

PN-ABD 567
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3. E-31

DESIGN, CONSTRUCTION AND INSTALLATION OF TWO
THERMOSYPHON SOLAR WATER HEATERS FOR PUBLIC
DEMONSTRATION

SIXTH INTERIM REPORT

SUBMITTED TO

AGENCY FOR INTERNATIONAL DEVELOPMENT, WASHINGTON D.C.

BY

S.N.S. SUDHANSHU, PRINCIPAL INVESTIGATOR
MAHENDRA MORANG ADARSHA CAMPUS, BIRATNAGAR.

NEPAL

ON

30 TH AUGUST 1987

The following works have been done and are going on during this period;

(a) Construction of Distillation unit has been started

(b) Construction of 200litre capacity Tank has been started in full swing.

(c) Consultation

(d) Demonstration of the fabrication process to the students

(e) Informations collection

a. CONSTRUCTION OF DISTILLATION UNIT :

The construction of the distillation unit has been started. Since we have selected a design which is not generally in use, therefore we have decided to test its performance after when it is constructed before coupling with the solar water heater.

First we started a prototype of this unit so that we may test it according to our convenience. The test will indicate the necessary changes to be done. Nearly 75% of work of the prototype has been completed and we hope to complete it in the forthcoming trimester and to test it also. The problem of obtaining the required materials of specific dimension and quality has again cropped up.

(2)

b. FABRICATION OF THE TANK OF 200Ltr. CAPACITY.

Fabrication of the Tank of the 200Ltr. capacity

has been started. This tank will be associated with the collector of parallel pipe type riser tubes.

There will be two collectors having 8 riser tubes.

The 200 litre storage Tank under construction has been shown in the figure (). The hot water storage Tank has been constructed by two co-axial cylindrical walls. The technical details of the Tank has been give already. The inner wall being 24 SWG galvenised iron sheet. The annular spacing between the walls is completely filled with insulating materials. We decided to use 25% glass wool, 75% local insulating materials. The tank has two inlets, one for the hot water coming from the collector and other one with the provision of float valve. A long air cavity insulated tube that will allow the cold water from mains to run right to the bottom of the Tank without mixing with hot water. This will maintain the temperature gadiation in the hot water storage Tank. The provision of the float valve will make the storage Tank non- pressure type. A long plastic rod will be place d in the watercolumn of the Tank to

(3)

support the thermocouple junctions at different depths of the tank. This will later on help to record the temperature gradation of the storage Tank. The temperature measurement will be done by means of the potentiometre. The thermocouple which will be used is general type copper-constantan thermocouple.

Nearly 60% of the fabrication has been completed in this period.

c. CONSULTATION:

We have invited to Dr. M.S Sodha from Indian Institute of Technology , NewDelhi to come down to this place and to supervise our work. He has very kindly accepted our request. we are planning to bring him very soon as soon as our fabrication is completed. Dr.Sodha will also supervise the installation works if possible.

d. DEMONSTRATION OF THE FABRICATION WORKS:

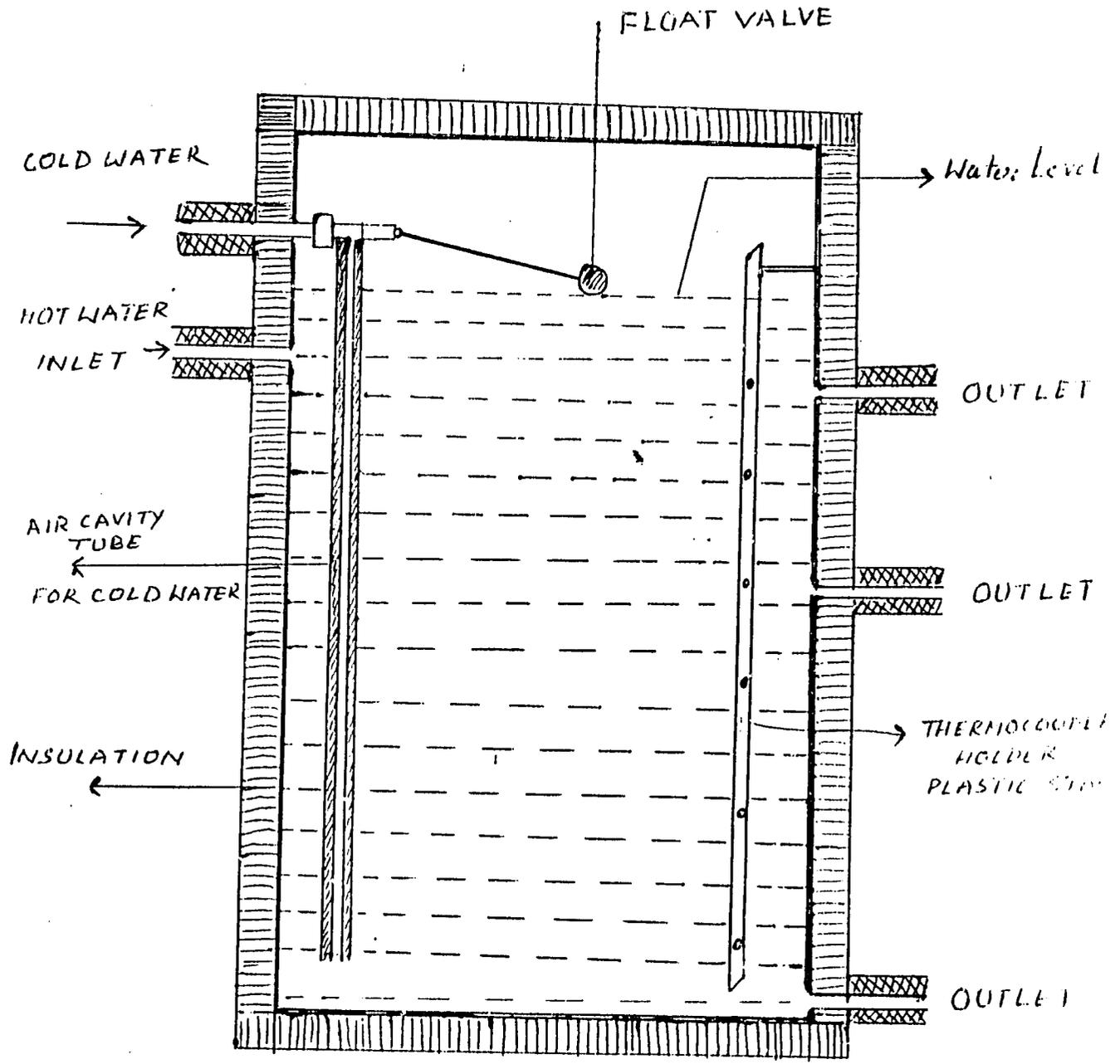
The whole fabrication works have been demonstrated to the students of various discipline.

FINANCE:

Total expenditure is NRS. 44,000 only.

REMRKS:

There is no problem for any technical work. Despite our best effort the release of trimester fund is not regular due to some government official procedure.



[LONGITUDINAL SECTION OF STORAGE TANK]

NOT TO THE SCALE

3. E-31

DESIGN, CONSTRUCTION AND INSTALLATION OF TWO
THERMOSYPHON SOLAR WATER HEATER FOR PUBLIC
DEMONSTRATION

FIFTH INTERIM REPORT

SUBMITTED TO

AGENCY FOR INTERNATIONAL DEVELOPMENT, WASHINGTON, D.C.

BY

S. N. S. SUDHANSHU, PRINCIPAL INVESTIGATOR
MAHENDRA MORANG ADARSHA CAMPUS, BIRATNAGAR.
NEPAL

ON

28 TH FEBRUARY 1987

MAR 29 1989

The following works have been done during this period :

- (a) Design of distillation unit to be augmented with Solar water heater for the use of the Department of Chemistry.
- (b) Fabrication of hot water storage tank (120Ltr.)
- (c) Test of the performance of hot water storage tank.
- (d) Construction of the collector for 120 litre capacity.
- (e) Information collection.

