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Applications of a low cost pipe type Solar Water Heater

M. Chandra, R. Ganguly, J. S. Puri *

Abstract

A low cost pipe type solar water heater of 100 litres capacity was designed and developed at Central Building Research Institute, Roorkee. This is a built in storage type solar water heater in which eight numbers of large diameter pipes of 12.5 litres capacity each perform the dual function of absorbing solar energy and storing the heated water. The unit has been tested under different operating conditions and is found to be quite efficient if the hot water is utilized during daytime. The hot water can also be stored in a separate insulated storage tank for overnignt use. The feasibility of this solar water heater for coupling with electric geyser as a preheater has also been investigated and saving in electrical energy determined under winter conditions. This unit can also be easily adopted for use in rural areas, particularly for preparing the slurry for gobar gas plants in winters when their efficiency is low due to low slurry temperatures. The possibility of using this solar water heater for different purposes and technical data on its performance are reported here.

Introduction

Solar water heaters operating either on thermosyphonic circulation or forced circulation of water and having a separate insulated storage tank are now technically and economically viable and are commercially available for domestic and industrial applications (1,2,3,4,5). However, not much attention has been paid to the development of low cost solar water heater which can become popular in low income group starta of our society in urban areas as also in villages and can be used in a number of ways. A low cost pipe type solar water heater of this type was designed and developed at Central Building Research Institute, Roorkee and tested for its technical soundness (6).

This is a built in storage type solar water heater in which eight large diameter pipes perform the dual function of absorbing solar energy and storing the heated water. This solar water heater works very efficiently if the hot water is utilized during the afternoon hours or is withdrawn in small quantities spread over the daytime. If no water is withdrawn during the daytime, the maximum temperature of the water is of the order of 67–70° at about 15-00 hrs. The hot water can also be stored in a separate insulated storage tank at this time for overnight use. The feasibility of this solar water heater for coupling with electric geyser has been investigated and saving in electrical energy under the normal winter condition prevalent in north India. The saving is of the order of 50 percent. This is particularly important in view of frequent load shedding now a days. The possibility of adopting this unit in rural areas has also been discussed particularly for preparing the slurry of gobar gas plants in winters when the efficiency of these plants is reported to be substantially reduced due to reduced slurry temperatures.

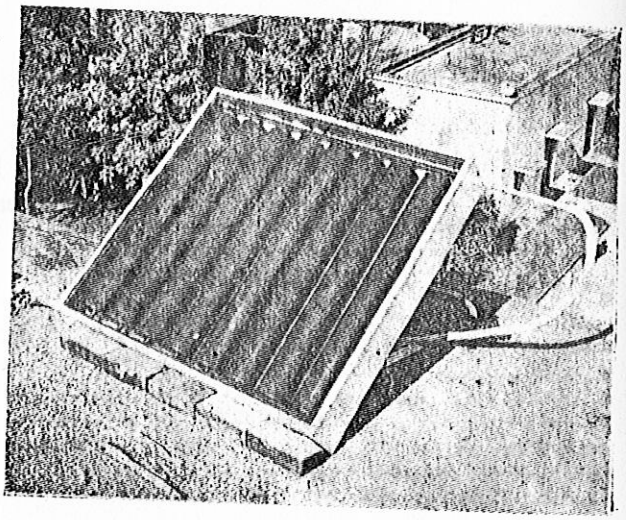

Fig 1 : Photograph of low cost pipe type Solar Water Heater

Design and Construction

This type of solar water heater is shown in Fig. 1. It essentially consists of eight number of pipes fabricated from 10 SWG galvanized iron sheets. The total storage capacity of the pipes is 100 litres. Each of the pipes is 1 m long and has an inner diameter of 12.5 cm. Each of the two ends of pipes are closed by two circular G. I. dises having central holes of 1.25 cm for fixing the

