

**INTERMEDIATE VOCATIONAL COURSE**  
**Second Year**

**NON CONVENTIONAL ENERGY**  
**SOURCES LAB**

*For the Course of Rural Engineering Technician*



**State Institute of Vocational Education**  
**Directorate of Intermediate Education**  
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## **PREFACE**

The main objective of vocational education is to train the students at +2 level for meeting the demands for the skilled manpower in both organised and unorganised sectors and also to provide an alternative channel for those who aimlessly pursue higher education and to prepare them for self reliance. The State Institute of Vocational Education (SIVE) in collaboration with the Board of Intermediate Education, Andhra Pradesh has developed curriculum for 43 vocational courses in the field of

**Engineering & Technology**

**Agriculture**

**Health & Paramedical**

**Business & Commerce**

**Home Science and Humanities**

Accordingly the text books have been developed by SIVE as per the restructured curriculum by utilizing the services of various professional teachers in the respective fields. I am sure that this book will be immensely useful to the vocational students and teachers in understanding the concepts.

I wish to place my sincere thanks on record to Sri Shali Habibulla, Author of this text book for extending his support in developing this book for printing and publishing.

I shall be grateful to receive suggestions and observations from all the readers which would help in bringing out a revised and improved version of this book in future.

**Sri. Shashank Goel, I.A.S.,**  
Director & Secretary  
Board of Intermediate Education  
Andhra Pradesh, Hyderabad

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## SOLAR RADIATION MEASUREMENT

### Experiment No : 1.1

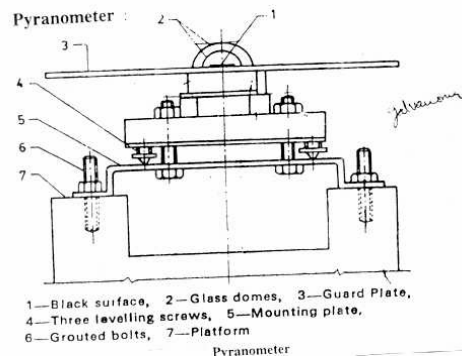
**Aim :** Study of Solar Radiation by using Pyranometer.

**Apparatus :** 1. Black surface

2. Glass domes
3. Guard plate
4. Three levelling screws
5. Mounting plate
6. Grouted bolts
7. Platform
8. Thermopile

**Procedure :** A pyranometer is an instrument which measures either global or diffuse radiation.

A black surface on the guard plate is covered by a transparent glass domes. The hot junctions of the thermopile is connected to black surface and the cold junctions of thermopile is connected where there is no solar radiation. The other ends of thermopile are connected to millivoltmeter. The entire equipment rests on the mounting plate. The mounting plate is fixed on the plat form with the help of bolts. Levelling screws are provided.



When the sunrays falling on the black surface, heat is generated inside the glass dome. This causes the temperature difference takes place in the two junctions of the thermopile. As a result, an e.m.f is generated and it is recorded in the milli voltmeter.

**Data Required to be noted**

Name of the instrument : \_\_\_\_\_

Name of the manufacturer / supplier : \_\_\_\_\_

Sl. No.	Experiment Conducting Time	Duration hrs.	e.m.f. Produced

**Questions For Evaluation :**

**After performing the practical task the students are required to answer the following questions.**

Q1. What is Pyranometer?

Ans. A Pyranometer is an instrument which measures either global or diffuse radiation.

Q2. What are the main parts of Pyranometer?

Ans. 1. Black surface; 2. Glass domer, 3. Guard plate; 4. Three levelling screws; 5. Mounting plate; 6. Grouted bolts; 7. Platform; 8. Thermopile.

Q3. How many junctions has thermopile and what are they?

Ans. Thermopile has two junctions. They are : (a) Cold junction and (b) Hot junction.

Q4. What is the use of millivoltmeter?

Ans. It records an e.m.f. (electro motive force) generated.

## SOLAR DISTILLATION

### EXPERIMENT NO : 2.1

**Aim :** Study of Solar Distillation or Solar Still.

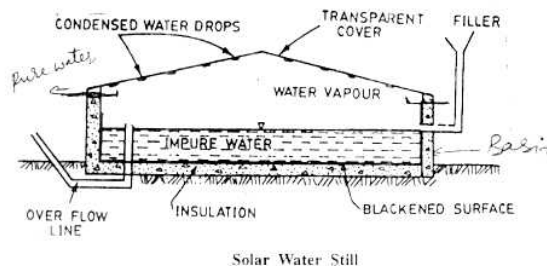
**Apparatus :** 1. Transparent Covers

2. Filler
3. Over flow line
4. Insulation
5. Blackened surface
6. Basin

**Objective :**

Fresh water is a necessity for the sustenance of life and also the key to man's prosperity. It is observed that, arid and costal areas which are thinly populated, the family members are always busy in bringing fresh water from a long distance. In these areas solar energy is plentiful and can be used for converting saline water in to distilled water by using solar still.