(a) DESIGN OF DISTILLATION UNIT:

A distillation unit has been designed to augment with the 120 liter capacity SWH to provide approximately 2.5 litre distilled water for the use of the students of Intermediate level science for their general chemistry practical works in the laboratory. To meet this requirement solar water heater will be used and installed directly on the roof of the Chemistry laboratory.

DESCRIPTION OF DISTILLATION UNIT:

This is box type unit having a screen of glass, tilted at an angle of 38° (Latitude $+10^{\circ}$). The inside view of the unit has been shown in the fig. ().

(2)

Inside the box there are three steps to slow down the hot water fall entering through the inlet holes from hot water outlet of the solar ~~hot~~ water heater. The flow rate of the water can be regulated with the help of the stopper. The steps are covered with the 2cm, thick, clean cotton or jute covering, so that the hot water is absorbed by this cotton or jute and evaporation may take place immediately. Excess of water accumulated at the last step will be syphoned out by the syphon provided.

A vapour collector is provided right ~~below~~ below and at the end of third step to collect distilled water droplets after condensing and seeping downward due to the inclination of the roof of the box. Distilled water collected will be taken out through out let tube provided at the end of the vapour collector. To help increase the rate of evaporation air inlet for cold air and out let for hot air may be provided.

Technical details are given below:

(3)

TECHNICAL DETAILS:

Height of the vapour collector trough(CD)	: 15cm
Area of the collector trough	: 1400cm ²
Depth of the Vapour trough	: 4cm.
Area of the glass cover screen	: 2280 cm ²
Height of the rear side (AB)	: 50 cm.
Area of the each step(evaporator)	: 360 cm ²
Inclination of the glass cover screenθ	: 30 ⁰
Diameter of the siphon tube	: 4cm.
Diameter of the vapour outlet tube	: 6cm.
Cover metallic sheet	: 22SWG galval
Area of the base of the distillation	: 1800 cm ²
Insulation materials	: Wool

The whole arrangement of the SWH equipped with the distillation unit has been shown in Fig()

FABRICATION OF TANK(20 Litre)CAPACITY:

----- The technical details of the Tank of capacity 20Litres has been reported already. The fabrication work have been just started. Only some primary works have been done for the Tank. This will ~~eventually~~ be installed in front of the Campus main Building.

(4)

CONSTRUCTION OF COLLECTOR FOR 120LTR. CAPACITY:

The materials for the collectors were purchased. The materials for required specifications were not available in the market therefore we had to wait for for the same for quite a good time. The diagram of the collectors are shown in the fig().

Technical details of the Collector:

Particulars	Specification
Riser tubes	: 1.80 m long, 0.025m diameter : galvenised Iron pipe
Cover Sheet	: 24 SWG galvenised Iron sheet : Painted black from inside by : blackboard paint.
Glass screen	: 3mm thick window glass
Header pipe	: 0.013 diameter ,Galv. Iron pipe
Circulation pipe	: 1.39cm Diameter Galv. Iron pipe
Collector area	: 1.425 m ²

(5)

The galvenised riser tubes are brazed longitudinally at 0.10m pitch across a 24 SWG Iron sheet (190X75) cm. The riser joined at the ends by 0.03m diameter galvenised Iron headers.

The sheet will be painted black with black board paint and are placed inside a metal box made of 0.7mm thick galvenised Ironsheet and are insulated at the bottom and sides with insulation of thickness 6cm. The top of the box has been glazed with a 3mm thick window glass cover leaving an air spacing of 8 cm. from the absorber plate. The collector will be inclined at an angle of 39° from the horizontal and will face due south.

The complete works have been done only some minor finicing works are still to be done.

INFORMATION COLLECTION:

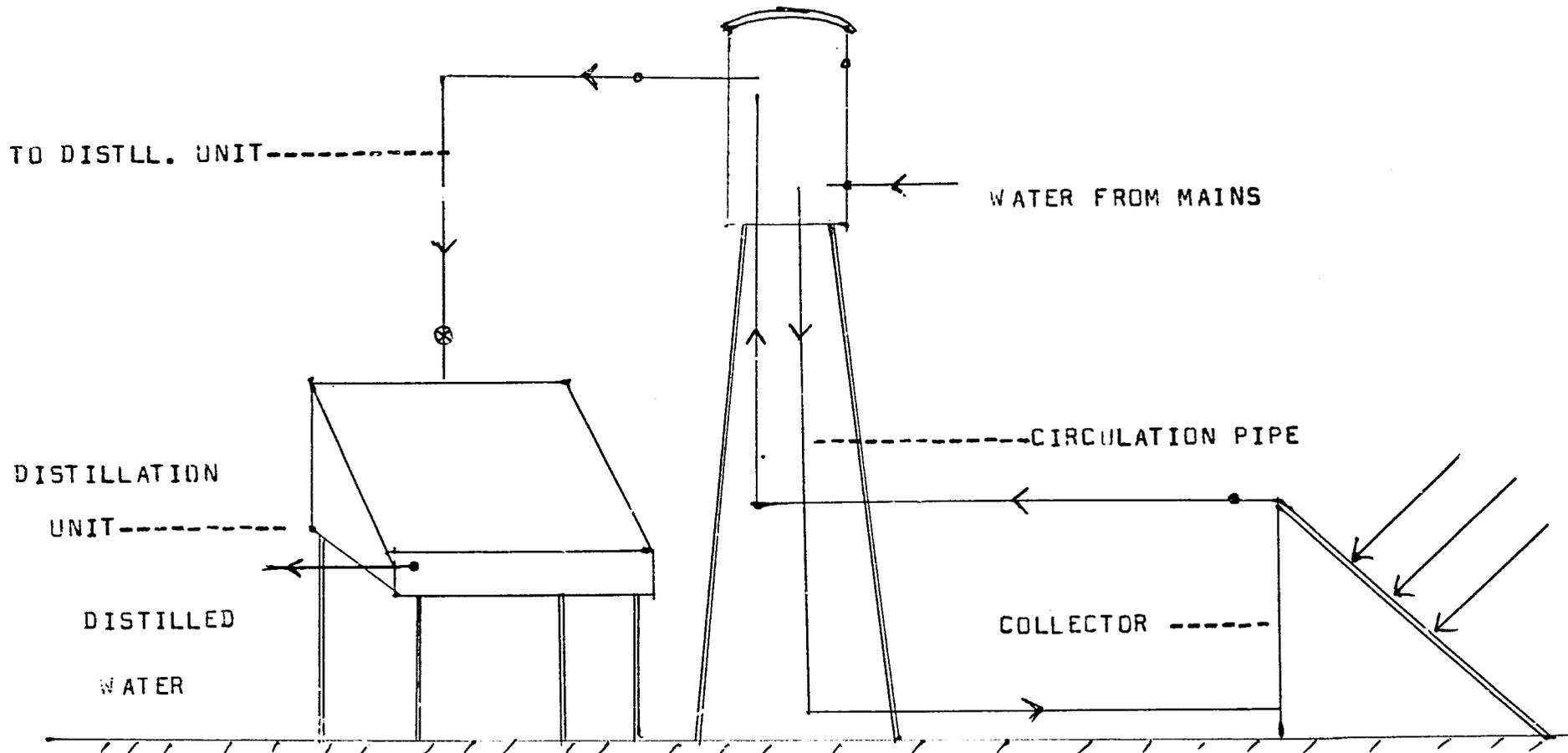
The works of collecting informations are still going on and we have been able to collect some information regarding fabrication of collectors from BYS Kathmandu

FINANCE:

EXPENDITURE: NRs. 44,000. Only.

REMARKS:

The major problem of the project have been solved and the work is going on smoothly. We hope to complete the work without any trouble.