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heaters. All of the pipes are placed close together horizontally with a spacing of 2.5 cm in between and welded to two G. I. pipe headers at both the ends. The two headers are G. I. pipes of length 1.27 m and 1.9 cm diameter. Eight short pieces of G. I. pipes which are 3.0 cm long and 1.25 cm in diameter are welded to header pipes perpendicularly having centre to centre distance of 15.0 cm. The exposed surface of the pipes is coated matt black. The assembly is then placed on 5.0 cm thick layer of insulating material placed in a trough of M.S. or A.C. Sheet. The front of the trough is covered with a 4 mm thick glass and aluminium angles provided at the edges to hold the glass sheet in position. This complete unit is then mounted at an angle of 'latitude +15' degree from the horizontal facing due south which is the optimum orientation for solar energy collection by flat plate collectors in winter (7). For summer and year round solar energy collection the optimum orientations are 'latitude-15' and '0.9 x latitude' degrees, respectively. In view of this it is always advisable to use an adjustable stand for the collector so that the angle of inclination can be changed according to the season. This type of stand can be easily fabricated.

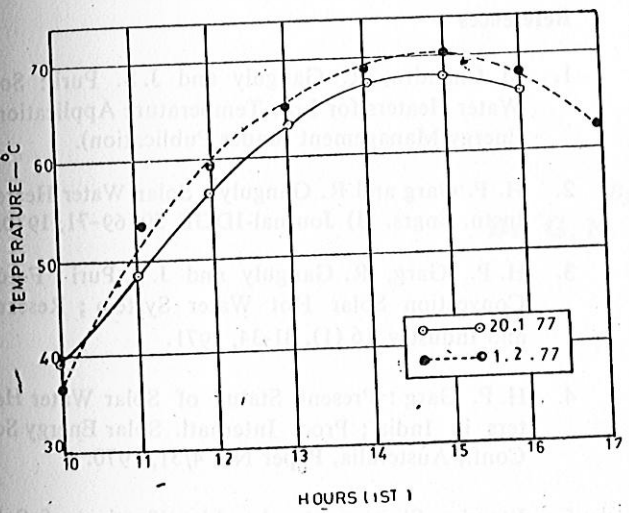

Fig. 2 : Hour wise temperature variation of water at the gutlet of the Heater.

Performance of the Heater

The performace of the heater was tested under different operating conditions (6). It is found that the maximum temperature of the water is attained at about 15-00 hrs. when no water has been withdrawn earlier. At this time temperature has been found to vary from 65° C to 70°C depending upon the meteorological conditions. The variation of water temperature at the outlet from the heater recorded at different hours on two different typical days is shown in Fig. 2. In actual domestic situations the hot water can be withdrawn from about 10-00 hrs. at the rate of 1 bucket (15 litres) hourly or at the rate of two buckets at two hourly intervals. In such cases the average temperature of water withdrawn may vary from about 31°C in the morning to about 58°C in the afternoon hours depending upon the nature of withdrawls as shown in Fig. 3. The efficiency of this solar water henter was calculated for some typical winter days and was found to be more than 60 percent.

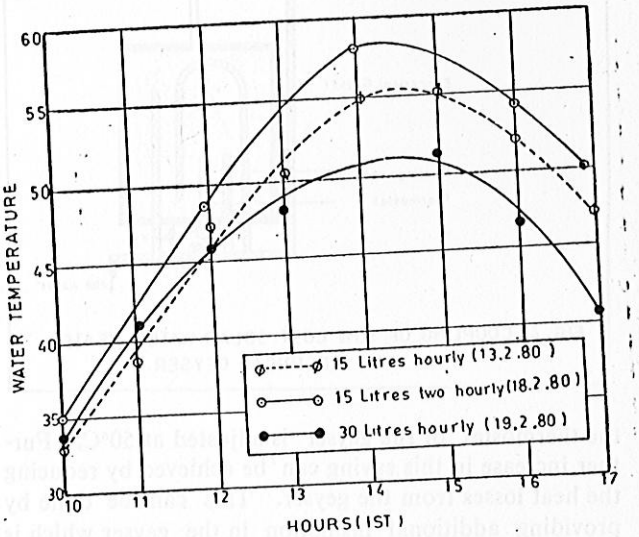

Fig. 3 : Temperature of Water Drawn in case of Regular Withdrawls.

