SfB : (53)
UDC : 683.97 : 662.997

BUILDING RESEARCH NOTE

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA

23

SOLAR WATER HEATER—DOMESTIC TYPE

Introduction

Of the many uses of solar energy, water heating is one which has been exploited the most. Solar water heating is economical and attractive too. A reliable and versatile model of solar water heater has been evolved at this Institute. The prototype model is shown in the Photograph Fig. (1). This Research Note describes some of the technical details of the present model.

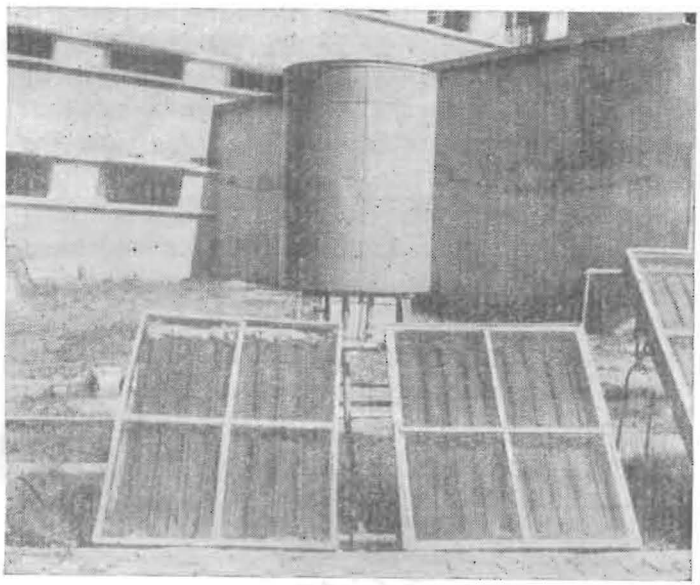

Fig. 1. Prototype Model of Soiar Water Heater

Tropical areas lying between the latitudes 30° North and 30° South and having at least 2000 hours of bright sunshine per year are ideal for utilization of sun's energy. Thus Indian climate is very suitable for such application. Equatorial zones are, however, unsuitable due to excessive humidity.

Principle of Operation

Heat from tne sun is collected by black painted metallic absorber, behind which, runs a grid of G.I. pipes. The heat collected by the absorbers is transfered to the water in the pipes. The hot water in the pipes rises and is stored in a tank. Cold water from the tank flows under gravity to the absorber. Thus the essential components of solar water heater are (a) solar collector. (b) storage tank and (c) the circulation system.

(a) Solar Collector

Solar collectors may be classified as flat and focussing types. Flat plate collectors are simple in operation, easy to fabricate, absorb diffuse aa well as direct solar radiation. They are inexpensive, but tho temperature attained is below the boiling point of water. On the other hand, focussing type devices are quite expensive bulky, and require diurnal and periodical adjustmente. The corrugated type of flat plate collector has the maximum heat exchange efficiency but suffers from many other defects such as bulging under high hydro-static pressure, leaking through the rivets and comparatively shorter life. So tube in plate type of collectors are preferred. These collectors may have soldered or cantact bond. Due to their simplicity, reliability and durability, contact bond type collectors have been chosen. Among these, the simplest is a wrapped and wire wound type.

Absorber Box

Solar collector is encased in an insulated and watertight metal cover box having a single glass sheet cover on the exposed side. Generally, 50 mm thick

glass wool insulation is placed between the cover box and the collector. The insulation reduces heat losses through the rear and the sides of the absorber and thus increases the efficiency of the unit. The glass cover traps high temperature radiation of the sun and acts as a perfect barrier for low temperature re-radiation from the absorber.

Orientation

The whole unit is installed at a clear site. The collectors are mounted at an optimum angle depending on the latitude of the site. Orientation of these collectors should be due south, preferably a few degrees towards the west (so as to take advantage of the warm afternoon sun). The optimum angle of tilt should be latitude plus 15° for winter use and 0.9 the latitude for year round use.

