Vaibhav Bhagwat Harinkar

Course No :- ENGG - 243

SEM - IV (NEW)

MO. NO - 8408079028.

Q1. Define Renewable Energy & Give its classification

Renewable Energy :- Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves and geothermal heat.

OR material that can be replaced through natural / or human processes

Types of Energy

Basically energy can be classified into two types

① potential energy
② kinetic energy.

① potential energy :- potential energy is stored energy and the energy of position. It exist in various forms.

② kinetic energy :- kinetic energy is energy in motion. the motion of waves, electrons, atoms, molecules, and substances. It exist in various forms.

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Various forms of energy

① **Chemical energy :-** chemical energy is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, Natural gas, propane and coal are examples of stored chemical energy.

② **Nuclear Energy :-** Nuclear energy is the energy stored in the nucleus of an atom – the energy that holds the nuclear together. The nucleus of a uranium atom is an example of nuclear energy.

③ **Stored mechanical energy :-** Stored mechanical energy is energy stored objects by the application of a force. eg:- compressed springs & rubber bands

④ **Gravitational Energy**

Gravitational energy is the energy of place or position. water in a reservoir behind a hydropower dam is example of Gravitational energy.

⑤ **Radiant Energy :-** Radiant energy is electromagnetic energy that travels in transverse waves. eg:- x-ray, Gamma

⑥ **Thermal Energy :-** Thermal energy is the internal energy in substance. eg:- Geothermal energy.

⑦ **Electrical Energy :-** Electrical energy is the movements of electrons. Lightning and electricity are example.

⑧ **Motion :-** The movement of objects from one place to another is motion eg:- Wind, Hydropower.

⑨ **Sound :-** sound is the movement of energy through substances in longitudinal waves.

⑩ **Light energy :-** Light energy is a type of wave motion. That is, Light is a form of energy caused by light waves. It enables us to see, as objects are only visible when they reflect light into our eyes.

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Classification of energy Resources

① commercial primary energy resources

→ Non- Renewable sources of energy or conventional sources of energy are being accumulated in nature.

→ For very long time and can't be replaced if exhausted. Nature gifted resources which are consumed can't be replaced.

Eg:- coal, petroleum, natural gas, thermal power, Hydro power, etc.

② Renewable sources of energy

→ Energy sources which are continuosly and freely produced in the nature and are not exahaustible are known as renewable energy sources.

→ Eg:- solar energy, biomass, wood energy, wind energy.

③ New sources of energy

→ The new sources of energy is available for local exploitation. In many cases, autonomous and small power plants can be built to avoid transmission losses.

→ Most prominent new sources of energy are tidal energy, ocean waves, peat, tar sand, oil shales, coal tar, geo-thermal energy, etc.

→ The total energy production in India is $1455g \times 10^{15}$ Joules. 93% of India requirement of commercial energy is being met by fossil fuel, with coal contributing 56%, oil gas 37%.

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Q2. Define Biofuel and write down the production process of ethanol and biodiseal. with environmental beneffits.

Biofuel :- A Biofuel is a fuel that is produced through contemporary biological processes such as agriculture and anaerobic digestion rather than a fuel produced by geological processes such as those involved in the formation of fossil fuels, such as coal and petroleum, from prehistoric biological matter.

production process of ethanol

Ethanol :- A colourless volatile flammable liquid which is produced by the natural fermentation of sugar alcohol.

Production process

→ Ethanol can be commercially produced by a variety of methods. The fermentation method is the one which makes use of naturally occuring renewable raw materials.

→ Any material, which is capable of being fermented by enzymes, can serve as a source for ethanol production.

→ Farm crop residue, starch based feed stock include cereals, grains & tubers like cassava, yam sweet potato, etc

→ Starchy feed stocks can be hydrolyzed to get fermentable sugar syrup and give average yield up to 42 litres / 100 kg feed stock.

→ The starch bearing materials are steamed for one to two hours at 2-3 atm. pressure.

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→ The resultant pulp is cooled at 50°c and equal volume of water and 10% malt is added.

→ The mixture allowed to stand for short time for starch is converted into dextrin. The Temp. raised 50°c while dextrin is converted first to maltose and then dextrose

→ Yeast is added to liquid mash & fermentation is allowed for a couple of day. The yeast converts sugar into ethanol. The ethanol water mixture is sent through additional distillation columns where ethanol concentration is increased to 190 proof (95%). This in turn is dried through an extra active distillation process to yield 200 proof ethanol.

→ Distillation columns separate ethanol from the fermented mash, with additional purification taking place in rectification columns to produce an ethanol and water mixture.

→ Dehydration is the step of removing the last of the water, taking the mixture beyond its azeotropic equilibrium to produce anhydrous ethanol, or bio-ethanol.

Bio - Diseal :- vegetable oils and their derivatives (especially methyl esters), commonly refered to as bio-diseal, are prominent candidates as alternatives diseal fuels.

The Three basic routes for biodiseal production from non-edible oil generally widely used are as follows :- ① Acid catalyzed esterification of the oil with methanol.

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② conversion of the oil to fatty acids and then to methyl esters with acid catalysis.

③ Base catalyst transesterification of the oil with methanol.

Biodiseal production process

→ 15 - litre measured quantity of fresh, moisture free oil has to be poured in the reactor vessel.

→ Heat the oil up to 55°C temperature and continuously stirred at constant slow speed.

→ The 55°C oil temperature and stirring speed has to be maintained for period of 1 Hour.

→ After the period of 1 hour poured reactant material into transparent vessel and allowed cooling at room temperature for settling and separation of glycerin at bottom.

→ put the upper biodiseal into other transparent vessels for ~~settling and separation~~ washing with equal amount of water.

→ Bubble washing with water will remove most of the impurities from the biodiseal.

→ The valve takes out upper layer of washed biodiseal from the bottom milky water. which contains dissolve KOH.

→ The biodiseal has to heat up to 110°C for 10 minutes to remove excess water if present Then biodiseal was cooled down to room temperature before use.

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Q 3 Define Biogas & write down its process of production, composition, features and classification of biogas. (4)

Biogas :- A mixture of methane and carbone dioxide produced by the decomposition of plant and animal waste, that used as fuel.

Process of biogas production.

* Anaerobic digestion *

The treatment of any slurry or slude containing a large amount organic matter utilizing bacteria and other organisms under anaerobic condition is commonly referred as anaerobic digestion. Anaerobic digestion consist of the three stages :- ① Enzymatic Hydrolysis
② Acid formation
③ Methane formation

① Enzymatic Hydrolysis

In this stage, a group of facultative micro-organism acts upon the organic matter and convert insoluble, complex, high molecular compounds of biomass into simple, soluble, low molecular compounds. The organic substances such as polysaccharide protein and lipid are converted into mono-saccharide peptide, amino acids, and fatty acids, Then they are further converted into acetate, propionate and butyrate.