**Procedure :** It consists of a insulated blackened basin containing saline water. A transparent cover is enclosed on the top of the basin. It has a roof like shape. The cover, which is usually glass or plastic sheet. . Solar radiation passes through the cover and is absorbed and converted into heat in the black surface. Impure water in the basin is heated and the vapour produced is condensed as water drops on the interior of the roof. The condensed water can be collected through the pipes provided in the solar still.



**Data Required to be noted**

Name of the instrument : \_\_\_\_\_

Name of the manufacturer / supplier : \_\_\_\_\_

Sl. No.	Experiment Conducting Time	Duration hrs.	Quantity of Saline of Impure Water	Quantity of Pure Water Collected	Remarks

**Questions for evaluation :**

After performing the practical task the students are required to answer the following questions :

Q1. What are the main parts of Solar Distillation or Solar Still ?

Ans. 1. Transparent covers; 2. Filler; 3. Over flow line; 4. Insulation;  
5. Blackened surface; 6. Basin.

Q2. What is the use of Transparent ?

Ans. Transparent cover acts as an solar collector.

Q3. What acts as an absorber ?

Ans. A black body acts as an absorber.

Q4. What is the use of Solar Distillation ?

Ans. The impure water can be purified with the help of Solar Distillation.

## SOLAR PUMPING

### EXPERIMENT NO : 3.1

**Aim :** Study of solar water pumping

**Apparatus :** 1. Solar collector array

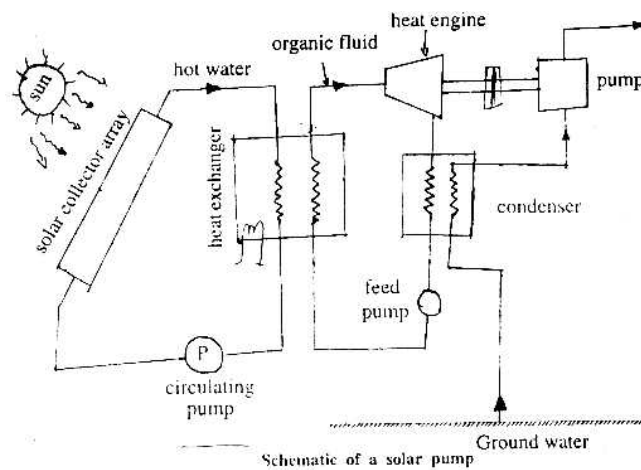
2. Heat exchanger

3. Organic fluid

4. Heat engine

5. Condenser

6. Pump



#### **Description :**

1. **Solar collector array :** It consists of solar collector and water tubes. The inner surface of the collector and the water tubes are coated with black paint.
2. **Heat Exchanger :** It consists of two pipes, one is for carrying hot water and other is for circulating organic fluid.
3. **Organic fluid :** The organic fluid changes its phase from liquid to vapour when it is hot and vapour to liquid when it gets cool.
4. **Heat engine :** It consists of a turbine
5. **Condenser :** It consists of two pipes one is for carrying organic fluid and other is for pumping the ground water.
6. **Pump :** Pump shaft is coupled with heat engine shaft. It is used to pump the water.

**Working :**

When the sun rays falls on the solar collector, black body absorbs the sun rays and water in the tubes gets heated up and circulates in the heat exchanger. Through the heat exchanger, hot water is again pumped back in the solar collector with the help of a pump.

The organic fluid in the other tube senses the heat produced in the heat exchanger and converts its phase in to vapour. The vapour runs the turbine provided in the heat engine and losses its heat, and again converted in to liquid. This organic fluid again pumped back in to the heat exchanger with the help of a feed pump.

Ground water is pumped with the help of a pump, which is coupled with heat engine.

**Data Required to be noted**

Name of the instrument : \_\_\_\_\_

Sl. No.	Experiment Conducting Time	Duration hrs	Amount of Water Collected	Remarks

**Questions for Evaluation :**

**After performing the practical task the students are required to answer the following questions:**

Q1. What are the main parts of Solar Water Pumping ?

Ans. 1. Solar collector array; 2. Heat exchanger; 3. Organic fluid; 4. Heat engine; 5. Condenser; 6. Pump

Q2. Describe solar collector array ?

Ans. It consists of solar collector and water tubes. The inner surface of the collector and the water tubes are coated with black paint.

Q3. Describe Heat Exchanger ?

Ans. It consists of two pipes, one is for carrying hot water and other is for circulating organic fluid.

Q4. Describe organic fluid ?

Ans. The organic fluid changes its phase from liquid to vapour when it is hot and vapour to liquid when it gets cool.

Q5. Describe Heat engine ?

Ans. It consists of a turbine and it is coupled with a pump.

