Model Answer Paper

MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END THEORY EXAMINATION
B.Sc. (Hons.) Agriculture

Semester	: IV (New)	Term	: II	Academic Year	: 2022-23
Course No.	: ENGG-243	Title	: Renewable Energy and Green Technology		
Credits	: 2 (1+1)				
Day & Date	:	Time (hrs.)	: 2 hrs.	Total Marks	: 40

Note :
1. Solve **ANY EIGHT** questions from **SECTION 'A'**.
2. All questions from **SECTION 'B'** are compulsory.
3. All questions carry equal marks.
4. Draw neat diagrams wherever necessary.

SECTION 'A'

Q.1 What is biomass? Give the uses of biomass. 4M

2.3 Definition of Biomass

Biomass is the name given to combustible organic matter that has been derived from living organisms as a result of the photosynthetic conversion process. Biomass energy is derived from plant and animal material, such as wood from forests, residues from agricultural and forestry processes, and industrial, human and animal wastes.

Biomass is sources for producing feed, food, fiber, fertilizer and fuel for mankind & its associates activities. The energy value of biomass from plant matter originally comes from solar energy through the process known as photosynthesis (Fig 2.2). The chemical energy that is stored in plants and animals, or in the wastes that they produce, is called bioenergy. During conversion processes such as combustion (burning), biomass releases its energy, often in the form of heat, and the carbon is reoxidised to carbon dioxide to return the carbon that the organism absorbed while growing back to the environment. Essentially, the use of biomass for energy is the reversal of photosynthesis.

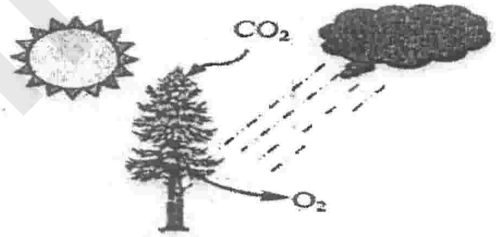


Fig. 2.2 Photosynthesis in plant

2.4 Biomass Uses

In nature, all biomass ultimately decomposes to its elementary molecules with the release of heat. Therefore the release of energy from the conversion of biomass into useful energy imitates natural processes but at a faster rate. Therefore, the energy obtained from biomass is a form of renewable energy. Utilising this energy recycles the carbon and does not add extra carbon dioxide to the environment over time, in contrast to fossil fuels. Among all the renewable sources of energy, biomass is unique in that as it is effectively stored solar energy. Furthermore, it is the only renewable source of carbon, and is able to be processed into convenient solid, liquid and gaseous fuels. Biomass can easily be used for meeting energy requirement for domestic industrial and power generation sectors. There are number of applications of the biomass

Biomass can be used directly (eg burning wood for heating and cooking) or indirectly by converting it into a liquid or gaseous fuel (eg ethanol from sugar crops or biogas from animal waste). The net energy available in the biomass when it is combusted ranges from about 8MJ/kg for green wood, to 20MJ/kg for oven dry plant matter, to 55MJ/kg for methane; compared with about 23 - 30MJ/kg for coal. The efficiency of the conversion process determines how much of the actual energy can be practically utilised.

Q.2 | Explain KVIC biogas plant with its advantages and disadvantages. | 4M

(A) KVIC plant : In 1945 scientists of Indian Agricultural Research Institute (IARI), New Delhi worked on semi-continuous flow digesters and in the year 1961 Khedi and Village Industries Commission (KVIC) patented a design which is being popularized by various agencies in many countries. This design consists of a deep well shaped underground digester connected with inlet and outlet pipes at its bottom, which are separated by a partition wall dividing the ¾th of the total height into two parts. A mild steel gas storage drum is inverted over the slurry which goes up and down around a guide pipe with the accumulation and withdrawal of gas. Now FRP and ferro-cement gas holders are also being used in the KVIC plant (Fig. 5.1).

