order to enhance the productivity during the winter months and when the Sun is at lower altitudes, multi-basin , tilted type solar still was later developed.

As a project for the students, we slightly modified this solar still during 1992 for the production of rose water, where additional facilities were provided to feed the device with rose petals and also facilities to remove the rose pulp remaining after boiling. This waste pulp mixed with soil can be used as fertiliser. The design details and performance of this device is reported in this paper.

3. DESIGN PARTICULARS

The solar still (figure 1) consists of a wooden box of outer dimensions 1005 mm x 210 mm x 230 mm having a top door that can be opened out side . The door consists of a frame with glass cover of area, 0.6 m^2. Three aluminium trays each having basin area, 950 mm x 140 mm made from 20 gauge aluminium sheet are fixed in stepped fashion inside the wooden box. The height of each tray is t60 mm at rear side and 27 mm at the front. Fibre glass insulation is provided at the base of the trays. For collecting the distillate, an aluminium channel is provided at the bottom. An adjustable M.S angle iron stand is provided to change the inclination of the solar still from 3° to 45° from horizontal with an idea of utilising the maximum solar radiation throughout the year. The still is made leak proof by providing rubber gasket beneath the wooden frame of the openable door. The details of the design is given in figure 2.

4. PERFORMANCE

The performance of this solar still was carried out in the spring season, September 1992 in Madras, India. The unit was oriented due south-east in alignment with Sun's transit and its inclination was adjusted to maximum tilt i.e., 45° to the horizontal. Rose flowers, 2 kg of mass mixed with 7.2 kg of water was fed into the three trays equally distributed. The rose water output was measured daily. During the production, the solar radiation on the glass plane of the still was recorded by a pyronometer coupled with an integrator. The performance readings are shown in the table 3.

The efficiency of the solar still was calculated by using the Angstrom formula, $\eta = \frac{243 \times M}{R}$, where

η = the percentage efficiency of the solar still,

M = the quantity of rose water collected in $kg.m^{-2} day^{-1}$.

R = total solar radiation on the glass plane in $MJ.m^{-2}day^{-1}$.

Considering the first reading from the table 3, the rose water collected on 15 Sept.

$$M = \frac{1.385}{1000x0.6} = 2.31x10^{-3} \quad kg.m^{-2}day^{-1}.$$

Solar radiation, $R = 24.57\ MJ.m^{-2}day^{-1}$.

$$\text{Hence, } \eta = \left(\frac{243x2.31x10^{-3}}{24.57}\right)x100 = 22.84\%.$$

From the readings shown in table 3, it is clear that under local conditions the multi-basin tilted solar still supplies 3.662 litres of rose water in one feeding for three days during the spring season and 21.4 % efficient

5. COST ANALYSIS

The materials for fabrication of this solar still are aluminium sheet to make trays, wood, fibre glass insulation, plain glass, mild sheet angle etc. The cost production of this unit workout approximately P 80/- only. The monthly production of rose water is about 37 to 40 litres and it may be more during summer. Considering the cost of rose water in the local market at P 15 per litre, it can be estimated that this device gives an output of rose water worth of P 370/- per unit. If we consider the cost of rose flower petals at P3/- per kg. the cost of roses per month will be P 30/- for ten trials. It is therefore, clear from the above stated estimate the money pay back period of this unit is less than a month.

6. CONCLUSIONS

- The multi-basin, tilted type Solar still is suitable for rose water production in the rural areas and this programme can be included as one of the small scale industries developments of Botswana.
- The efficiency of Solar still is 21.4 % and the input is abundantly available Solar Power.
- The money pay back period of one unit is less than a month.
- The solar still explained in this paper can be easily and successfully fabricated at the cheapest cost
- No extra power is required to heat and boil the rose water.
- No extra power or fuel is required for condensing the rose water vapour.

The solar still is simple to fabricate and it will operate for long period with little attentions

7. REFERENCES

1. Thanvi K.P and Pande P.C. Designing a suitable solar still for production of distilled water in rural areas. Proc. Natural solar energy convention, Bangalore , India . 4.022 ~ 4.026, 1990

2. Bhalotra Y.P.R Climate of Botswana, Part II. Elements of climate and evaporation. Botswana Meteorological Services, Gaborone.