2) Acid formation

The micro organisms of facultative and anaerobic

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group collectively called as acid formers, hydrolyse and ferment the productions of first phase. i.e- water soluble substances into volatile acid.

→ The major component of the volatile acid is the acetic acid. In addition to acetate or hydrogen and carbon dioxide, some other acids like butyric acid and propionic acid are also produced.

③ Methane formation

→ Finally, acetate or hydrogen plus carbon dioxide are converted into gas mixture of methane (CH_4) & CO_2 by the bacteria which are strictly anaerobes.

→ These bacteria are called methane fermentators.

→ For efficient digestion, these acid formers and methane fermentators must remain in a state of dynamic equilibrium.

→ The remaining indigestible matter is refers as slurry.

Composition of biogas

Compounds	Formula	Percentages (%)
Methane	CH_4	50 - 75
Carbon dioxide	CO_2	25 - 50
Nitrogen	N_2	0 - 10
Hydrogen	H_2	0 - 1
Oxygen	O_2	0 - 0.5

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Classification of Biogas / Types of biogas

i) Floating dome type

Eg - KVIC (Khadi Village Industries commission).

ii) Fixed dome type

Eg:- Janata type (Chinese model).

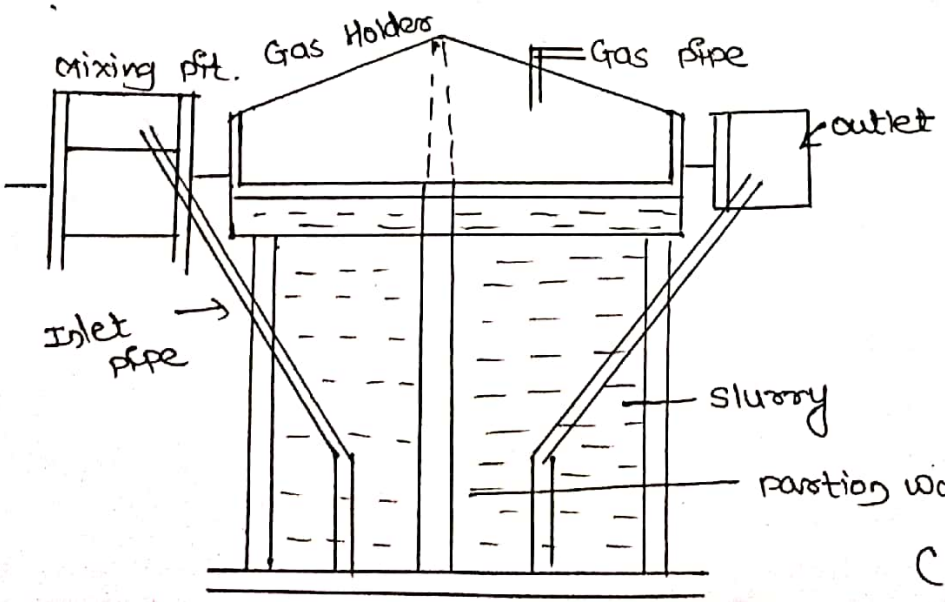
1] KVIC type biogas plant

→ This mainly consists of a digester or pit for fermentation and a floting drum for the collection of gas. Digester is 3.5 - 6.5 m in depth and 1.2 to 1.6 m in diameter.

→ There is a partion wall in the centre, which divides the digester vertically and submerges in the slurry when it is full.

→ The digester is connected to the inlet & outlet by two pipes. Through the inlet, the dung is mixed with water (4:5) and loaded into the digester.

→ The fermented material will flow out through outlet pipe. The outlet is generally connected to compost pit.



(KVIC Biogas Plant)

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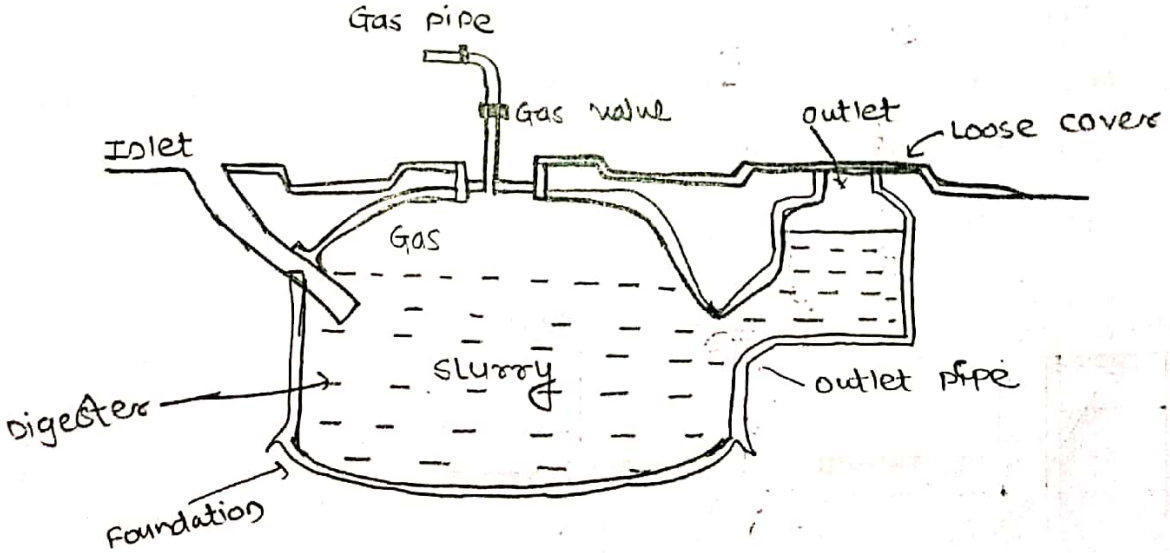
2] Janata type Biogas plant

The design of this plant is of chinese origin but it has been introduced under the name of Janata biogas plant. by Gobar Gas Research station, Ajitmal in view of its reduced cost. This is a plant where no steel is used. there is no moving part in it and maintainance cost is low.

→ The plant can be constructed by village mason taking some pre explained precautions and using all the indigenously available building materials.

→ Good quality of bricks and cement should be used to avoide the afterward structural problems like cracking of the dome and leakage of gas.

→ This model have a higher capacity when compared with KVIC model, Hence it can be used as a community biogas plant.



Janta biogas plant.