(b) Storage Tank

The size of storage tank depends on the daily demand of hot water and also on the radiation intensity available at the place. In order to store hot water for taking bath in the morning hours, the tank should be insulated well so as to prevent heat losses.

(c) Circulation System

The principle of thermosyphon is utilised to circulate water in this model. Cold water from the bottom of the tank flows down to the absorber and the heated water, because of its low density rises to the top of the tank. This automatic circulation starts a little after sunrise and stops with the sunset. Short and (preferably) insulated connecting pipes are most effective for circulating water. However, the bottom of the tank should be 300 mm above the top of the absorber.

Size of the System

For an average family of five persons, 140 litres of water at a temperature of 50°C is adequate. It is obvious that the collector area depends on the climatic conditions, i.e., radiation intensity, shade-air temperature etc., and also on the operating cond'tions like season, time of use, and the amount of hot water drained. For those who desire to compensate for the intermittant nature of sunshine and overnight cooling, an electric immersion heater with a thermo stat may be fitted at one third the height of the tank.

Fabrication

For fabrication of various components of the soler water heater, material in standard sizes may be chosen from the market so that wastage is reduced to the minimum.

(a) Absorber

Two absorbers each having an area of 1.0 m² are used. The absorber consists of seven numbers of galvanisad iron tubes of 19 mm nominal diameter, fitted at 100 mm centre to centre on to two G.I. pipe headers of 25 mm nominal diameter. A 28 SWG aluminium sheet is wrapped on the pipe network overlapping half the diameter of each pipe (Fig. 2) and then tied with G.I. binding wire to establish good thermal contact between the pipe and the aluminium sheet. Two fine coats of lamp black paint (lamp black dispersed in spirit shellac solution) with an additive (zinc dust), to make the paint more adhesive and thermally stable, are then sprayed on to the absorber plate. This absorber configuration has a plate efficiency factor of 0.94 and is recommen ded on the basis of studies carried out to achieve maximum efficiency per unit cost.