Q6. Describe condenser ?

Ans. It consists of two pipes one is for carrying organic fluid and other is for pumping the ground water.

Q7. Describe Pump ?

Ans. Pump is used to pump the water and it is coupled with heat engine.

## SOLAR COOKER

### EXPERIMENT NO : 4.1

**Aim :** To study the constructional details of a box type solar cooker.

**Apparatus :** 1. Insulated box

2. Two transparent glass plates (collectors)
3. Reflecting mirror
4. Guide for adjustment of reflecting mirror
5. Handle
6. Cooking pots
7. Black board paint (Absorber)

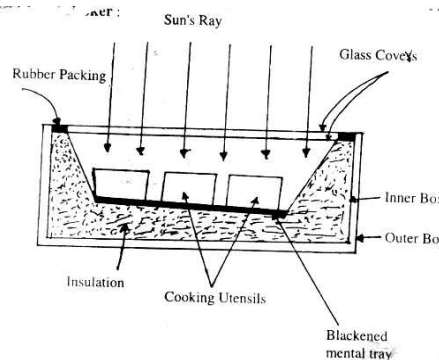


Fig. 5.2. Principle of box type cooker

#### Procedure :

Two transparent glass plates of 3mm thick are fixed on the top of the insulated box, keeping about 25mm distance between the two glass covers. Neoprene rubber sealing is provided around the glass covers and the cooker box. A black paint is coated on the surface of the vessels and inside the box. This black body acts as an absorber.

The solar radiation entering the box are of short wave length. The two glass covers minimises the heat loss and transmission of long wave radiation.

When the sun rays falls on collectors or glass plates, enters in to the cooker box. The black body absorbs the solar radiation and generates heat inside the box. The cooking pots gets heat energy and food will be cooked.

Solar energy can be tracked by using reflector or mirror. A mechanism or clamp is provided to adjust the reflector at different angles on the cooker box.

Insulating materials like glass wool or saw dust is filled in the space between blackened tray and outer cover of the box. This minimises heat losses.

**Data Required to be noted**

Name of the instrument : \_\_\_\_\_

Name of the manufacturer / supplier : \_\_\_\_\_

Sl. No.	Experiment Conducting Time	Initial Temperature	Final Temperature	Duration Hrs	Remarks

**Questions for Evaluation :**

**After performing the practical task the students are required to answer the following questions :**

Q1. What are the main parts of Solar Cooker ?

Ans. 1. Insulated box; 2. Two transparent glass plates (Collectors); 3. Reflecting mirror; 4. Guide for adjustment of reflecting mirror; 5. Handles; 6. Cooking pots; 7. Black board paint (Absorber);

Q2. What is Solar Collector ?

Ans. Solar Collector is a device which collects solar radiation. Usually transparent glass plates are used as solar collectors.

Q3. What is an absorber ?

Ans. A black body acts as an absorber. It absorbs the solar radiation.

Q4. What is the use of reflector ?

Ans. It is used for tracking the solar energy. Usually a mirror is used as a reflector. A mechanism or clamp is provided to adjust the reflector at different angles on the cooker box.

Q5. What is the use of insulating material ?

Ans. The material which does not conduct heat is called insulating material. Insulating materials like glass wool or saw dust is filled in the space between blackened tray and outer cover of the box. This minimises heat losses.

Q6. What is the thickness of transparent glass plates ?

Ans. The thickness of transparent glass plate is 3mm.

Q7. What is the distance between the two glass covers ?

Ans. The distance between the two glass covers is 25mm.

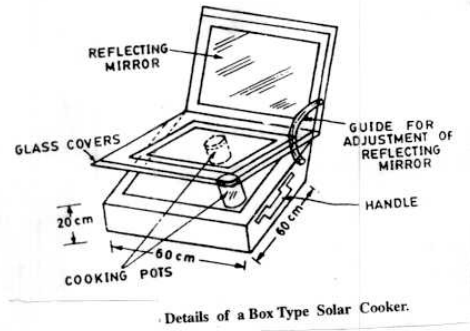
## Preparing delicious food by using Solar Cooker

### Experiment No : 4.2

**Aim :** Prepare delicious food by using solar cooker.

**Apparatus :** Solar cooker, cooking pots

**Ingredients :** Rice, water, salt



### Procedure :

1. Place the cooker in the sun. The place selected should receive direct sun shine. Ensure that it will not come under the shadows of trees or buildings.
2. Leave the reflector mirror in the open position at an angle which permits the sun's rays on the collector or glass covers.
3. Wipe dust, foreign particles and moisture from both mirror and glass surfaces.
4. Allow a minimum pre – heating time of about 30 minutes if the food is to be sent in the cooker at 10-00A.M., place the cooker in sun at 9-30A.M ro earlier.
5. While the cooker gets pre – heated, lift the glass cover of the cooking tray and remove the cooking pots.
6. Load the material to be cooked along with the required quantity of water and close the cooking pots.
7. Keep the cooking pots on the tray and close the double glass cover of the tray.
8. None the food is left to be cooked.