SCHEMATIC DIAGRAM OF SWH AND DISTILLATION UNIT

DESIGN, CONSTRUCTION AND INSTALLATION OF TWO
THERMOSYPHON SOLAR WATER HEATERS FOR PUBLIC
DEMONSTRATION (3E-31)

FOURTH INTERIM REPORT

SUBMITTED TO AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D.O.

BY

S.N.S. SUDHANSHU, PRINCIPAL INVESTIGATOR
MAHENDRA HONANG ADARSH, A CAMPUS, BIRAT NAGAR
NEPAL

ON

30TH AUGUST 1986.

The following works have been done during this period;

(a) Collection of materials

(b) Fabrication of SWH for the use of the students of
for distilled water has been started

(c) The study of local available SWH

(d) Consultation for distillation unit.

(e) Demonstration of the fabrication process to the students of I.Sc. and U.Sc level.

COLLECTION OF MATERIALS:

We collected some basic fabricating materials from the local market. Contact have been made to achieve the required materials in time.

FABRICATION OF SWH:

The fabrication of SWH has been started. The design has been already selected. We first started the fabrication of the Tank. The Tank is of non pressure type. The ratio between height and diameter of the Tank has been kept 1:1.6 (85cm Ht and 53cm diameter). The inner tank wall was made by 26 Gauge Iron sheet and the outer wall by 24 Gauge galvanized iron sheet. The ratio of height to diameter of the outer wall is 1:1.37.

The gaps between inner and outer wall were kept 10cm, approximately for insulation. Since the use of the glass wool was found to be more expensive, we selected some local insulators like used wool, cotton, saw dust etc. for insulation.

(2)

The 11 cm thick layer of cotton, jute, wool etc. will be prepared together with saw dust and will be inserted between the two walls of the Tank. Care was taken to keep the shape of the inner wall to keep intact while inserting the insulators, in between two walls.

Perfect holes were drilled at the bottom of the Tank to augment the circulation pipes to lower and upper headers, of the collectors.

Similarly one hole for hot water outlet was drilled at the height of 55cm. from the bottom of the Tank. This outlet later on will be augmented with distillation unit for having quicker distillation process.

Similarly two holes were drilled at the height of 55cm and 25 cm from the bottom of the Tank to provide an arrangement for the measurement of the temperature of the water ~~egf~~ of the Tank, externally with the help of laboratory thermometers. The arrangements for the measurement of the temperature is shown in the figure ().

During the construction of the Tank we took care of keeping the measurement exact. While joining the two end of the sheet of the Tank soldering was done neatly and excess of metal was removed perfectly.

It has been verified by SATA that this type of storage Tank can with stand a pressure of $2\text{Kg}/\text{cm}^2$.

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TEST OF THE PERFORMANCE OF THE TANK:

The test for the performance of the Tank is necessary. We carried a rough experiment for the performance of the Tank by recording its temperature at different intervals of time. There is no problem of temperature loss at day time because the loss of temperature is not very high, but the main problem comes at night time. Since we didn't make any particular arrangement for night loss. The record of temperature shows that the efficiency of the Tank shall increase if the insulation material quality is increased.

STUDY OF LOCAL SWH:

We recorded the performance of the local SWH. We tried to find out the night loss of local SWH. We also recorded the temperature of the tank. There is no provision for the measurement of the temperature in this SWH externally.

The data of records of Solar Radiation has been achieved.

AVERAGE SOLAR RADIATION IN TERAI (PLAIN) REGION

Solar radiation (kWh/Day)

Monthly average at Nepalgunj and Biratnagar (1976)

Month	Terai	Hills	Mean Radiation (kWh/m ² /day)
Jan			
Feb			
Mar			
Apr			
May			
Jun			
Jul			
Aug			
Sep			
Oct			
Nov			
Dec			

(4)

AVERAGE SOLAR RADIATION IN TERAI REGION

Solar radiation (Ly/Day)

Monthly average of Nepal gunj and Birat nagar(1976)

Month	: Terai	: Hills	: Mean radiation(Kwh/m ² /day)
Jan	: 341	: 314	: 4.0
Feb	: 397	: 365	: 4.6
March	: 445	: 426	: 5.25.2
Apr	: 459	: 451	: 5.3
May	: 537	: 457	: 6.2
June	: 468	: 411	: 5.4
Jul	: 468	: 408	: 5.7
Aug	: 438	: 389	: 5.1
Sep	: 431	: 375	: 5.0
Oct	: 464	: 403	: 5.4
Nov.	: 378	: 337	: 4.4
Dec.	: 309	: 315	: 3.6

Monthly average range : 430 ; 330			
: 228 ; 143			

(5)

DISTILLATION UNIT

A distillation unit to be augmented with this SWH has been proposed. This unit will provide nearly 2Ltrs distilled water for the use of the students of Chemistry for their practical works.

A special type of distillation unit will be designed to work with this solar water heater. This design will be finalised in next trimester of the project.

DEMONSTRATION OF FABRICATION :

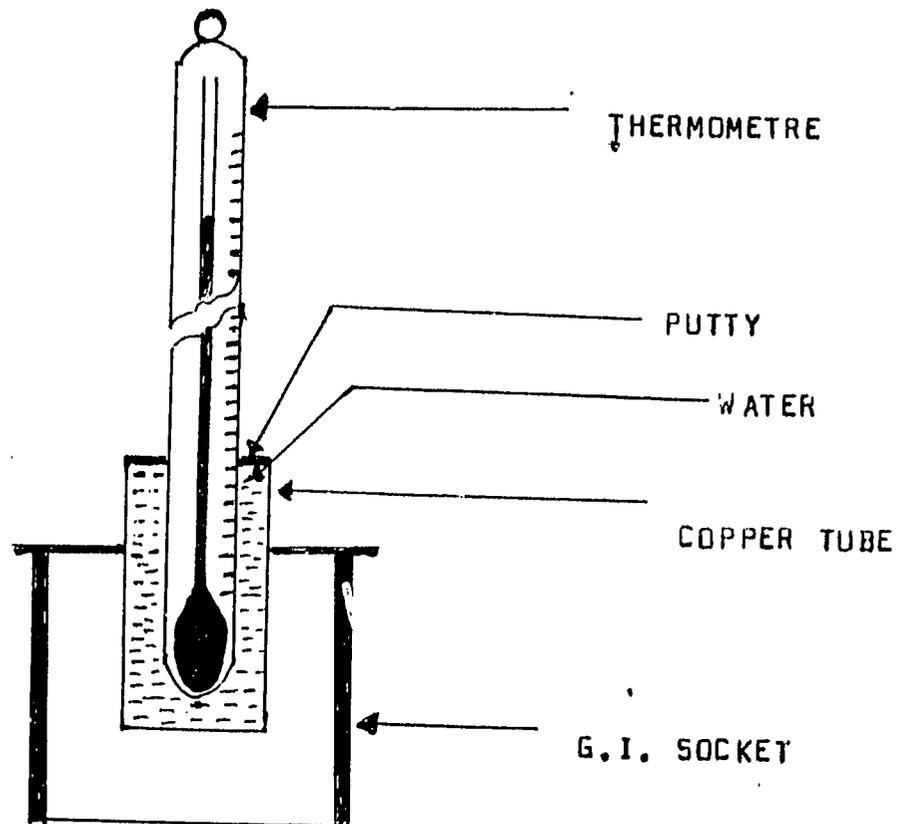
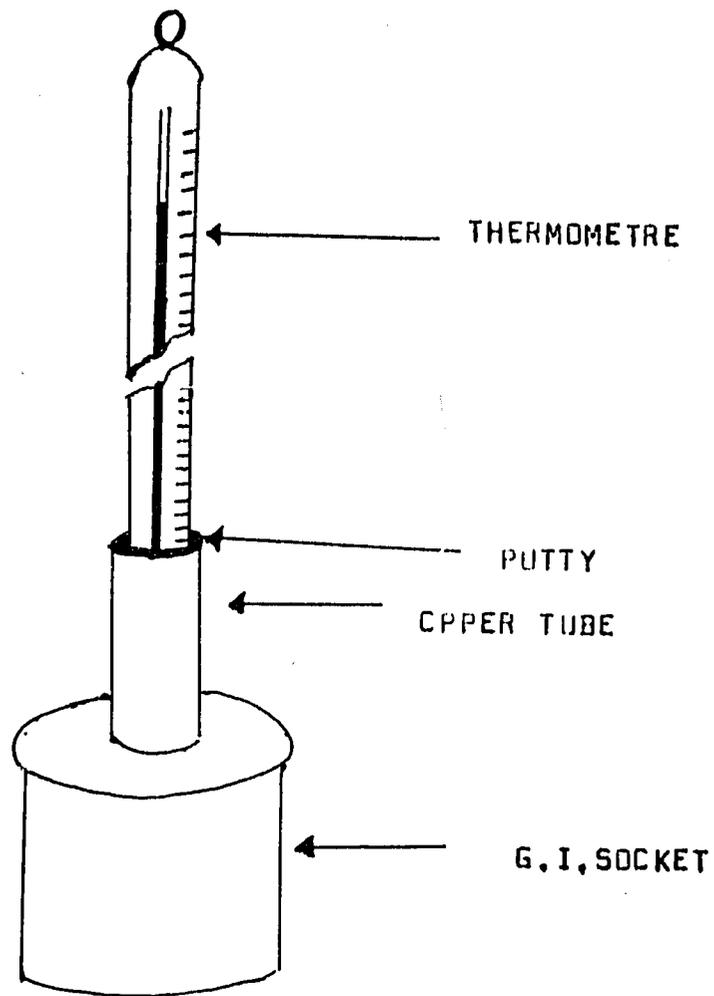
Students of the I.Sc and H.Sc. level are shown the fabrication process of the SWH and they were told the principle of the hot water storage Tank.