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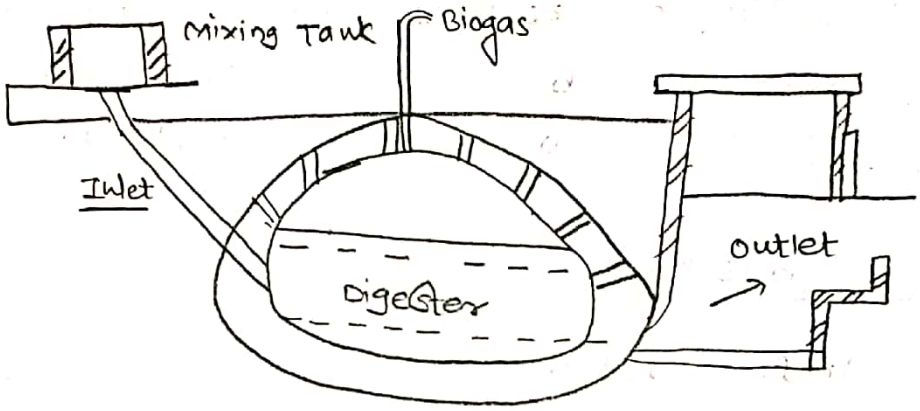
③ Deenbandhu Biogas plant.

→ This is a fixed dome type biogas plant developed by Action for food production (AFPRO), New delhi in 1984. In order to have low cost biogas model.

→ The principle of working is as same as that of Janta model. The foundation in these type of plants is constructed in conical shape which is section of a sphere. On the outer periphery of this foundation, work of dome shape digester is started of which base diameter is kept same as that of top diameter of foundation.



Application of Biogas

1) It can illuminate a mantle lamp (60 W) for 7 Hours.
2) It can be used for cooking three meals for a family of five.
3) It can run 2 hp engine for one hours.
4) It can run 100 lit capacity refrigeration for 9 Hrs.
5) It can generate electricity of 1.25 KWH.

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Q4. Define Gasifier and types of gasifers, Gasification process and its constituents.

Gasification :- Gasification is the process of converting solid biomass with a limited quantity of air into producer gas.

OR The process to convert biomass solid raw material into fuel gas or chemical feedstock gas is called gasification or thermo – chemical gasification.

Gasifiers :- Gasification of wood and other agricultural cellulosic residue was a common practice at the beginig of this century to produce low calerific fuel gas.

Types of Gasifiers

1. Updraft Gasifiers.
2. Down draft Gasifiers.
3. Cross draft gasifiers.
4. Fluidized bed gasifiers.
5. Open top gasifiers.

① Updraft gasifiers

→ The oldest and simplest type of gasifier is the counter current or updraft gasifier.

→ Air is introduced at the bottom and act as countercurrent of fuel flow.

→ The gas is drawn at higher location. The updraft gasifier achives the higest efficiency. The air intake is at the bottom and the gas leaves at the top. Near the grate at the bottom.

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→ In the upper part of gasifier, heating and pyrolysis of the feedstock occurs because of heat transfer by forced convection and radiation from the lower zone. as well as posibility of operation with many types of feedstock (sawdust, cereal hulls, etc).

② Down draft Gasifier

→ Air enters at the combustion zone and the gas produce leaves near the bottom of the gasifier.

→ In this types of gasifier. The volatile and the tar produced from the descending fixed bed have to pass through the reaction zone where mostly they are cracked and Gasified. In addition, a speciel funnel shaped construction, called the throat is prowided in the heart just below the air entry point, which ensure that the gaseous products pass through the hottest zone.

→ Thise gasifier are switable for fuels like wood, agricultural wastes and other uncarbonized residue.

→ They may be used for power generation up to some 150 KW and beyond that, there may be geometrical limitations upon gas quality.

③ Cross-draft Gasifier

→ In a cross-draft gasifier, air is fed into the gasifier through a horizontal nozzle. The resulting fuel gas is discharged through a verticle grate on the opposite side of the air injection location.

→ The biomass can be fed to the gasifier either from the top or from the side.

→ The reaction in the cross-draft gasifier are similar to downdraft gasifier.

→ The crops grown for ...

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④ Fluidized bed gasifier

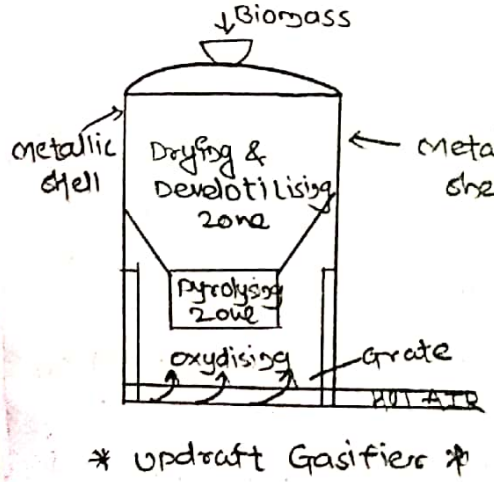
→ The selection of the design of the gasifier, either fixed bed or fluidized bed, will depend on the actual application. The performance of a fixed bed gasifier will depend on fuel properties, such as chemical composition, volatile content, calorific value, size distribution and ash characteristics.

→ On contrast, a fluidized and gasifier is more versatile and any biomass can be gasified using this type of gasifier.

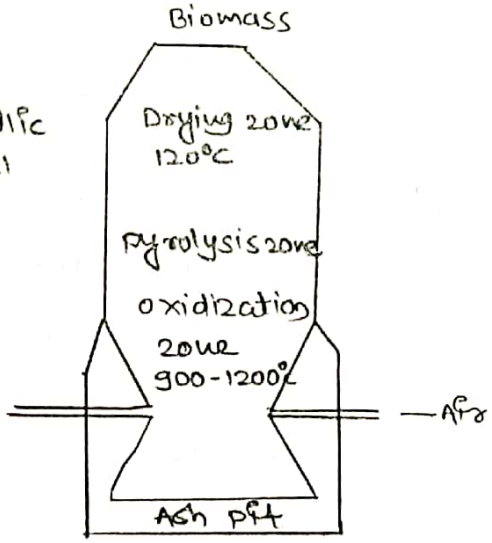
⑤ Open Top Gasifier

→ It is recent development in the field of gasification where, the top of the reactor is open to access the atmospheric air. The biomass material is feed from the top of the gasifier and the air for gasification is supplied from the bottom or at the middle of the reactor

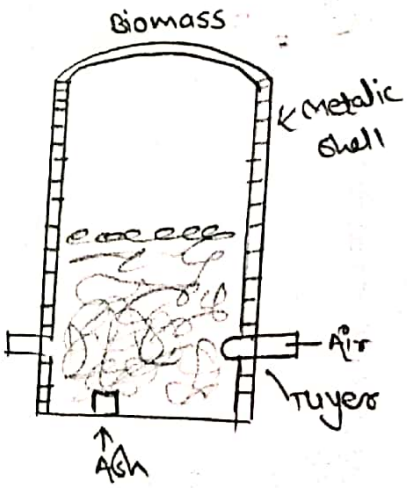
→ The gas outlet is placed at top of the reactor. The tar content in producer gas is very low as compared to the other system.