The food will be ready in one or two hours, depending upon the intensity of sun.

**Data Required to be noted**

Name of the instrument : \_\_\_\_\_

Name of the manufacturer / supplier : \_\_\_\_\_

Sl. No.	Experiment Conducting Time	Type of food	Duration hrs.	Remarks

**Questions for Evaluation :**

After performing the practical task the students are required to answer the following questions.

Q1. What are the main apparatus required for preparing food ?

Ans. Solar Cooker and Cooking Pots.

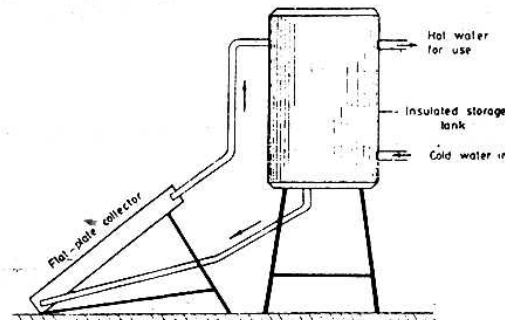
**Note:** The remaining questions are followed from experiment No. 4.1

## SOLAR WATER HEATER (Thermosiphon)

### EXPERIMENT NO : 5.1

**Aim :** Study of Thermosiphon solar water heating system

**Apparatus :** 1. Flat plate collector  
2. Insulated storage tank  
3. Connecting pipes.



### Procedure :

A flat plate collector is used to collect solar radiation and converts it into thermal energy. Insulated storage tank is used to hold the hot water for use and cold water for feeding the flat plate collector.

Connecting pipes inlet and outlet is used for feeding cold water from the storage tank and taking hot water from the storage tank.

As water in the collector is heated by solar energy, it flows automatically to the top of the water tank and its place is taken by colder water from the bottom of the tank. Hot water for use is with drawn from the top of the tank. An auxiliary heating system is provided for use on cloudy or rainy days.

**Data Required to be noted**

Name of the instrument : \_\_\_\_\_

Name of the manufacturer / supplier : \_\_\_\_\_

Sl. No.	Experiment conducting Time	Quantity of Water	Initial Temperature	Final Temperature	Duration hrs.

**Questions for Evaluation :**

**After performing the practical task the students are required to answer the following questions :**

Q1. What are the apparatus required for solar water heating system ?

Ans. 1. Flat plate collector; 2. Insulated storage tank; 3. Connecting pipes

Q2. What is the use of flat plate collector ?

Ans. A flat plate collector is used to collect solar radiation and converts it in to thermal energy.

Q3. What are the different types of solar water heating systems ?

Ans. 1. Thermosiphon or Natural Circulation System and 2. Forced circulation system.

Q4. What is the use of an auxiliary heating system ?

Ans. An auxiliary heating system is provided for use on cloudy or rainy days.

Q5. What is the use of insulating material ?

Ans. It minimises heat losses.

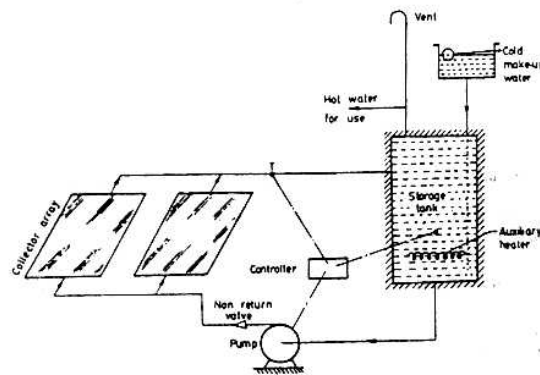
## Solar Water Heater (Forced Circulation)

### EXPERIMENT NO : 5.2

**Aim :** Study of Forced circulation solar water heating system

**Apparatus :**

1. Arrays of flat plate collector
2. Insulated storage tank
3. Pump
4. Connecting pipes
5. Auxiliary heating system



**Procedure :**

Water is fed by some mechanical device like pump is known as forced circulation system. This type of water heater is used for industrial purposes where large quantity of water required to heat. The main components are :

**(i). Arrays of Flat plate collector :**

It is used to absorb solar radiation and convert it in to thermal energy.

**(ii). Insulated storage tank :**

It is used to hold the hot water for use and cold water for feeding the arrays of collector.

**(iii). Pump :** It is used to feed cold water into arrays of flat plate collector

**(iv). Connecting pipes :**

In let and out let pipes are used for feeding cold water from the storage tank and taking hot water from the storage tank.

**(v). Auxiliary heating system :**

It is provided for use on cloudy or rainy days and during nights.

