



**NBRRI REPORT
NO. 5**

**SOLAR WATER HEATERS FOR DOMESTIC USE IN
URBAN AND RURAL NIGERIA**

NIGERIAN BUILDING AND ROAD RESEARCH INSTITUTE

FOREWORD

One of the obvious applications of solar energy is to heat water. The development of a solar water heater by the Nigerian Building and Road Research Institute is described in this report. The report provides details of the design, fabrication and performance of the solar water heater.

The special feature of this development is that the fabrication was made from materials available locally and can be easily replicated by individuals and agencies interested in the use of solar energy in urban and rural areas of Nigeria.

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SUMMARY

This report describes the design and construction details of two different types of solar water heaters suitable for application in urban and rural areas. The natural convection type solar water heater designed to heat 150 litres of water up to 60°C by 4.00 p.m. daily essentially consists of two flat plate solar energy collectors and an insulated storage tank for storing the hot water for use in the following morning. The flat plate collectors are tube-in-plate type and can be constructed with locally available materials and local skilled labour. The second type of solar water heater known as built-in-storage type solar water heater consists mainly of eight large diameter pipes which perform the dual function of absorbing solar energy and storing the heated water in them. Since the collector itself acts as a storage in this unit, water cannot be stored for use till the following morning but should be used same day by 10.00 p.m. The temperature attained in this solar water heater is higher than that of the first one.

1. INTRODUCTION

Of the many uses of solar energy in buildings, water heating is the one process which has been exploited the most. It is now being accepted as a practical way of providing domestic hot water in Japan, Australia, Israel, U.S.A., India, France and some countries in Latin America. The solar installation has usually a higher capital cost as compared to an electrical system but it is more than compensated for by savings in running and maintenance costs. At NBRRI, two different types of solar water heaters, known as natural convection type and built-in-storage type, respectively have been constructed. The units were constructed with locally available materials and with local skilled labour. Their performance under diverse weather conditions has been found satisfactory. The natural convection type solar water heater seems to be more suitable for application in urban areas particularly in low cost houses whereas the second unit, namely built-in-storage type is particularly ideal for rural areas.

2.1. DESIGN AND CONSTRUCTION FEATURES OF NATURAL CONVECTION SOLAR WATER HEATER

Essentially, a natural convection type solar hot water system consists of three major components, namely:

- (i) The solar collector.
- (ii) The storage tank, and
- (iii) The circulation system.

Various factors affect the design of these components and must be taken into account for making an efficient and durable solar water heater.

2.1.1. The Solar Energy Collector

Solar energy is transmitted from the sun through space to the earth as electromagnetic radiation. It must be converted to heat before it can be used in practical heating and cooling systems. The devices that are used to convert sun's radiation to heat are called solar collectors. In the recent past, about 20 solar collector

designs have been demonstrated as functional. These designs are separated into two categories: the concentrating type and the non-concentrating type.

In the concentrating collectors, sun rays are reflected by a shaped mirror or some other reflecting surface called aperture on to an absorber. The area of the absorber is much smaller than the aperture area. This reduces the heat losses and temperatures of the order of several hundred degrees or even up to 1,000 °C or more can be obtained. But concentrators can use only direct radiation and also they must track the sun path which is rather a costly affair. Non-concentrating or flat plate collectors intercept solar radiation on a metal absorber plate from which heat is transferred and used for the required purpose. Temperatures up to about 100°C above ambient temperature can be obtained if they are well designed. Their advantages over focussing collectors are as follows

- they absorb direct, diffuse as well as reflected radiation.
- they do not require any sun path following arrangement.
- they can be easily fabricated.
- they are of low cost.

In view of the above considerations, flat plate collectors are the most preferred means of getting low grade heat from the sun's energy and therefore are normally used for domestic water heating. There can be several types of absorbers in the flat plate collectors like corrugated type, soldered-bond type, contact-bond type etc. In the NBRRI type solar water heater, wire-wound contact-bond type absorber, which is easy to make with locally available materials and local skilled labour has been used. A cross-sectional view of this type of solar collector is shown in Figure 1. More technical details about the functioning of this collector are given in the Appendix.