FINANCE:

Expenditure Rs. 38,000;Only.

REMARKS:

The fabrication has been started smoothly despite the difficulties of getting materials and other necessary things in proper time. The collection of materials are time consuming. Now the workshop is also equipped to carry out the job smoothly.



SCHEMATIC REPRESENTATION OF THE PROVISION FOR TEMP. MEASUREMENT ON THE HEADER ENDS

3E-31

DESIGN, CONSTRUCTION AND INSTALLATION OF TWO
THERMOSYPHON SOLAR WATER HEATERS FOR PUBLIC
DEMONSTRATION(3E-31)

THIRD INTERIM REPORT (1986)

SUBMITTED TO
AGENCY FOR INTERNATIONAL DEVELOPMENT

WASHINGTON D. C.

BY

S. N. S. SUDHANSHU, PRINCIPAL INVESTIGATOR
MAHENDRA MORANG ADARSHA CAMPUS, BIRA TNAGAR
(NEPAL)

ON

28th FEBRUARY, *1986

MAR 29 1989

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The following works have been done during this period:

- i) Designing second solar water heater for public demonstration
- ii) Collection of fabrication materials
- iii) Fabrication of a model and demonstration
- iv) Training and fabrication have been started.
- v) Apparatus
- vi) Collections of informations.

1. DESIGNING SECOND SOLAR WATER HEATER FOR PUBLIC DEMONSTRATION.

This thermosyphon solar water heater has been designed for public demonstration and is supposed to be installed on the campus ground. This will be a bit larger in capacity and it will serve the purpose of demonstration as well as experimentation also.

The main objective is to make this solar water heater low-cost and to show the temperature gradation. For this a thermocouple arrangement will be provided to monitor the temperature at different heights of the tank.

This solar water heater will have two collectors having parallel pipes arrangement in the collector. Rest design will be the same.

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TECHNICAL DETAILS

Particulars : ~~Water~~ Materials and measurement

Tank (200Ltrs) : Diametre = 56 cm.
: Height = 118 cm.
: 24 SWG galvenised Iron sheet

Collectors(two) : Length = 190 cm.
: Breadth = 75 cm.
: Area = 1.42 m²
: Pipe = 1.25 cm diametre (16)

Pipe (Circulation) : 2/3" diametre galvenised iron pipe

Glass screen : 12mm Window glass

Insulation : 10 cm thick local insulation material
: wool, cotton, paddy husk, saw dust etc.

Thermocouple : Copper-constantant thermocouple

+++-----
Figure () and figure () are given in another pages.

COLLECTION OF MATERIALS:

Some fabrication materials are purchased from the local market. It is difficult to get required materials in due time in this market. We collected some materials, such as galvenised iron sheet, glass sheet, circular pipes etc. Some local insulating materials are also collected.

FABRICATION OF MODEL OF THERMOSYPHON SOLAR WATER HEATER AND ITS DEMONSTRATION IN THE EXHIBITION:

The fabrication of a small model of the thermosyphon SWH has been started. This will help the investigators as well as the skilled mechanics to train themselves in fabrication of final SWH. Secondly this model will be displayed in the forthcoming science and technology exhibition to be held in Hatisar Campus Bharan. This will help it increase the interest of the people towards the application of solar energy. However we are trying to achieve maximum possible precision in constructing SWH.

REQUEST FOR THE APPARATUS:

Since the solar energy equipments are not available in our country and at the same time we felt difficulty obtaining from India. The investigators

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(4)

decided to request to USAID/Nepal to make the required equipments available to this project. The US AID/Nepal has assured us to help in this regard.

LECTURES DELIVERED:

Short lectures were delivered on the need and application of solar energy. One lecture session were attended by the teachers of Science, Humanities and Business-Administration faculties with great interest. A lot of questions were asked and answered. Teachers of the faculty of Business Administration took a greater interest in discussing the ways and means for commercial production of SWH together with the pros and cons of removing the social hesitation.

Second lecture session were attended by the science students of Intermediate level and graduate level on solar energy, its scope and applications. Teachers as well as some students spoke on the different aspects of the subject.

MODEL DISPLAY:

The model SWH was displayed in the exhibition of Science and Technology arranged by Institute of Science and Technology and Royal Nepal Academy of Science and Technology in Dharan Campus, on the occasion of birth day of His Majesty The King. A great appreciation and interest were shown by the visitors.

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INFORMATIONS COLLECTION:

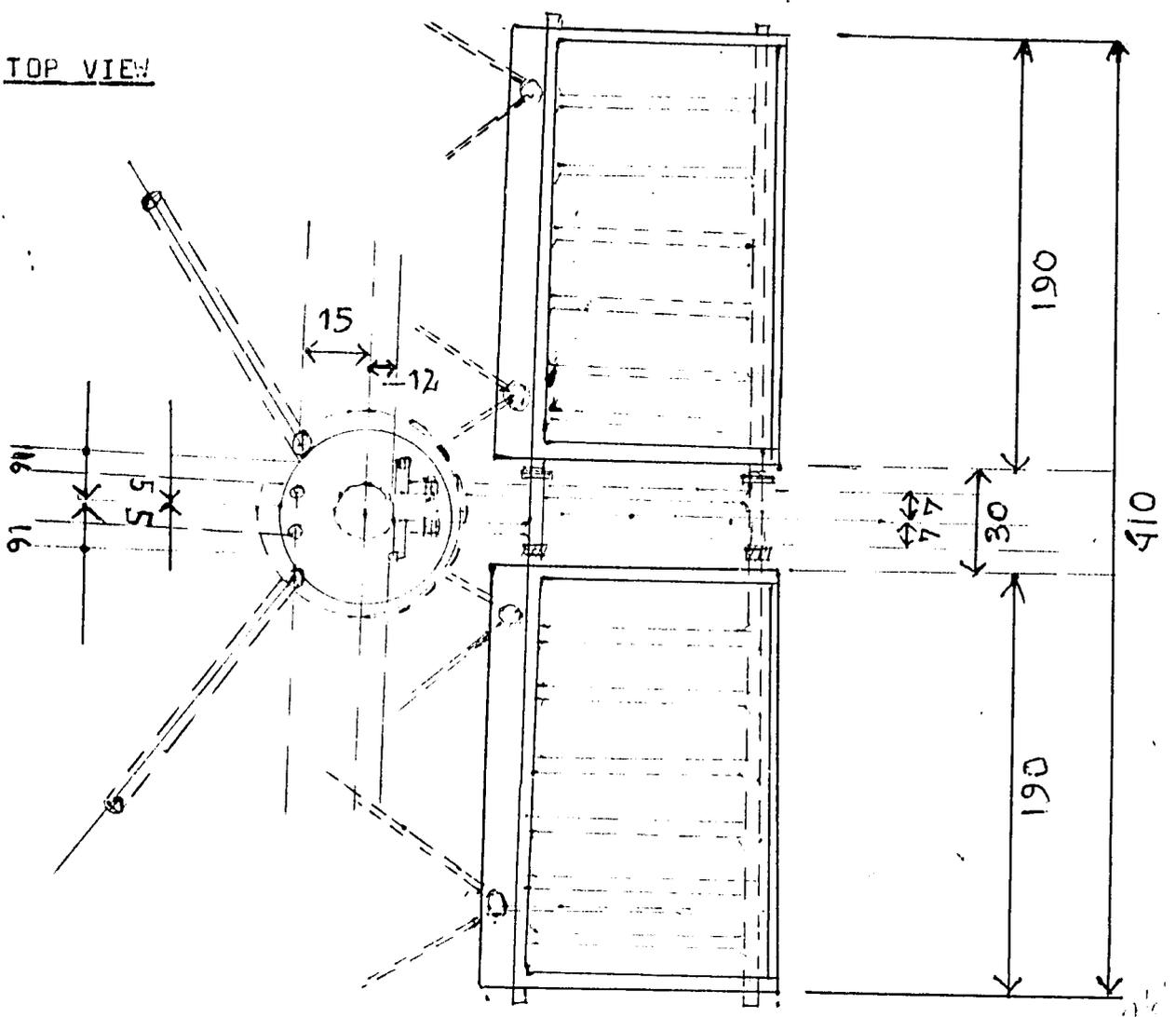
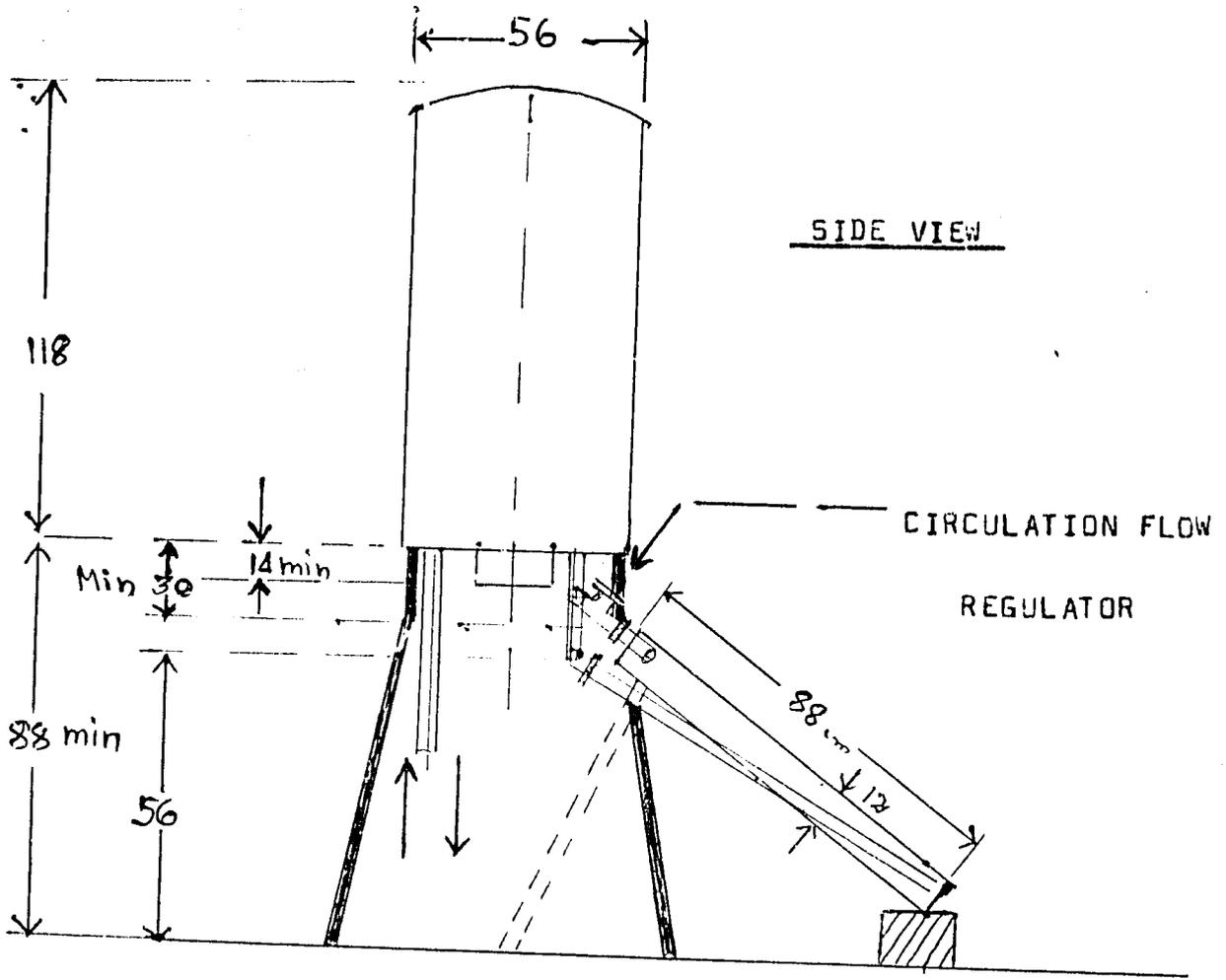
Different informations were collected from R and D of the different Institutions of India.

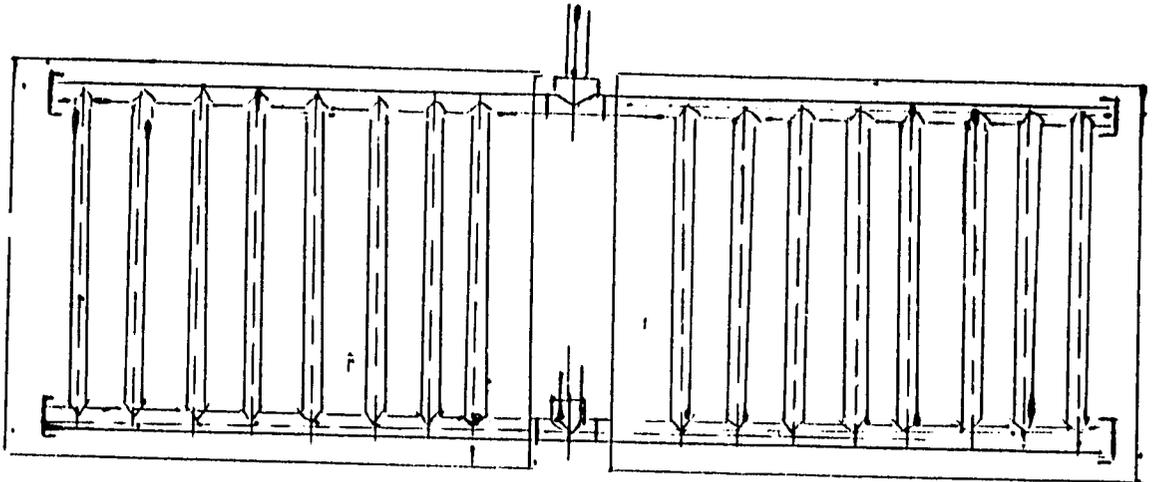
FINANCE:

Total expenditure Nrs. 42,000. Only.