Coupling of the Heater with the Electric Geyser

Many people who already have electric geyser are often desirous of having solar water heater in addition to the geyser. In such circumstances this pipe type solar water heater coupled with the geyser proves to be an useful proposition. This combined system conserves electrical energy and provides hot water even during the load shedding period which is quite often now a days. We have carried out feasibility studies on this aspect. The connections of the heater to the geyser are made as shown in Fig. 4. The hot water can be drawn directly from the solar water heater if no operation of the geyser is desired particularly outside the winter period for use in kitchen or bathroom for washing purposes. This is done by opening the gate-valve VI. However, in winter the water may be withdrawn through the geyser intermittently during daytime and at about 15-00 hrs. The water from the heater should be fully transferred to the geyser. This operation is accomplished by opening the gate valve V2. At this time the water in the geyser is about 40°C which is stored for the morning use. During night the cooling of the water takes place but still it provides a saving of about 50 percent in the electrical power consumption when

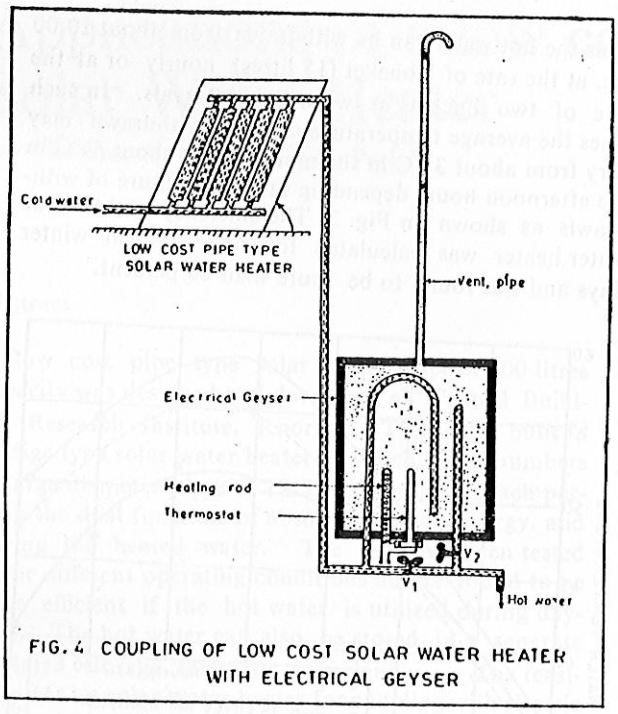

FIG. 4 COUPLING OF LOW COST SOLAR WATER HEATER WITH ELECTRICAL GEYSER

the thermostat of the geyser is adjusted at 50°C. Further increase in this saving can be achieved by reducing the heat losses from the geyser. This can be done by providing additional insulation in the geyser which is inadequate for night storage. Where no electricity is available in the morning the electric heater may be switched on in the night before going to bed. This will raise the water temperature to the level at which the thermostat is set and can be used in the morning. For the purpose of this coupling, a smaller unit of about 60 litres capacity can be used.

Other Applications

This unit can prove useful for low income group families which cannot afford the high cost of domestic type solar water heater. The present cost of domestic type solar water heater designed at this Institute and licensed to five firms in the country through NRDC is estimated to be between Rs. 2,500/- to Rs. 3,000/- whereas that of the low cost unit described here is about Rs. 800/- to 900/-. This unit can also find application in villages where hot water is normally needed intermittently during daytime around noon. If the water is to be used in the morning and no separate storage tank is provided, an insulated cover for the solar water can be fabricated which is put on the heater in the evening. Despite losses this maintains appreciable hot water in the collector itself till the morning. In areas where no cold water supply line exists the system can be provided with a small tank of about 50 litres capacity for supplying the cold water to the collector. This should be placed on a stand or some other in-expensive structure near the solar water heater at a height slightly greater than its upper header. In villages the number of gobar gas plants is at increase. The functioning of these plants is normally retarded in winter due to reduced slurry temperature. To enhance the gas production in cold season the hot water from this heater can be economically utilized for preparing the slurry of these plants.

Conclusions

The low cost solar water heater described here is technically sound and economically viable. Its integration in low income group housing schemes in cities and popularization in rural areas is advocated. It is also quite suitable as a pre heater to the geyser. The efficiency is found to be more than sixty percent.

Acknowledgement

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