* Updraft Gasifier *



② Down draft



④ cross-draft gasifier.

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* Gasification Process *

→ It is the process of converting solid fuels, such as wood, agricultural residues and coal, into a combustible gas. A biomass gasifier consist primarily of a creator or container into which fuel is fed along with a limited supply of air.

→ Heat for gasification is generated through partial combustion of the feed material. The resulting chemical breakdown of the fuel and internal reactions result in a combustible gas usually called producer gas.

→ The heating value of of this gas is in the range of 4-6 MJ/Nm³, or about 10-15 % of the heating value of natural gas.

→ Producer gas is the mixture of the combustible gases hydrogen (H_2), carbon monoxide (CO) and methane (CH_4) and the incombustible gases carbon dioxide (CO_2) and nitrogen (N_2). The actual gas composition may vary considerably depending on fuel type and gasifier design.

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Q5 what is bio-oil and pyrolysis oil and destructive distillation.

Bio-oil :- pyrolysis oil, sometimes also known as biocrude, or bio-oil, is a synthetic fuel under investigation as substitute for petroleum. It is obtained by heating dried biomass without oxygen in a reactor at temperature of about 500°C with subsequent cooling.

* pyrolysis oil & destructive distillation *

→ Destructive distillation is the chemical process of the decomposition of unprocessed material by heating it to a high temperature, the term generally applies to processing of organic material in the absence of air or in the oxygen or other reagents, catalysts, or solvents, such as steam or phenols.

→ The process break up or cracks large molecules.

→ coke, coal gas, gas carbon, coal tar, ammonia liquor, and coal oil are example of commercial products historically produced by the destructive distillation of coal.

→ Destructive distillation of any particular inorganic feedstock produces only a small range of products as a rule, but destructive distallation of organic material commonly produces very many compounds, often hundreds, although not all products of any particular process are commercially important.

→ The distillate are generally lower molecular weight

→ currently the major Industrial application of destructive distillation is to coal.

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* Process of pyrolysis *

→ The process of pyrolysis can be conducted in a distillation apparatus to form the volatile products for collection.

→ The mass of the product will represent only a part of the mass of the feedstock, because much of the material remains as char, ash, and non-volatile tars.

→ In contrast, combustion consumed most of the organic matter, and net weight of the products amount of roughly four times the mass of the fuel consumed.

Applications

① Destructive distillation of wood produces hundreds of compounds including tar, terpenes, turpentine and methanol together with a solid residue of charcoal.

② Destructive distillation of a ton of coal can produce 700 kg. coke 100 litres of liquor ammonia, 50 litre of coal tar and 400 m^3 of coal gas.

③ Creation of synthetic rubbers such as neoprene.

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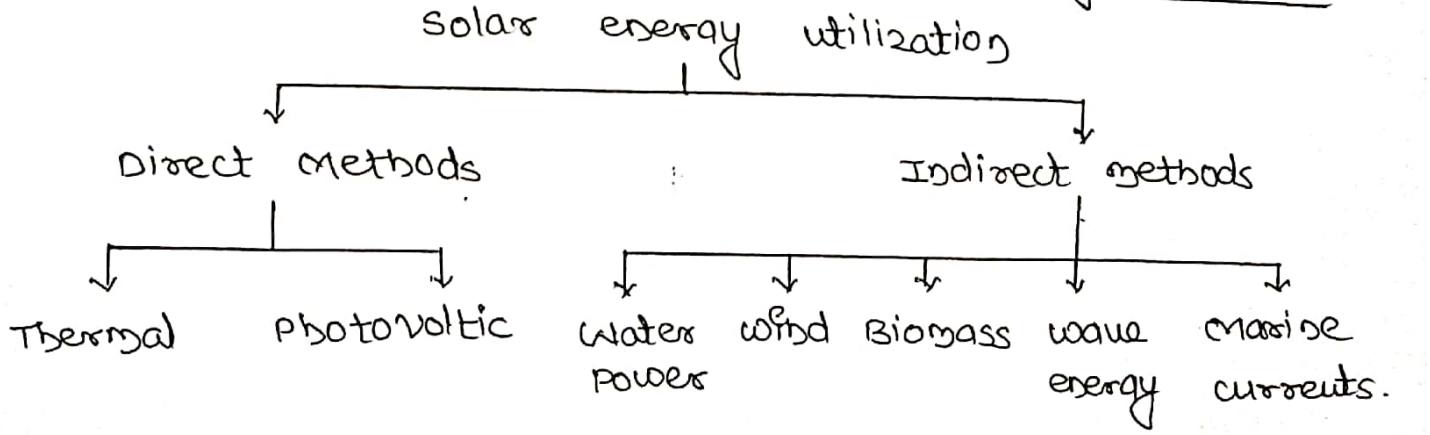
Q6 Define solar energy & what are the application of solar energy.

Solar energy :- Solar cells can be used to generate electricity from sunlight. It is device that converts light energy into electrical energy.

Applications of solar energy.

1] Heating and cooling of buildings
2] solar water and air heating
3] salt production by evaporation of seawater.
4] Solar distillation
5] Solar drying of agricultural products.
6] Solar cookers
7] solar water pumping
8] solar refrigeration
9] Electricity generation through photo voltaic cells.
10] Solar furnaces
11] Industrial process heat.
12] solar thermal power generation.

* Classification of methods for solar energy utilization *



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Q7 Enlist solar energy devices and explain in detail.

solar energy devices

1) solar cooker
2) solar water Heater
3) solar distillation
4) Solar dryer
5) Solar pond
6) Solar photovoltic ~~cell~~ system (SPV)

① **Solar cooker :-** solar cookers works on the principle of conversion of solar energy into heat for cooking of the food material in a closed container.

There are two types of solar cookers.

① Box type solar cooker.
② concentrating solar cooker

① Box type

→ A box solar coocker is a device that coocks food, using heat from the sun. It consist of an inswlated box with a glass cover and a top lid, which has a mirror inside to refelct sunlight into the box when the lid is kept open.