REMRKS:

The work of fabrication will be started very soon. We aim to fabricate the unit for the use of the department of Chemistry. Some expertise has been achieved by our people involved in fabrication. The most time consuming part of the project has been finished already. However due to some official proceedings the release of our Trimester budget did not reach to us in time. We have requested the concerning authority for this trouble.





[COLLECTOR FOR 200ltr. TANK]

3. E-31

DESIGN, CONSTRUCTION AND INSTALLATION OF TWO
THERMOSYPHON SOLAR WATER HEATER FOR PUBLIC
DEMONSTRATION (3E-31)

SECOND INTERIM REPORT

SUBMITTED TO
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D.C.

BY
S.N.S. SUDHANSHU, PRINCIPAL INVESTIGATOR
MAHENDRA MORANG ADARSHA CAMPUS, BIRATNAGAR
(NEPAL)

ON
30 th AUGUST, 1985

MAR 29 1989

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The following works have been done during this period.

- (a) Selection of two thermosyphon solar water heaters for fabrication
- (b) Workshop set up
- (c) Collection of relevant informations.

(a) SELECTION OF TWO THERMOSYPHON SOLAR WATER HEATERS FOR
FABRICATION:

Two thermosyphon solar water heaters were selected for fabrication. One will be installed on the roof of the Department of Chemistry laboratory to provide hot water and also distilled water for the use of the students. Other will be installed on the ground of the Campus for public demonstration.

The solar water heater which will be fabricated and installed on the ground of the campus for public demonstration, will have thermosyphon system and will cost low. The figure (1) is the schematic diagram of the system.

THEORY: D.J. Close is the first to analyse the thermosyphon solar water heater circuit, and other various studies are based on this analysis.

The efficiency of the collector can be predicted for a specific weather and flow conditions in a single pass circuit by evaluating rational design

procedure for flat absorber. However if the water is recirculated through a tank and absorber at a constant flow rate using pump, the continuous ~~of~~ variation of inlet temperature (which is a function of weather and flow condition) creates a problem. In case of thermosyphon action the problem becomes quite difficult because the flow condition ~~ie-~~ themselves are functions of weather and system geometry.

THERMOSYPHON FLOW:

To determine the rate of flow, due to ~~±~~ thermosyphon action generated by heating of water in the collector and the consequent movement by natural convection, it is necessary to consider the density distribution at various points of the flow circuit at any instant. Shown in figure (2).

Following H.J.Close, assuming a quadratic density distribution, neglecting pipe losses-

$$D_w = A_t^2 + B_t + C \quad \dots (1)$$

It can be shown that thermal pressure head generated by solar heating

$$h_t = \frac{t_5 - t_3}{2} \left[2 A_{t_n} + B \right] f(s)$$

$$\text{Where } f(s) = H_0 \sin \xi + 2 \beta + (H_t - Y)$$

and

$$t_n = (t_3 + t_5) / 2$$

Where $f(s)$ = System function determined
system geometry parameters

In the flow circuit thermal pressure head is balanced by frictional head loss (h_f) in flow circuit. Using Darcy & Weishach's equation

(3)

$$h(f) = \frac{f l_u^2}{2 g d_p}$$

where $f = 0.035$ for usual flow in such system which are laminar type under most conditions of operation. Using velocity in terms of the mass flow rate (w_0).

$$h_f = \frac{D w_0^2}{d_p^5} \quad (1)$$

$D = \text{Constant}$, $l = \text{effective length of the flow}$

$$h = \left\{ \frac{5 H_0}{B_c} \left(\frac{d_p}{d_c} \right) + B_c \left(\frac{d_p}{d_h} \right)^2 \right\}^2 + \left\{ H_0 + H_z - Y + \beta \right. \\ \left. (1 + \text{Cosec } \epsilon) \right\} + l_c + L_0$$

$$w_0^3 = - \left(\frac{d_p^5}{21 D C_p} \right) \left\{ (w_{wT} + w_T) \frac{d_{tn}}{d_0} + U_T \left(\frac{t_a}{t_n} \right) \right\} \left\{ 2 A t_n + B \right\} f(s)$$

where w_0 can be determined.

TECHNICAL DETAILS:

The details of the proposed thermosyphon solar water heater is given below.

Particulars	Dimension and materials
Tank(120Ltr)	: Interior Diametre; 53 cm. : Height : 86 cm : Material : 26 SWG galvenised Iron sheet : Outer diametre: 63cm , Heght; 96 cm : 24 SWg Galvenised Iron sheet

(4)

Particulars : Dimension and materials

Collector : Length ; 190 cm
(Parallel pipe) : Breadth: 75 cm
type : Area ; 1.42 m²
:Material ; 24 SWG Galv. Iron sheet
: Pipe ; 1.2 cm diameters Ironpipe

Number : 8

Circulation Pipe ::: Diametre : 2.5 cm Iron Galv.

Hot and Cold water : Diametre : 1.8cm
inlet pipe :

Insulation : 10 cm thick
: Local material ; wool, Cotton, saw
: dust, paddy husk etc

Glass cover : 10 mm thick window glass

The distillation unit will be designed later on.

WORKSHOP SET UP:

We tried to set up a small workshop in the department of Physics. Campus chief has kindly gave the permission to use one room in upper floor of the campus to use as a workshop, where we have collected and stored

(5)

various small working tools.

Out side the Campus, a local workshop M/S Krishna Grill & Engineering Works has agreed to under take this fabrication works. For this , this workshop has agreed to install and purchase the required tools for workshop. However this firm has some experience of this type of works. This workshop has also agreed to give the training ,two of its skilled workers for doing this kind of work in Kathmandu or somewhere. Probably within next few months this workshop will have all necessary requirements fulfilled.

COLLECTION OF INFORMATIONS AND CONSULTANCY:

Meanwhile a number of literatures regarding solar energy application have been collated from different documentation centres of India.

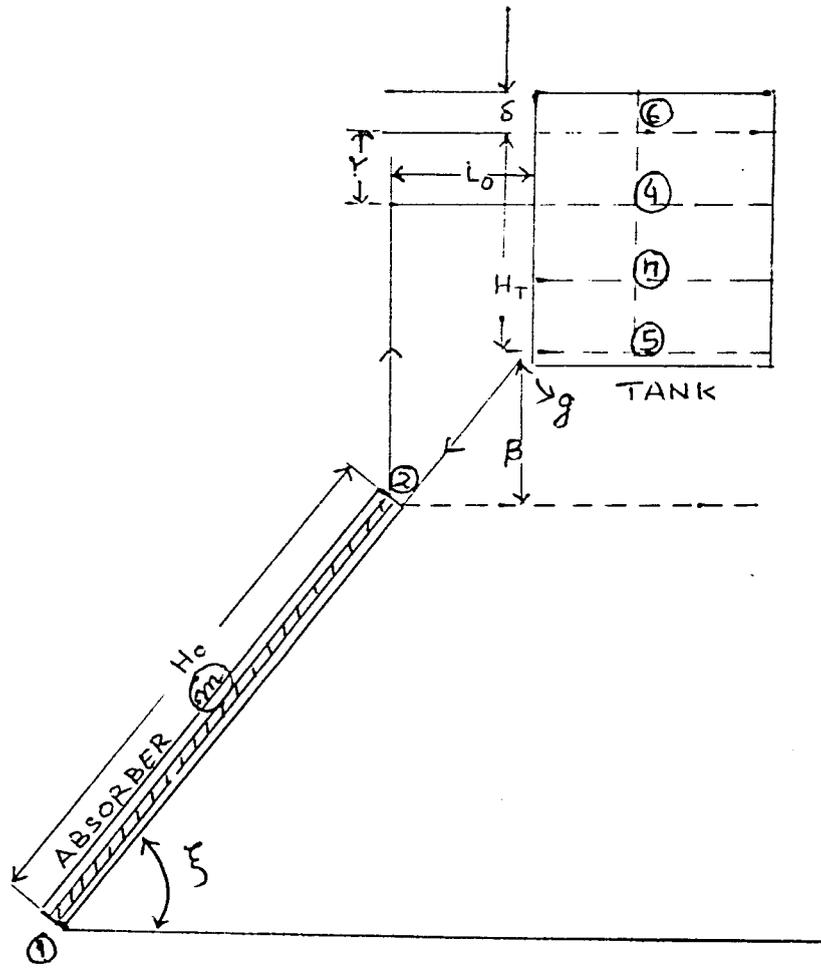
Some local engineers having interest towards research and development of solar energy have readily accepted to supervise and suggest to our works.