Systems of this type are well suited for places like hospitals, hotels, milk dairys, industries etc.

**Data Required to be noted**

Name of the instrument : \_\_\_\_\_

Name of the manufacturer / supplier : \_\_\_\_\_

Sl. No.	Experiment Conducting Time	Quantity of Water	Initial Temperature	Final Temperature	Duration hrs.	Remarks

**Questions for Evaluation :**

After performing the practical task the students are required to answer the following questions :

Q1. What are the main apparatus used in forced circulation solar water heating system ?

Ans. 1. Arrays of flat plate collector; 2. Insulated storage tank; 3. Pump; 4. Connecting pipes; 5. Auxiliary heating system;

**Note :** The remaining questions are similar to experiment No. 5.1

## SOLAR LANTERNS AND STREET LIGHT

### EXPERIMENT NO : 6.1

**Aim :** Study of Solar Street Lighting and Lanterns.

**Apparatus :** 1. Photovoltaic module or solar array

2. Lighting device
3. Inverter
4. Battery

#### **Objectives of solar lighting :**

In our country out of six lack villages, one lack village are still to be electrified. Even in electrified villages, only a quarter of house – holds have proper connection.

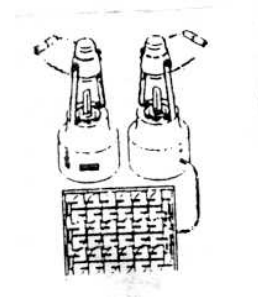
The bulk of rural house – holds in India, normally use kerosene lanterns for meeting their lighting requirements. These lanterns provided insufficient and poor quality of light.

A variety of solar photo – voltaic system have been developed and employed for rural applications such as lighting.

#### **(a) Solar Lantern :**

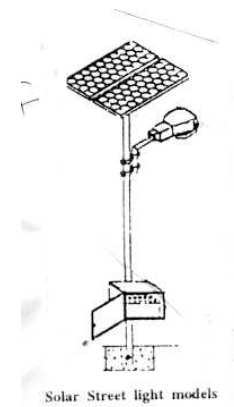
This consists of a small photovoltaic module or solar array, a lighting device, inverter, battery etc. During day time, module or array is placed under the sun and is connected to lantern through cable for charging. A typical lantern uses a 100 watt lamp.

Storage battery is one crucial component in lantern. The battery has a life of 3 to 5 years.



#### **(b) Street lighting system :**

It consists of two photo – voltaic modules, mounting frame, 4mt long pole, battery box, lead – acid battery and inverter. It works with one flouroscent tube light of 20 watts for whole night.



**Questions for Evaluation :**

**After performing the practical task the students are required to answer the following questions.**

Q1. What are the main apparatus used for solar street lighting and lanterns ?

Ans. 1. Photovoltaic module or solar array; 2. Lighting device; 3. Inverter; 4. Battery;

Q2. What is solar photo – voltaics ?

Ans. The direct conversion of solar energy in to electrical energy by means of the photo voltaic effect, that is, the conversion of light in to electricity.

Q3. Define photo voltaic effect ?

Ans. The photo voltaic effect is defined as the generation of an electromotive force as a result of the absorption of ionizing radiation.

Q4. What is solar cell ?

Ans. Energy conversion devices which are used to convert sun light of electricity by the use of the photovoltaic effect are called solar cells. Solar cells are made of semi – conductors like silicon.

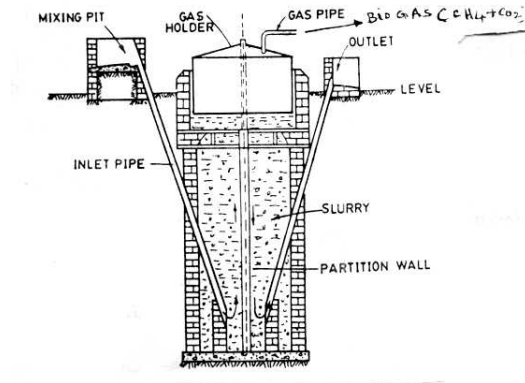
## BIO GAS

### Experiment No : 7.1

**Aim :** Study of K.V.I.C Bio gas plant.

**Apparatus :**

1. Digester
2. Gas holder.
3. Gas pipe
4. Mixing pit
5. Out let
6. Inlet pipe
7. Outlet pipe
8. Partition wall
9. Cow dung or organic matter
10. Water



**Description :**

[K.V.I.C] Khadi and village Industries Commission bio gas plant is also called as Floating gas holder type plant. In this, the gas holder floats on digester. Gas holder is made of mild steel.

It is the costliest component and its life is comparatively less. The remaining parts of the plant is made of masonry construction.

The plant consists of essentially of two parts. (a). Digester and (b). Dome.