→ The inner part of box is painted black. usually four black painted vessels are placed inside the box along with the material to be cooked.

→ The cooking time is about 1/1½ to 3 hours depending on the items being cooked and the intensity of solar radiation. The cooker can be used for preparing food items like cakes, biscuits, deserts,

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pickles, sweets, etc.

→ Apart from cooking normal food. It can also be used for roasting groundnuts and cashew nuts, drying grapes, etc.

Advantages :- ① No required expense on fuel, A solar cooker if used regularly can save 3-4 LPG cylinder per years.

② It save time. Four item can cooked at same time.

③ There is no fear of overheating or burning of foods.

④ It ensures a better and more nutritions cooked food.

⑤ It acts as a hot case & keeps the food warm for several hours even after sunset.

⑥ It is eco-friendly & conserves energy.

Limitations :- ① A solar box coocker work well only on a clear sunny day.

② It can be used for boiling, rosting and baking but not for frying purpose.

③ cooking with solar cooker is slow.

Technical specification (Box type)

Reflector → 3 mm toughened Glass mirror.

Size → 0.5 m x 0.5 m x 0.165 m

Body → Aluminium

Temperature → 100 - 110°C

cooking capacity → 03 Litre

Cooking pots → 03

Insulation → Glass wool

Application → coocking of food without fuel & smoke

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2] Concentrating solar cooker

→ A parabolic solar cooker is a solar concentrating device made of highly reflecting aluminium sheets to or a spherical dish. The dish is oriented on a metallic stand, which has an arrangement of tracking the dish in the direction of sun at a point where the cooking pot is kept for preparation of the food.

Salient features

① A fast cooking device like LPG/ Kerosene stove. Frying and capati making is possible as the temperature attained at the bottom of the cooking pot is 350 - 400°C.

② Suitable for large families and small establishments like roadside dhabas, teashops, canteens. It can cook food for 10 - 15 peoples at a time.

③ Normally one dish can be cooked in 20 - 30 minutes.

Technical specification

Type :- parabolic solar cooker

model :- SK - 14

Reflector :- selective Aluminium sheet (Reflectivity > 75 %)

Diameter :- 1.4 m

Temp. :- 200 - 215°C

Thermal efficiency :- 40 %

Cooking capacity :- 13 litre / hrs.

Application :- community cooking, water Heating, mess.

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2] Solar Water Heater

→ small capacity domestic solar water heaters are also available in simpler design, in which the functions of the collector and storage tank are combine in one unit.

→ solar water heating is one of the most attractive solar thermal applications from and economic stand point. In India, a large number of systems have been installed. most of the systems use flat bed- collectors. It is cumulatively estimated that the total area of the flate- plate collectors in the systems installed in India till June 2006 is about 1.5×10^6 m².

→ most of the systems have capacities in the range of 100 – 200 litre per day.

→ The hot water is used for domestic purposes or for meeting the needs of industries & commercial establishments.

→ solar water heating systems can be classified into two categories

i) Natural circulation (thermo-syphon)
ii) Forced circulation system.

→ **Basic elements of solar water heating systems.**

① Flat plate collector
② Storage tank
③ circulation system
④ Auxiliary heating system.
⑤ control of the system.

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3] Solar Distillation system.

→ Distillation process is considered to be one of the simplest and widely adapted technique for distillation or converting seawater or blackish water into fresh water.

→ It is consists of insulated flat square pan having glass cover. The water is poured in to the pan.

→ Due to radiation, falling on glass the water get evaporated and condenses at glass cover due to low atmospheric temperature.

→ The glass is given 1':3 slope and Gallery is provided at the end of slope to collect distilled water.

→ These systems works by using the light and heat energy i.e. solar energy, which is radiated by the sun abundantly on the earth. Heat from the sun falling on the glass of the still is traped in the body where the hard water is kept.

→ Due to the heat, only pure water gets evaporated and comes at the bottom of the glass due to slope.

→ This distilled / evaporated water is collected through the semicircular PVC pipe.

Salient features

→ It produces distilled water at the rate of 3 - 3.5 lpd/m^2 of still area.

→ Any type of hardwater can be converted into fresh distilled water.

→ The powred water is used for laboratories, hospitals, battery station & drinking purpose.

→ No fuel or electricity is required.

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Specification

Principle - Natural Hydrological cycle.

Area - 1m x 1m

Inclination - 30%

Body - Fibre - Reinforced plastic

Glazing - 4mm Toughened glass.

output - 2.5 - 3 Lpd.

Efficiency - 65%

Application - Production of distilled water for Batteries, Hospitals, Drinking, etc.

* solar distillation system works on the principle of latent heat.

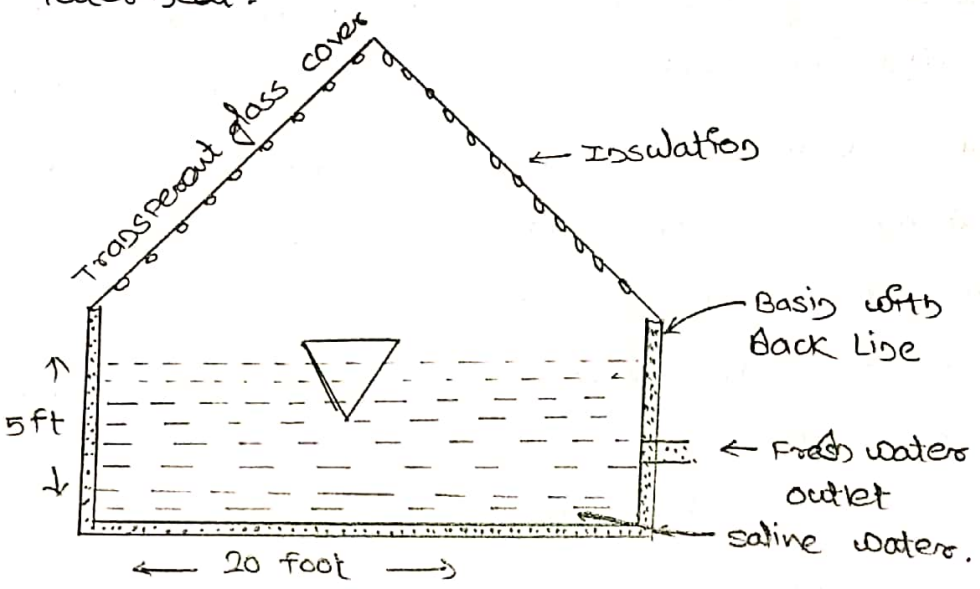

Fig:- solar distillation system.