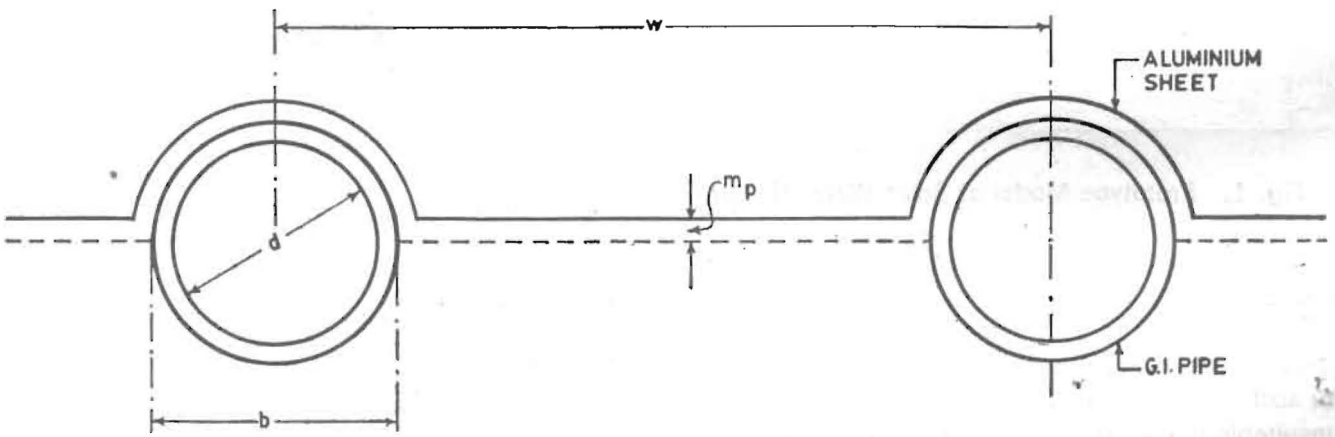

Fig. 2 Aluminium Sheet Wrapped on G.I. Pipe

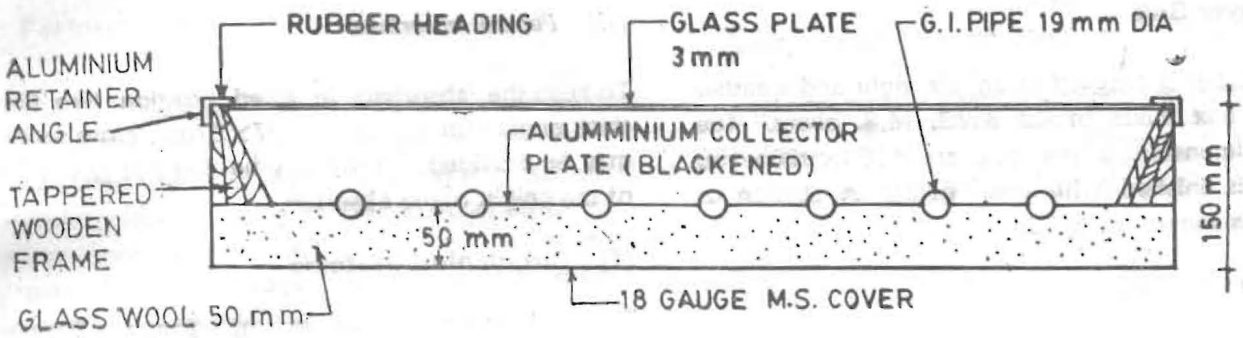

FIG.3 SECTION OF COLLECTOR UNIT

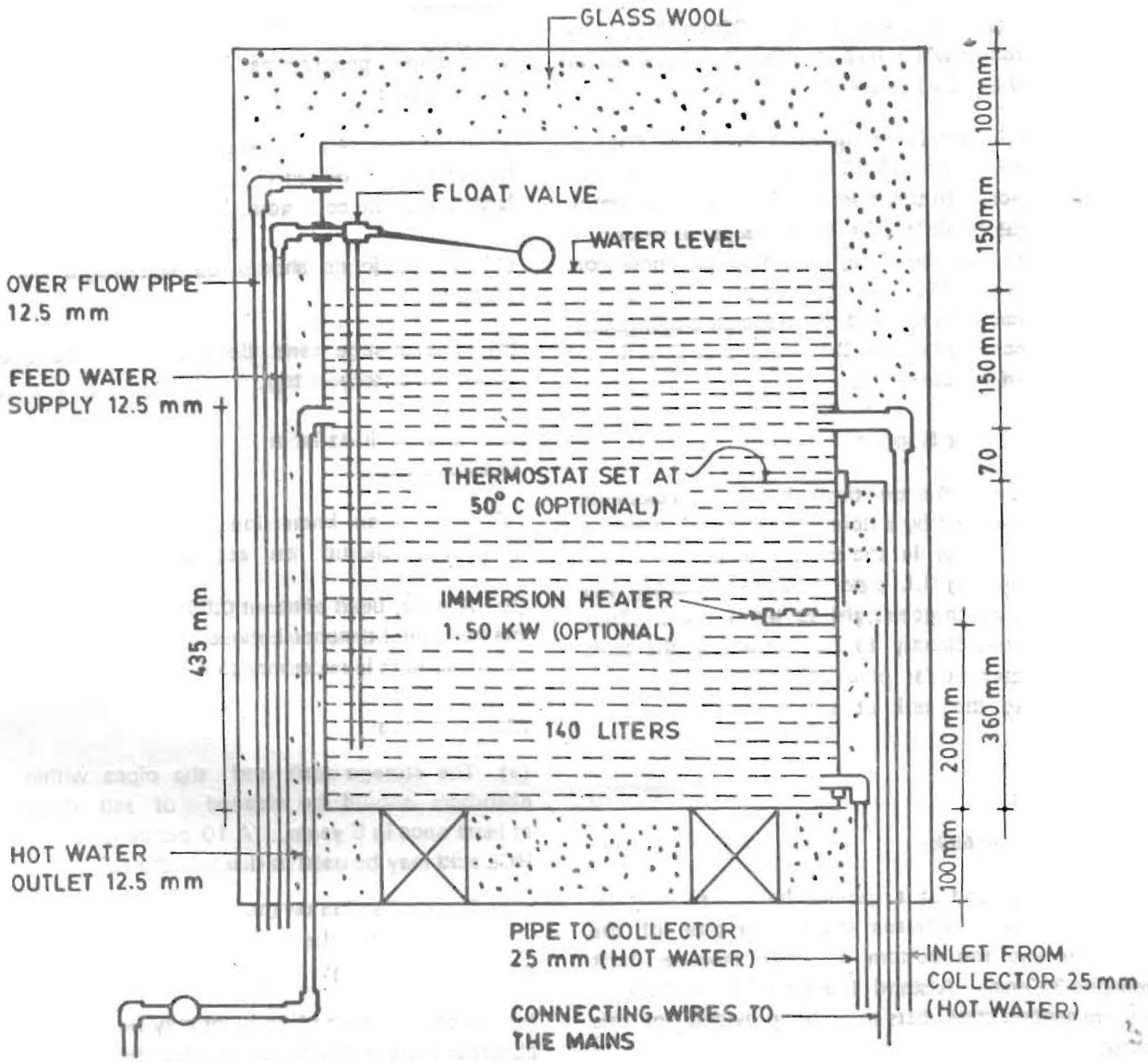

FIG. 4 SECTION OF STORAGE TANK UNIT

(b) Cover Box

The absorber is encased in an air tight and weather resistant box made of 18 SWG, M.S. sheet. The overall dimensions of the box are 1380×920×150 mm. It is finished with grey paint. A section of the box is shown in Fig. 3.

(c) Storage Tank

A cylindrical drum may be used as storage tank. The diameter of the inner tank is 570 mm and height 730 mm as shown in Fig. 4.

The inner tank is insulated by 100mm thick glass wool all around which has another cylindrical cover made of 20 SWG M.S. sheet.

This solar heater is designed to heat 140 litres of water up to about 50-55°c in the afternoons of winter season. In the morning the water temperature is about 45–48°c. On cloudy days or when the load is more than the designed value an immersion heater of 1.5 K.W. may be pressed into service. The immersion heater and its associated thermostat is to be incorporated in the storage tank only at the option of the customer.

(d) Cold Water Supply