**Construction and Working :**

The digester is normally below ground level and two pipe lines provided at its bottom. They are called as Inlet and Out let. The pipe which is at right side is called Inlet and which is at left side is called Out let. The digester contains animal waste in the form of slurry. Bio mass is fed in to the digester through Inlet. The digested slurry can be collected from the out let.

The dome or gas holder will be sliding on the guide ways provided in the digester. A gas pipe is fixed on the dome. By opening the gas pipe, we can utilise the gas according to our needs.

**Bio gas production ;**

Bio gas produces in two phases

1. Acid Phase and 2. Methane Phase.

When the organic matters is decomposed or fermented in the absence of air anaerobic group organisms called acid formers produces. This is called as Acid Phase.

The acid former bacterias are then converted into Methane (CH<sub>4</sub>) and carbon-di-oxide (CO<sub>2</sub>) after two weeks. The bacterias which are strictly anaerobs are called Methane former bacterias. The combination of Methane and carbon-di-oxide is known as Bio gas.

The produced bio gas will be stored in the dome. At the bottom of the digester a partition wall is constructed. This wall divides or separates In let and Out let. The digested slurry will be removed from the out let. The digested sludge contains nitrogen, phosphorous and potassium. It can be used as an excellent fertilizer.

The calorific value of Bio gas is 1600 to 2500 KJ/m<sup>3</sup>. It is an excellent fuel for cooking, lighting and for running the engines.

**Data Required to be noted**

Name of the Bio gas plant : \_\_\_\_\_

Location : \_\_\_\_\_

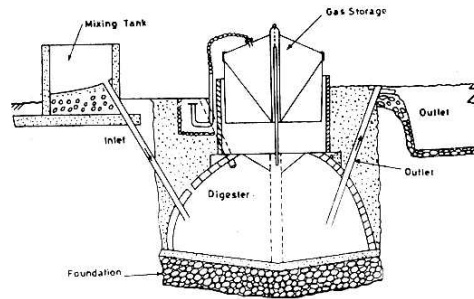
Sl. No.	Date of feeding Bio mass	Quantity of cow dung	Quantity of water mixed	Date of Bio gas production	Quantity of Bio gas produced

## EXPERIMENT NO : 7.2

**Aim :** Study of Pragathi Bio gas plant

**Apparatus :**

1. Digester
2. Gas holder
3. Gas pipe
4. Mixing pit
5. Out let
6. In let pipe
7. Out let pipe
8. Partition wall
9. Cow dung or organic matter
10. Water



4.8 Pragathi Design Bio Gas Plant

**Description :** Pragathi Bio gas plant is also called as floating gas holder type plant. In this, the gas holder floats on digester. In this design the depth of pit is less than K.V.I.C plant. The foundation of this plant is of conical shape. The plant consists of essentially of two parts. (a). Digester and (b). Dome.

### Construction and Working

The digester is normally below ground level, and its design starts from the foundation in conical shape for reducing the area and cost of construction. Bottom of the digester provided with two pipe lines, called Inlet and Outlet. The pipe which is at left side is called Inlet and which is at right side is called Out let. The digester contains animal waste in the form of slurry. Bio mass is fed in to the digester through Inlet. The digested slurry can be collected from the out let.

The dome or gas holder will be sliding on the guide ways provided in the digester. A gas pipe is fixed on the dome. By opening the gas pipe, we can utilise the gas according to our needs.

### Bio gas production :

Bio gas produces in two phases.

1. Acid Phase and 2. Methane Phase

When the organic matter is decomposed or fermented in the absence of air, anaerobic group organisms called acid formers produces. This is called as Acid Phase.

The acid former bacterias are then converted in to Methane (CH<sub>4</sub>) and carbon-di-oxide (CO<sub>2</sub>) after two weeks. The bacterias which are strictly anaerobs are called Methane former bacterias. The combination of Methane and Carbon-di-oxide is known as Bio gas.

The produced bio gas will be stored in the dome. At the bottom of the digester a partition wall is constructed. This wall devides or separates Inlet and Outlet. The digested slurry will be removed from the out let. The digested sludge contains nitrogen, phosphorous and potassium. It can be used as an excellent fertilizer.

The calorific value of Bio gas is 1600 to 2500 KJ/m<sup>3</sup>. It is an excellent fuel for cooking, lighting, and for running the engines.