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4] Write down in detail about solar dryers.

* Types of Dryers *

1] cabinate solar drying
2] convection solar dryer.
3] Natural open air dryer.
4] Direct solar dryer
5] solar chamber dryer
6] Indirect solar drier
7] solar drying barn
8] Chamber type solar drier.
9] solar timber drier.

⇒ solar drier works on principle of natural convection.

1] cabinate solar dryer.

→ The solar cabinate drier consist of a drying chamber with a transparent cover glass.
→ The material to be dried is placed on perforate trays.
→ Solar radition entering through the transparent cover in the drying chamber is absorbed by the product to be dried and surrounding blackened internal surface of it. This increases the cabinet temperature.
→ As a result, moisture is removed from the product.
→ The moisture (water vapor) liberated escaping through holes on the top sides of the drying chambers, while fresh air enters at the bottom in the drier by natural circulation. The airflow, thus, started continuously removes moisture from the products.

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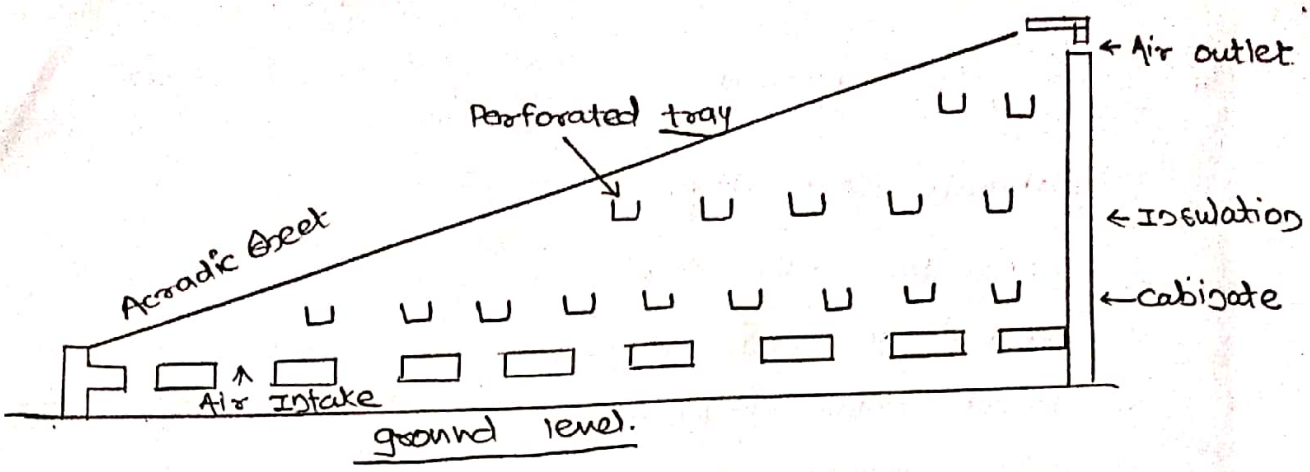

Fig :- Cabinate drier.

3] Natural open drier

→ These are very simple in construction, material to be dried is placed outdoor on a tray, a rack or the floor, and is dried by ambient sunshine and wind. some of this drier can have a fixed or movable roof to protect the crop against rain.

4] Direct solar dryer

→ In these driers, the material to be dried is placed in transparent enclosure of glass or plastic.

→ The material to be dried is heated by the sun and heat is built up inside the enclosure due to green house effect. sometimes ventilation through the enclosure is introduced via vents or chimneys.

5] solar chamber drier

→ solar chamber drier for grain incorporates a drying chamber on poles raising the system 0.5 m off the ground so as to prevent rodent attack. Air is allowed to permeate the grain from below through the still mesh mounted on a rectangular wooden frame. The increase internal temperature of chamber.

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6] Indirect solar driers.

→ In this drier the sun does not act directly on the material to be dried. Thus making it useful in the preparation of those products whose ultimate content can be severely diminished by the action of sunlight. Air is heated in a special solar collector and is then ducted through to the drying chamber where the material to be dried is situated, and released. A chimney is usually introduced in order to improve air flow.

→ The indirect solar drier concept is flexible in that it can be incorporated into any crop storage building eg- bin, barn.

7] Solar drying barn

→ It is aligned longitudinally on an east-west axis, with the solar collector on the south facing side of the roof. The roof surface is painted black to absorb the solar energy. A transparent plastic material is supported 80 mm above the roof on a frame. The air drawn by a fan enters the top of the roof and moves through the collector roof down the south wall in the outside air duct. From here, the fan pushes the warm air in the inside air duct and through the grain and a perforated floor.

8] Mixed mode dryier

In these driers; the combined action of solar radiation incident on the material to be ried and the air preheated in a solar collector provides the heat required for the drying operation.

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5] Solar pond write in detail.

Solar pond :- A solar pond is a solar energy collector, generally large in size that looks like a pond. This type of solar energy collector uses a large, salty lake as a kind of a flat plate collector that absorbs and stores energy from the sun in the warm, lower layers of the pond. These ponds can be natural or man-made, but the solar ponds that are in operation today are artificial.

→ The solar pond is a simple device for collecting and storing solar heat. The solar pond combines solar energy collection and sensible heat storage. solar ponds are also called solar salt ponds.

Applications :- a) heating and cooling of buildings.
b) power generation
c) Agricultural crop drying.
d) desalination
e) Industrial process heat
f) Production of renewable liquid fuels.

Limitations :- a) Need for large land area.
b) required sunny climate.
c) Availability of ~~back~~ brackish water.

Types of solar ponds

1) convecting solar pond
2) Non-convecting solar pond.

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1] Convective solar ponds

Convective solar pond reduces heat loss by being covered a transparent membrane or glazing. Glazing material for the solar pond are polyvinyl chloride (PVC) film and clear acrylic panels.

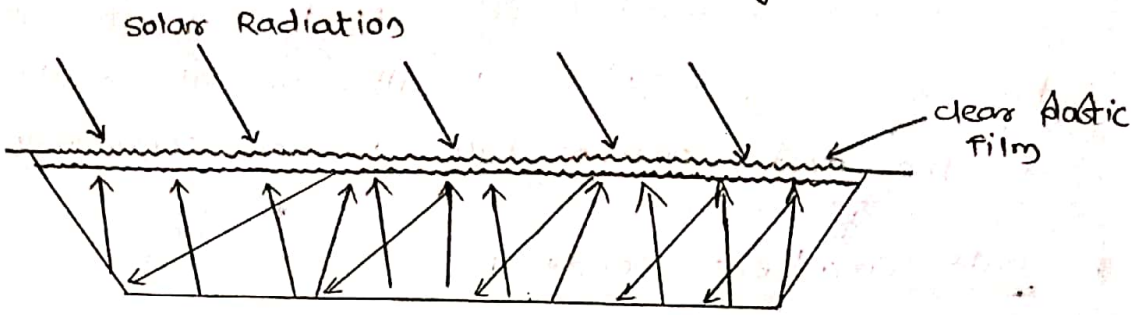

Fig:- Schematic diagram of convective solar pond.