3. Data obtained from Mr. Veg. and Sanitas pvt.Ltd. Gaborone.

FIG. 1 SOLAR STILL FOR ROSE WATER PRODUCTION

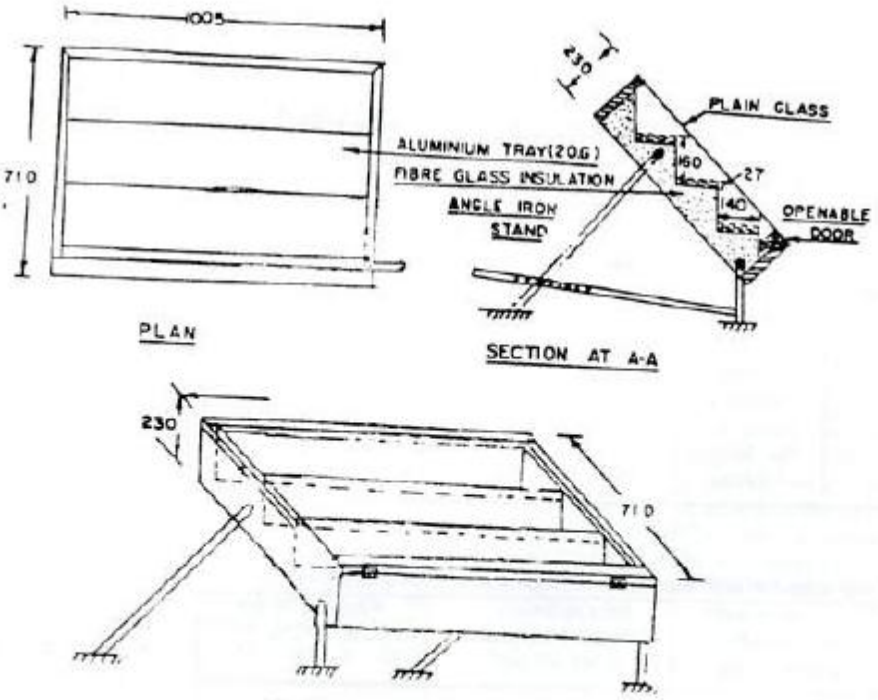

FIG 2 DESIGN DETAILS OF SOLAR STILL FOR ROSE WATER PRODUCTION

ALL DIMENSIONS ARE IN mm

Table 1 Solar power potential of Botswana. Hours of bright sunshine.

Station	Lowest	Mean	Highest
Gaborone	8.3 April	9.0	9.9 Aug.
	(67)	(75)	(88)
Mahalapye	7.9 March	8.5	9.2 Aug
	(65)	(71)	(82)
Kasane	6.2 Dec	8.2	10.0 Sept.
	(47)	(68)	(84)
Francis Town	7.5 Dec.	8.7	9.9 Aug.
	(56)	(73)	(88)
Maun	7.5 Feb.	8.9	10.2 Aug.
	(60)	(74)	(90)
Shakawe	7.1 Jan.	8.6	10.1 Sept.
	(55)	(72)	(85)
Ghanzi	8.2 Jan.	9.2	10.4 Aug.
	(62)	(77)	(92)
Tshane	8.5 Feb.	9.4	9.9 Aug.
	(66)	(78)	(88)
Tsabong	8.8 May	9.7	10.6 Dec.
	(82)	(81)	(78)

Table 2 Calculated average daily total solar radiation on horizontal surfaces in $MJm^{-2}day^{-1}$

Station	Lowest	Mean	Highest
Gaborone	14.6 June	21.1	26.2 Dec.
Mahalapye	16.2 July	20.7	24.7 Dec.
Francis town	16.1 June	21.3	24.1 Jan.
Kasane	16.8 June	20.8	23.9 Sept.
Maun	17.0 June	21.7	23.7 Jan.
Shakawe	17.4 June	21.3	24.0 Sept.
Ghanzi	15.9 June	21.8	24.9 Nov.
Tshane	15.3 June	21.8	26.9 Nov.
Tsabong	14.3 June	22.0	28.4 Dec.
Sebele	14.5 June	19.6	25.5 Dec.

Table 3 Daily output of rose water from the solar still of glass area 0.6 m^2.

Date	rose water output Litres per day	solar radiation on the glass plane MJ m^{-2} day^{-1}	efficiency of the solar still, %
15 Sept	1.385	24.570	22.8
16 Sept	1.202	24.738	19.7
17 Sept	1.075	20.160	21.6