FINANCE:

Total expenditure Nrs. 25,000.

REMARK :

1. The works of this project has not been carried out as per its shedule due to our own heavy teaching schedule.
 2. The collection of literatures and getting consultancy appears to be very time consuming which we hadn't guess in the begning.
 3. Similarly it will take enough time to prepare necessary manpower and workshop for this job.
- However we have solved most of our problem.



LAY OUT DIAGRAM OF THERMOSYPHON SYSTEM

fig 1

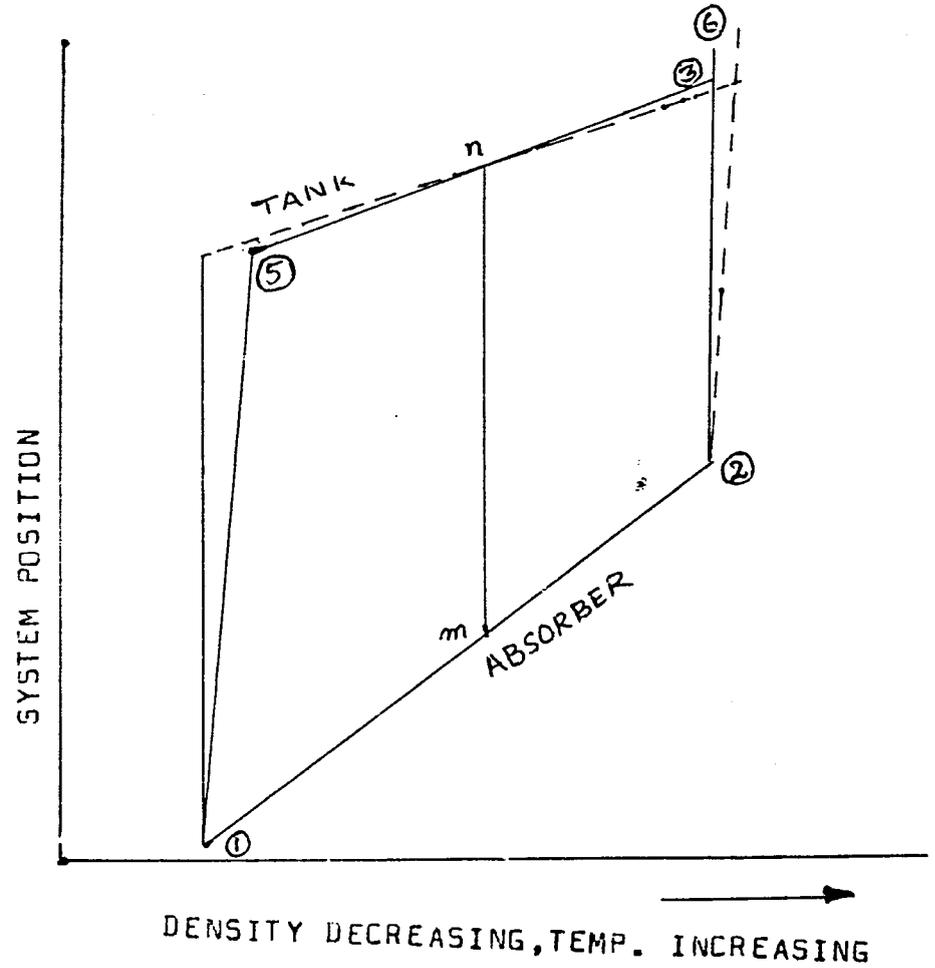
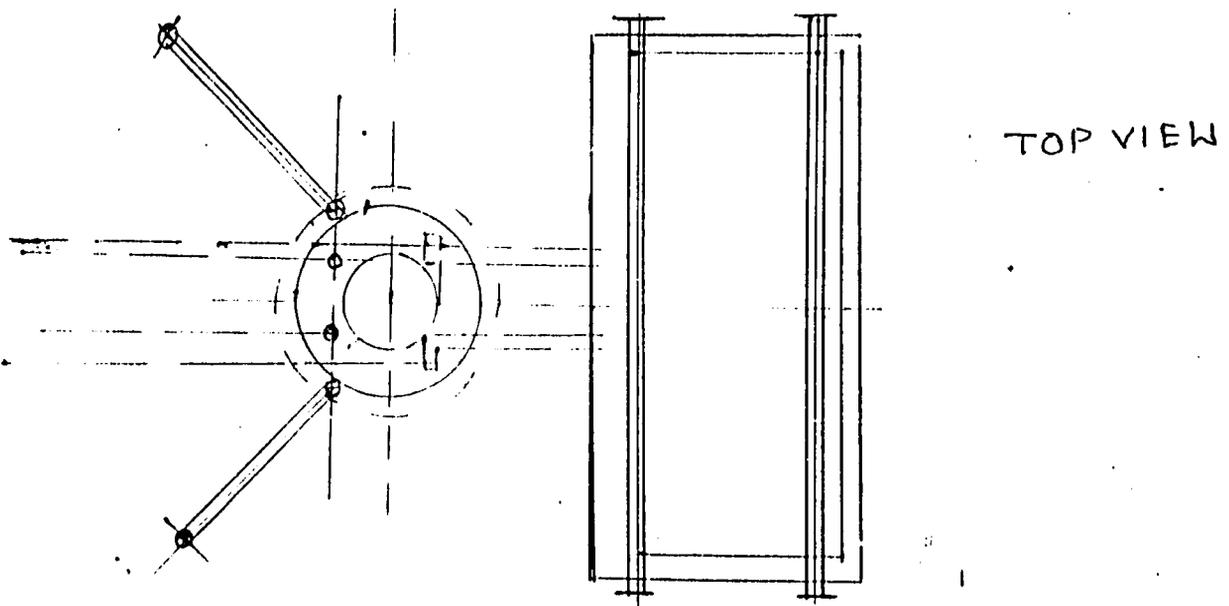
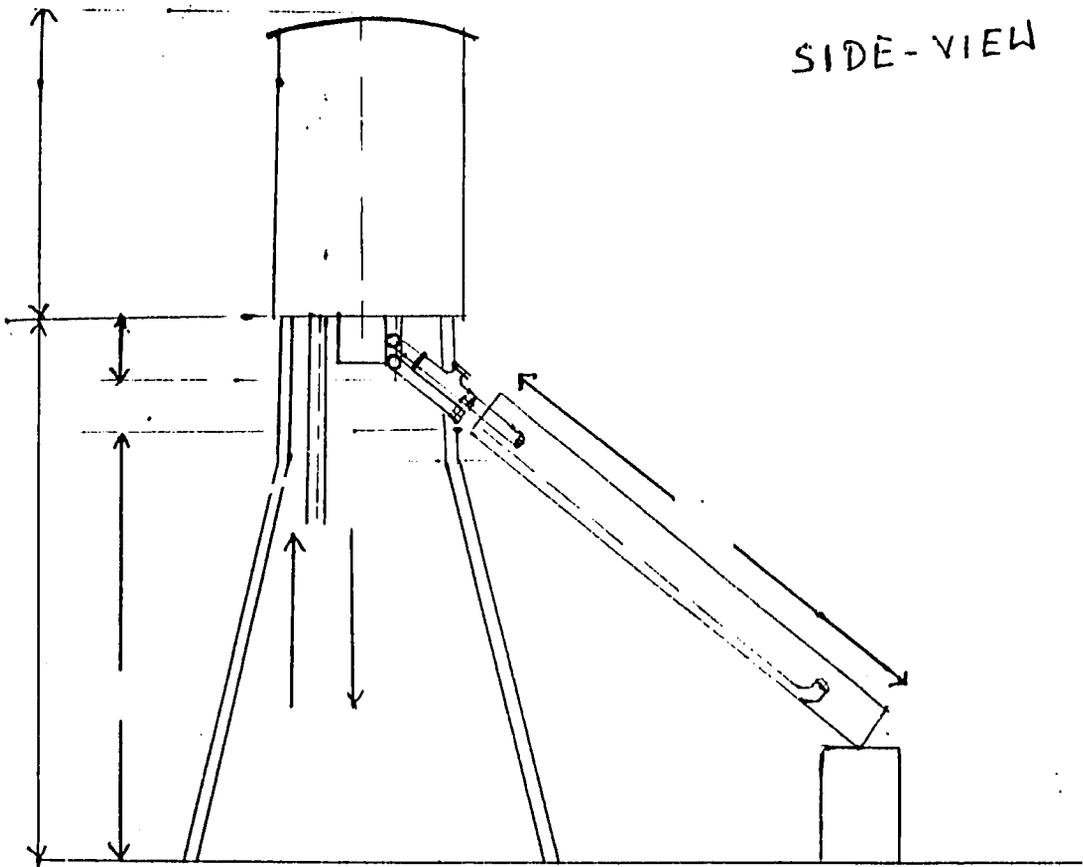