→ Each pond module includes a long, narrow plastic bag measuring 5×60 cm containing water 5-10 cm deep.

→ The bag has a transparent top to allow transmission of sunlight and to prevent evaporation losses. The bottom of the bag is black to absorb sunlight.

→ A layer of insulation beneath the plastic bag minimizes heat losses to the ground, one or two layers may be arched over the bag of water to suppress convective and radiative losses. In this type of solar pond, the hot water is removed late in the afternoon and stored in insulated reservoirs.

2] Non-convective solar ponds.

→ Non-convective solar ponds prevent heat losses by inhibiting the convective forces caused by thermal buoyancy.

→ In convective solar ponds, solar radiation is

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transmitted through the water to the bottom, where it is absorbed; in turn the water adjacent to the bottom is heated. Natural buoyancy forces cause the heated water to rise, and the heat is ultimately released to the atmosphere.

→ In a non-convective solar ponds may be stabilized by viscosity, a gel or a salt. The salt gradient pond is the most common type of non-convective solar pond.

* Salt Gradient ponds *

A solar pond is mass of shallow water about 1-1.5 m deep with a large collection area, which acts as a heat trap. It contains dissolved salts to generate a stable density gradient. salts have been dissolved in high concentrations near the bottom, with decreasing concentration towards the surface. The salts most commonly used for salt gradient ponds are sodium chloride and magnesium chloride.

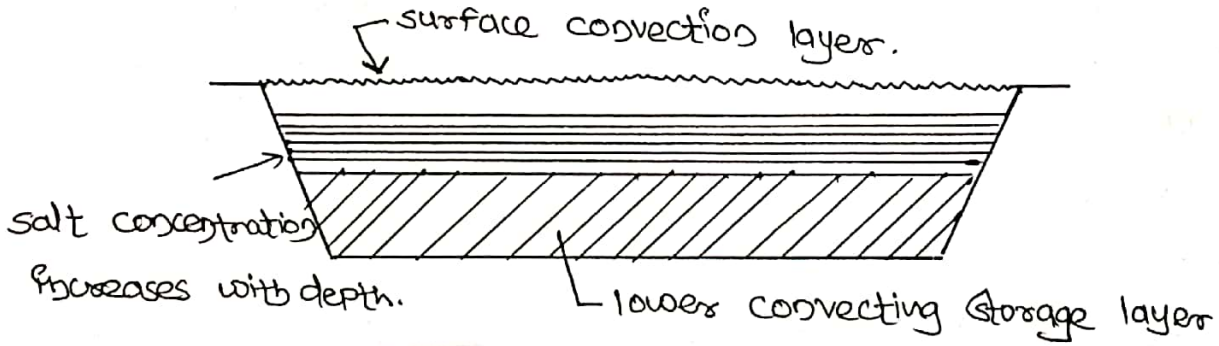

fig:- salt gradient pond.

In the top layer, vertical convection takes place due to effects of wind evaporation. There is no membrane or glazing covering this pond. The next layer, which may be as much as about one meter thick, contains an increasing concentration of salt with increasing depth. This layer is non-convective. The bottom layer is a convective layer of essentially salt conc. which provides thermal storage.

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6] Solar photovoltic system (SPV)

→ The most useful way of Harvesting solar energy is by directly converting it into DC electricity by means of solar photo-voltic cells.

→ Energy conversion devices which are used to convert sun light to electricity by the use of photo-voltaic effect are called solar cells.

→ The voltage generated by a solar cell depends on the intensity of solar radiation and the cell surface area receiving the radiations.

→ The maximum achievable power is about 100 W/m² of solar cell surface area.

Types of solar cells

1) Monocrystalline silicon cells.
2) Polycrystalline silicon cells.
3) Amorphous silicon cells.
4) Gallium arsenide (GaAs)
5) Copper Indium diselenide (CID) cells.

1] Mono crystalline silicon solar cells.

→ A silicon solar cell of size 10cm x 10cm produces a voltage of 0.5 V and power output of 1 W at a radiation intensity of 1000 W/m².

→ The solar cells are formed into modulus by enclosing in an air tight casing with a transparent cover of synthetic glass.

2] Poly crystalline silicon solar cells :-

The higher efficiency of solar module is 12 to 14%.

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* Advantages of photovoltaic solar energy conversion.

1) Absence of moving parts
2) Direct conversion of light to electricity at room temperature.
3) Low maintainance cost
4) No environmental pollution
5) very long life
6) Highly reliable
7) Solar energy is free and no fuel required.
8) Easy to fabricate.

* Limitation of photovoltaic solar energy conversion

1) Manufacture of silicon crystals is labour and energy intensive.
2) The principle limitations is high cost.
3) solar power plants require very high land areas.
4) Electrical generation cost is very high.

* Types of SPV *

① Solar lantern.
② Solar street light.
③ Solar fencing system.

① Solar lantern.

→ A solar lantern is a simple application of solar photovoltaic technology, which has found good acceptance in rural regions where the power supply

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is irregular and scarce.

→ Even in the urban areas people prefer a solar lantern as an alternative during power cuts because of its simple mechanism.

→ The solar energy is converted to electrical energy by the SPV panel and stored in a sealed maintainance - free battery for later use during the night hours.

Applications & use

→ Emergency or house lighting, table lamp, camping, patrolling, vendor stalls, mass communication, etc.

Benefits :- It is easy to install, no electrical connection is required and no electrical charges.

Safety features :- system is completely shock proof due to low voltage circuitry and short circuit protection.