Cold water enters the tank through a 12.5mm diameter inlet pipe regulated by a float valve which maintains the level of water in the tank. Beneath the float is fitted a connecting G.I. pipe 12.5mm diameter, the other end of which goes right to the bottom. Thus cold water goes directly to the bottom of the tank. The hot water outlet pipe of 12.5mm diameter is connected to the tank at a level below the float valve.

(e) Stands

(i) For storage tank

The tank is placed at a proper height so that the vertical distance between the header pipe of the absorber and the bottom of inner storage tank remains 300mm. A stand fabricated from 12.5mm square section steel bars may be provided for this purpose.

(ii) For the absorbers

To keep the absorbers in tilted position two 6mm thick angle iron stands of 37×37mm cross section may be provided. They may be fixed at two thirds of the height of the absorber.

(f) Circulaoion Systems

Two galvanised iron pipes of 25mm diameter connect the absorbers to the storage tank, both on cold as well as hot side.

Installation

Following precautions are necessary during installation :

(1) Site selected for installation of the solar water heater should be clear enough so that no shadow is cast over the collectors.

(b) All the joints should be water-tight and leak proof.

(c) The storage tank bottom should be 300mm above the absorbers top.

(d) During installation the absorbers should be kept covered.

(e) Should an immersion heater be used the thermostat should be set at 50°C.