fig 2



3. E-31

DESIGN? CONSTRUCTION & INSTALLATION OF T=O
THERMOSYPHON SOLAR WATER HEATER FOR PUBLIC
DEMONSTRATION(3E-31)

FIRST INTERIM REPORT

SUBMITTED TO
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D.C.

BY
S.N.S. SUDHANSHU? PRINCIPAL INVESTIGATOR
MAHENDRA MORANG ADARSHA CAMPUS, BIRATNAGAR
(NEPAL)

ON
28 th FEBRUARY, 1985

MAR 20 1985

INTRODUCTION: A considerable amount of work on solar water heater has been done in Kathmandu, but nothing has been penetrated in to eastern part of Nepal due to various reasons. The population in eastern region of Nepal is concentrated in Terai region where the climatic conditions (temperature, solar radiation etc) are suitable for solar research and application. Birat nagar is the nerve centre for whole of the eastern region.

MMA Campus is teaching institution which prepares nearly 500 students for University studies in science. These students either go to University or join various departments of His Majesty's Government or teach science in rural schools.

It is intended that this project will pursue its works directly based on previous and on going works in the area of low-cost thermosyphon solar water heaters as prepared in Kathmandu and Indian Institute of technology, New Delhi, India.

OVERALL OBJECTIVES: There are three main objectives of this project:

- (a) To train the science faculty of this campus through first hand experience, in the design, construction and installation of low-cost thermosyphon solar water heaters.
- (b) To expose the students and through them the rural population, in the application of solar hot water by becoming a small regional focal centre for demonstration.
- (c) To test the implication towards the promotional development of local industries and overcome some barriers of social acceptance.

(2)

WORK PLAN : This project has broadly the following work plan:-

- (i) Educational and Technical training of the investigators.
- (ii) Theoretical study of Design and fabrication of thermosyphon solar water heaters
- (iii) Installation and demonstration.

WORK DONE :

(a) Procurement and collections:- At the outset this project experienced a great difficulty in collecting the relevant informations regarding thermosyphon solar water heaters. Since Biratnagar is a small town in comparison to Kathmandu. There are no good libraries, book shops or no any research and development works in this field is carried out here. Thus this project undertook the first and major work to collect literatures, Journals and other informations from various sources within and outside the country. There are many institutions in ~~ind~~ India carrying out this type of works. A large amount of correspondences have done with the following sources of India Nepal.

- (1) Indian Institute Of Technology, New Delhi. (INDIA)
- (2) Indian Institute of Technology, Kharagpur. ,,
- (3) Indian Institute of Technology, Kanpur. ,,
- (4) Central Arid Zone Research Institute, Jaipur.
- (5) Kalyani University Kalyani, West Bengal
- (6) Indian Documentation Centre , Hillside road, New Del.

(3)

(7) Energy Documentation Centre. Bombay (TATA)

(8) Swiss Association for Technical Assistance, Kathmandu

(9) Balaju Yantra Sala, Balaju, Kathmandu.

(10) Research Centre for Science & Technology, Kathmandu.

(b) Collection of literatures:

(i) Books on SWH ;; 15 Copies

(ii) Journals : 5 Copies

(iii) Reports : 45 Copies

Besides aforementioned literatures the following literatures are also made available.

1. PSEC Bibliography -85-05 :: Florida Solar Energy Centre
300, State Road.

2. Measurement Performance
Results. Low cost SWH System : : Solar Energy Research
Inst. Colorado,
in Sansnisvalley-1983

3. RPSC REPORTER VOL. 2N2, 1976 :: Rice Process Engineering
Khargpur (IIT)

4. To determine the thermal performance of SWH :: The American Society of
heating, Refrigerating
and Air Cond. ATLANTA.

system 1981.

(5) Solar Collector cum Storage

System: :: IIT, New Delhi.

(6) Plastic Solar Collector :: IIT, New Delhi.

(7) Thermal Modelling of Solar

hot water System :: IIT, New Delhi.

(8) Evaluation of low Cost :: National Centre for Approp-
riate Tech. SEATTLE
thermosyphon SWH

(4)

- (9) Renewable energy resources in Nepal :: SATA, P.O. 113
- (10) Solar Water Heaters in Nepal :: SATA, P.O. Box 113
- (11) SWH installation Manual :: SATA, P.O. Box 113
- (12) Renewable Energy research in India :: TATA, Bombay
- (13) Science Today-- -- 4 Vols :: Times of India
- (14) National Solar energy Convention, Report
- (15) Science Reporter !-- 5 Vols. :: CSIR Publications
- (16) Other reports and Energy Digests:

APPARATUS: The following tools and apparatus were procured:

- i) Thermometres (0 -110^oC) ----- 12
- ii) Flowmetres ----- 2
- iii) Working tools ----- 10

Arrangements were made to set up a small workshop in the Department of Physics for minor works. Campus chief has assured us to provide necessary helps such as rooms to set up workshop and the place for demonstration etc.

CONSULTATION:

Dr. M.S. Sodha of IIT, New Delhi has been contacted for consultations. Besides this, this project has contacted local engineers and workshops for under taking the

(5)

construction works and to equip the workshop. They have agreed to help us in this regard.

FINANCE:

Total expenditure up to this part was Nrs.25,000 .

REMARKS:

There are some major problems, which we could not or can not solve immediately. The consultancy has appeared very time consuming work. We had to cancel several appointments because we can't go outside at our will only we can use our holidays for such works. The local market and ~~our~~ workshops are not appropriate to supply and undertake this kind of work. We felt the scarcity of skilled man power also to take this kind of job, therefore we felt essential to prepare manpower at first.