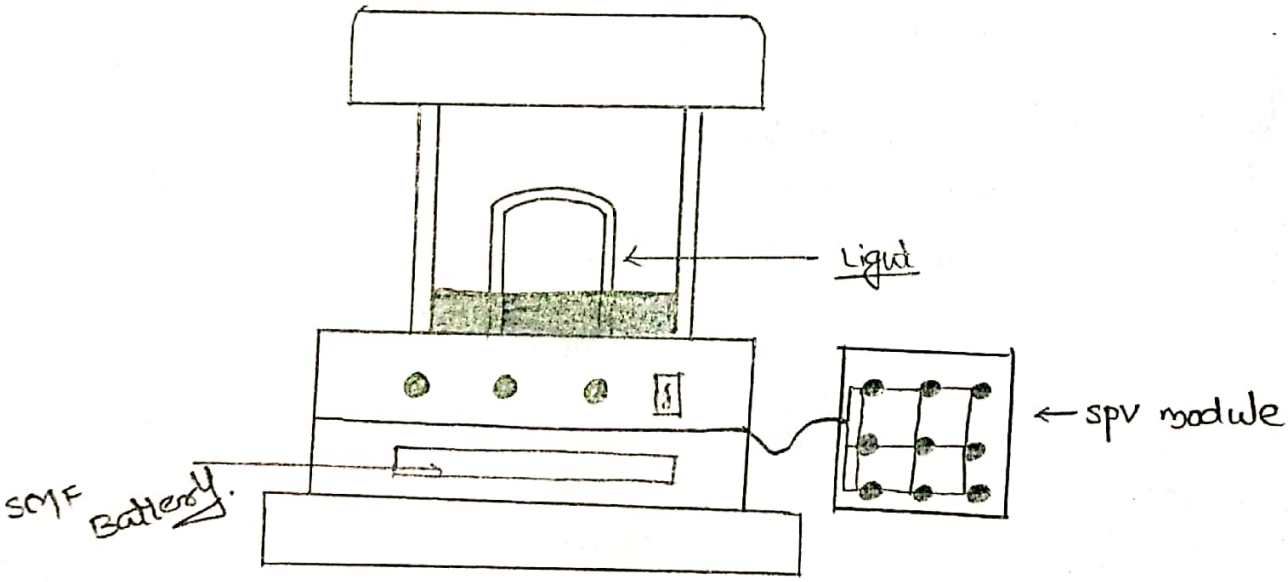

Fig :- solar lantern.

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2] solar street light

→ This systems is designed for outdoor application in un-electrified remote rural areas. This systems is an ideal application for campus and village street lighting.

→ The system is provided with battery storge backup sufficient to operate the light for 10-11 hours daily. The system is provided with automatic ON/OFF time switch for dusk to down operation and overchange/deep discharge prevention cut-off with LED indicators.

The solar street light system comprise of

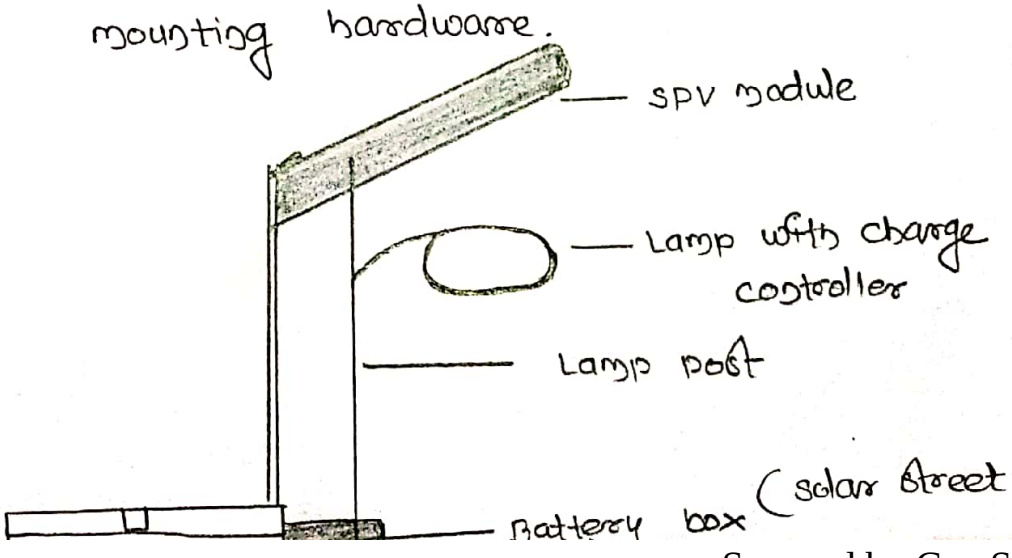
a) 74 Wp solar PV module

b) 12 V, 75 Ah Tubular plate battery with battery box.

c) charge controller cum inverter (20-35 KHz)

d) 11 watt CFL Lamp with fixtures.

e) 4 metre mild steel lamp post above ground level with weather proof paint and mounting hardware.



(solar street light)

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Q8 Define wind energy and write down its characteristics measurment equipments, conversion systems, and use of wind energy.

Wind energy :- wind energy is a renewable energy source that uses wind power to generate electricity. The primary means to obtain it are the turbines, windmills,.

characteristics

① Wind power system is non-polluting.

② It is renewable source of energy.

③ The energy generated by wind - power system is cheaper when produced on smaller scale.

④ Wind energy system avoid fuel provision & transport.

Measurement equipments.

1) cup anemometer with vane

2) Anemometers

conservation systems of wind energy.

→ Wind energy conversion systems (WECS) are designed to convert the energy of wind movement into mechanical power. with wind turbine generators, this mechanical energy is converted into electricity and in wind mills this energy is used to do work such as pumping water, mill grains, or drive machinery.

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use of wind energy.

→ wind power is the use of air flow through wi turbines to provide the mechanical power to turn electric generators. wind power, as an alternative to burning fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emission during operation, consumes no water, and uses little land.

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Q 9 Enlist the other renewable energy sources & explain in detail.

1] ocean thermal energy.
2] Tidal energy
3] Geothermal energy.
4] Hydrogen energy.
5] Fuel cells
6] Hydroelectric

1] Ocean thermal energy conversion (OTEC)

→ Ocean thermal energy conversion uses the temperature difference between cooler deep and warmer shallow or surface seawaters to run a heat engine and produce useful work, usually in the form of electricity.

2] Tidal energy.

→ Tidal power or tidal energy is a form of hydropower that converts the energy obtained from tides into useful form of power, mainly electricity. Although not yet widely used tidal energy has potential for future electricity generation.

3] Geothermal Energy

Geothermal energy is thermal energy generated and stored in the earth. Thermal energy that determines the temperature of matter.

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5] Fuel cell

→ A fuel cell combines hydrogen and oxygen to produce electricity, heat and water. Fuel cells are often compared to batteries. Both convert the energy produced by a chemical reaction into usable electric power.

6] Hydro-electric

→ Hydroelectricity is electricity produced from hydropower In 2015, hydropower generated 16.6% of the worlds total electricity and 70% of all renewable electricity, and ~~water~~ was excepted to increase about 3.1% each year for the next 25 years.

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