**Data Required to be noted**

Name of the Bio gas plant : \_\_\_\_\_

Location : \_\_\_\_\_

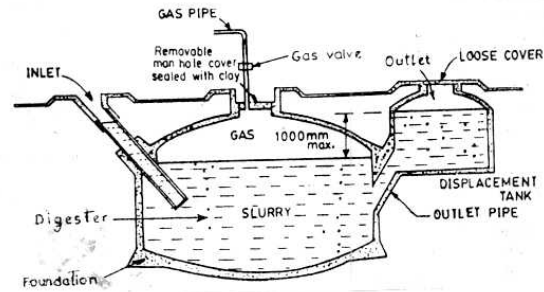
Sl. No.	Date of Feeding Bio Mass	Quantity of Cow Dung	Quantity of Water Mixed	Date of Bio Gas Production	Quantity of Bio Gas Produced

### EXPERIMENT NO : 7.3

**Aim :** Study of Janata Bio gas plant

**Apparatus :**

1. Digester
2. Gas holder
3. Gas pipe
4. Mixing pit
5. Out let
6. Inlet pipe
7. Out let pipe
8. Partition wall
9. Cow dung or organic matter
10. Water



**Description :** Janata Bio gas plant is also called as fixed dome type plant. The gas holder and the digester are combined together. This unit is entirely a masonry construction.

**Construction and Working**

The foundation of Janta or Janata bio gas plant is laid at the base of the under ground pit on a levelled ground bear the load of the slurry as well as digester walls. Digester is cylindrical in shape constructed with bricks and cements. It contains animal waste in the form of slurry. The diameter and height ratio fo the digester is kept 1.75 : 1 ratio.

The gas is stored in the gas portion, which is an integral part of plant, between the dome and digester. The heights of the gas portion is above the inlet and outlet.

Dome or gas holder rests on gas portion. It must be constructed such that no leakage of gas can take place. Gas pipe is fixed on the top of the dome. Inlet and Out let portions are constructed for putting the fresh slurry inside the plant and to take the digested sullury out. The inlet and outlet are of larger sizes, provided on each side of the digester, facing each other. The discharge of digested slurry occurs due to the pressure of the gas in the plant. Over the inlet portion an inlet mixing tank is also constructed to mix the dung and water.

### Bio gas Production

Bio gas produces in two phases.

1. Acid Phase and 2. Methane Phase

When the organic matter is decomposed or fermented in the absence of air anaerobic group organisms called acid formers produces. This is called as Acid Phase.

The Acid former bacterias are then converted in to Methane (CH<sub>4</sub>) and Carbon-di-oxide (CO<sub>2</sub>) after two weeks. The bacterias which are strictly anaerobs are called Methane former bacterias. The combination of Methane and Carbon-di-oxide is known as Bio gas.

The produced Bio gas stored in the gas holder can be utilised by opening the gas pipe according to our needs.

#### Data Required to be noted

Name of the Bio gas plant : \_\_\_\_\_

Location : \_\_\_\_\_

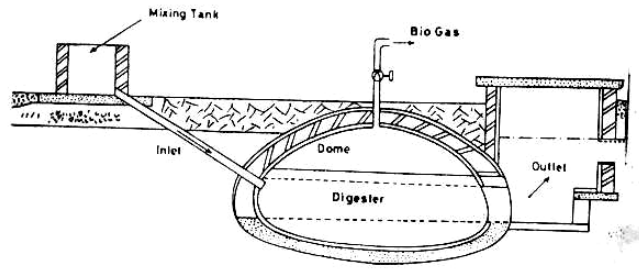
Sl. No.	Date of Feeding Bio Mass	Quantity of Cow Dung	Quantity of Water Mixed	Quantity of Bio Gas Production	Quantity of Bio Gas Produced

## EXPERIMENT NO : 7.4

**Aim :** Study of Deenabandhu Bio gas plant

**Apparatus :**

1. Digester
2. Gas holder
3. Gas pipe
4. Mixing pit
5. Out let
6. In let pipe
7. Out let pipe
8. Partition wall
9. Cow dung or organic matter
10. Water



**Description :**

Deenabandhu bio gas plant is also called as fixed dome type plant. The gas holder and the digester are combined together. This unit is entirely a masonry construction.

**Construction and Working :**

The principle of working of this plant is same as that of Janata model. The foundation of the plant is constructed in the spherical shape. The dome and digester is constructed with same base diameter. Hence the gas holder and digester look as a single unit. The brick masonry and concrete makes it safe, as the plant is always under pressure. In let and Out let portions are constructed for putting the fresh slurry inside the plant and to take the digested slurry out. The Inlet and Out let are of larger sizes, provided on each side of the digester, facing each other. The discharge of digested slurry, due to the pressure of the gas in the plant.

**Bio gas production :**

Bio gas produces in two phases

1. Acid phase and 2. Methane phase.

When the organic matter is decomposed or fermented in the absence of air, anaerobic group organisms called acid formers producers. This is called as acid phase.

The acid former bacterias are then converted in to Methane (CH<sub>4</sub>) and Carbon-di-oxide (CO<sub>2</sub>) after two weeks. The bacterias which are strictly anaerobes are called Methane former bacterias. The combination of methane and Carbon-di-oxide is known as Bio gas.

The produced Bio gas stored in the gas holder can be utilised by opening the gas pipe according to our needs.