(f) A water head of about 0.60m plus 5 percent of tne horizontal distance between the storage tank and overhead tank is necessary to fill the storage tank.

Maintenance

(a) The storage tank and the pipes within the absorbers should be cleaned of salt deposition at least once in 5 years. A 10 per cent soultion of HCL acid may be used to dissolve the salts.

(b) Dust collection on the absorber glass reduces the efficiency of the system. These should be cleaned periodically.

(c) A coat of lamp black paint may be given on the absorber plate if it is found spoiled by weathering.

Performance

Performance test on a prototype unit were conducted at Roorkee during winter season. It was observed that the maximum mean water temperature during clear days was of the order of 55°C and the next morning it was 48°C. However, it is expected that the solar heater will supply hot water on 80-90 percent of winter days in India.

Economics of Solar Water Heating

Annual distributed cost, assuming different life expectancies of solar water heater and of electric geyser is shown in table 1. This is based on the present price of Rs. 3000.00 for a single unit of tne solar heater.

Table 1
Cost Comparison of Solar and Electric Heating of Water

Life of the unit in years	Annual Distribution Cost (Rs.)				
	Salar heating	Electric heating			
		@ 0.50 I	@ 0 55 I	@ 0.60 I	@ 0.65
3	1509	...	...	...	...
7	1029	...	...	...	...
10	990	...	...	...	...
15	981	1147	1212	1258	1314

It may be sesn that if life of the solar heater is 6 years and power rate is Re. 0.50 per KWH, then the annual distributed cost of solar and electric heating are comparative. If the power rate increases substantially in future or the life expectancy of solar heater is raised, solar energy may become a far more attractive source of hot water supply.

Prepared by : Dr. Prakash Chandra
Published by :
Central Building Research Institute,
Roorkee (U.P.) INDIA
First Printed as B,D. No. 115 : June 1975
Reprinted : May 1984.
Revised : Feb. 1987.

Printed at :
Jain Printing Press, Roorkee

Copies : 3000

SPECIAL PUBLICATIONS**

Sl. No.	Title of Publication	Cost	Source
1.	Seminar on Taj Mahal.	Rs. 20/-	Director, CBRI Roorkee
2.	Your Own House–An Economical Proposal.	Rs. 30/-	—do—
3.	Building Detailing & Fixtures-Revised Edition, 1986.	Rs. 10/-	—do—
4.	Live Better with Mud and Thatch–Improved Rural Houses,	Rs. 40/-	—do—
5.	Workshop on corrosion of building materials in fertilizer & Chemical Industries.	Rs. 50/-	—do—
6.	Feed-back, Primary Schools—a case study.	Gratis	—do—
7.	Seminar on design Concept of Built environment for Physically Handicapped.	—do—	—do—
8.	Lectures on Housing	—do—	—do—
9.	International Conference on Low Cost Housing for Developing Countries.	Rs. 650/-	M/s. Sarita Prakashan, 175, Nauchandi Grounds, Meerut (U.P.)
10.	Three Decades of Building Research in India.	Rs. 200/-	—do—
11.	Proceedings International Workshop on Energy Conservation in Buildings.	Rs. 400/-	—do—
12.	Handbook on under-reamed and Bored Compaction Piles.	Rs. 30/-	M/s. G.S. Jain & Associate 48/207, Civil Lines, Roorkee-247 667
13.	Building Materials from Indian fly ashes.	Rs. 25/-	—do—
14.	Advances in Building Materials and Construction.	Rs. 45/-	M/s. Dialogue Publicaton R–686, New Rajendra Nagar New Delhi–110060
15.	School Buildings for Afro-Asian Countries–Proceedings of the International Symposium March 12–14, 1986.	Rs. 270/-	M/s. Tata McGraw–Hill Publishing Company Limited, 12/4, Asaf Ali Road, New Delhi.

**For shipment, outside India, please ask for invoice.

Please address your queries to Director, C. B. R. I., Roorkee — 247 667