**Data Required to be noted**

Name of the Bio gas plant : \_\_\_\_\_

Location : \_\_\_\_\_

Sl. No.	Date of Feeding Bio Mass	Quantity of Cow Dung	Quantity of Water Mixed	Quantity of Bio Gas Production	Quantity of Bio Gas Produced

**WIND ENERGY**  
**Experiment No : 8.1**

**Aim :** Study of Horizontal Wind Mill

**Apparatus :**

1. Induction generator and gear box
2. Blade (Single or Double or Multiblade)
3. Rotor
4. Transmission
5. Tower

**Description :**

In this, the axis of rotation of wind mill is horizontal. Horizontal axis wind mills are further classified as single bladed, double bladed and multibladed.

**Main components of the wind mill are :**

**(i). Rotor :** It consists of blades. Rotor is mounted on the horizontal shaft and connected to the generator through transmission with the help of bearings.

**(ii). Transmission :** It consists of gears, belts, chains, clutches etc., It controls the wind speed or rotor speed according to the generator speed. When the wind speed is low, the transmission system increases rotor speed. Similarly when the wind speed high, it decreases the rotor speed.

**(iii). Generator :** It generates Electricity

**(iv). Tower :** Tower is a supporting device. It holds all the parts of wind mill. It is made of reinforced concrete or Iron poles. The height of the tower depends on the capacity of the plant.

**Question for Evaluation :**

**After performing the practical task the students are required to answer the following questions :**

Q1. What are the main parts of Horizontal wind mill ?

Ans. 1. Introduction generator and gear box; 2. Hub; 3. Counter Weight; 4. Composite blade; 5. Tower.

Q2. How do you classify wind mills ?

Ans. Wind mills are classified as (a) Horizontal wind mills and (b) Vertical wind mills

Q3. What are caused because of two factors :

- (i) The absorption of solar energy on the earth's surface and in the atmosphere.
- (ii) The rotation of the earth about its axis and its motion around the sun

Q4. How wind mill works ?

Ans. A wind mill converts the Kinetic Energy of moving air into mechanical Energy that can be either used directly to run the machine or to run the generator to produce electricity.

## FUEL CELLS

### EXPERIMENT NO : 9.1

**Aim :** Study of Fuel cells.

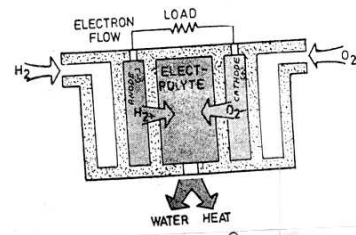
**Apparatus :** 1. Hydrogen electrode (Anode)  
2. Oxygen electrode (cathode) and  
3. An electrolyte

**Description :**

A cell or combination of cells capable of generating an electric current by converting the chemical energy of a fuel directly into electrical energy. Fuel cells are efficient and quiet, operate on a variety of hydrocarbon fuels, and produces almost no objectionable emissions.

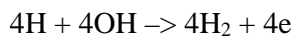
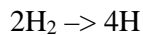
**Working of fuel cell :**

The fuel cell consists of an anode, a cathode and an electrolyte. Hydrogen fuel is fed in to the anode side of the cell. Positive  $H_2$  ions move from the anode side and enter the electrolyte through porous cell walls. The anode is left with a negative charge. Air is fed into the cathode side.  $O_2$  ions enter the electrolyte leaving the cathode with a positive charge. Excess anode electrons flow to the cathode creating a current flow.  $H_2$  and  $O_2$  ions combine in the electrolyte to form water which leaves the cell as steam.

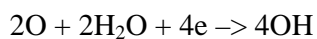
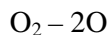


The reactions taking place at the electrodes are given below.

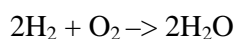
(1). Hydrogen electrode (anode)



(2). Oxygen electrode (Cathode)



(3). Over all cell reaction.



**Questions for Evaluation :**

**After performing the practical task the students are required to answer the following questions :**

Q1. What are the apparatus required for fuel cells ?

Ans. 1. Hydrogen electrode (Anode)  
2. Oxygen electrode (Cathode) and  
3. An electrolyte.

Q2. Define fuel cell ?

Ans. A fuel cell is capable of generating an electric current by converting the chemical energy of a fuel directly into electrical energy.

Q3. Write the chemical reactions which took place at the Hydrogen electrode ?

Ans.  $2\text{H}_2 - 4\text{H}$   
 $4\text{H} + 4\text{OH} - 4\text{H}_2 + 4\text{e}$

Q3. Write the chemical reactions which took place at the oxygen electrode ?

Ans.  $\text{O}_2 - 2\text{O}$   
 $2\text{O} + 2\text{H}_2\text{O} + 4\text{e} - 4\text{OH}$

Q4. Write the overall cell reaction ?

Ans.  $2\text{H}_2 + \text{O}_2 - 2\text{H}_2\text{O}$