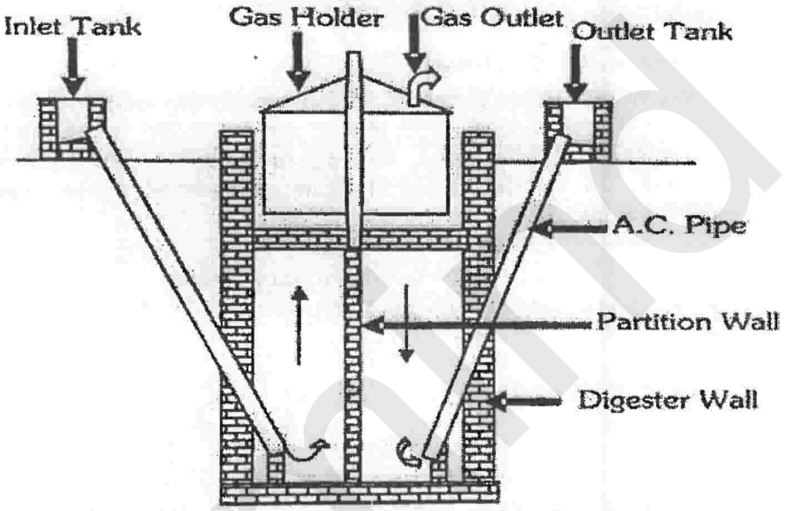


Fig. 5.1 Schematic View of KVIC biogas plant

Advantages of KVIC plant:

(i) Constant gas Pressure.
(ii) Minimum gas leakage problem.
(iii) Higher gas production.
(iv) Scum problem is minimum.
(v) Pressure is naturally equalizes.
(vi) No danger of mixing between biogas and external air. Hence no danger of explosion.

Disadvantages of KVIC type:

(i) Higher cost.
(ii) Higher maintenance cost.
(iii) The outlet pipe should be flexibale. It requires regular attention.
(iv) Heat is lost through gas holder.

Q.3 What is gasification? Enlist types of gasifiers and explain downdraft gasifier. 4 M

~~3.8~~ Gasification and Type of Gasifiers

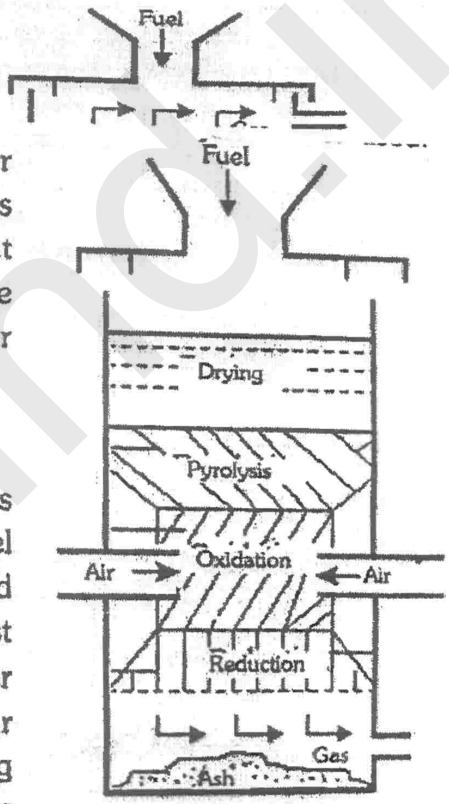
Gasification is a step forward to carbonisation, where end product of carbonisation is finally converted into gaseous mixture of combustible nature. This mixture is known as producer gas, which can be used for meeting domestic and motive power requirement. Design of gasifier depends upon type of fuel used and whether gasifier is portable or stationary. Gasifiers are classified according to air blast introduction in the fuel column and how producer gas travels in the reactor before its final use. The most commonly built gasifiers are classified as :

1. Updraft gasifier
2. Downdraft gasifier
3. Twin-fire gasifier
4. Crossdraft gasifier
5. Fluidized bed gasifier
6. Other gasifier

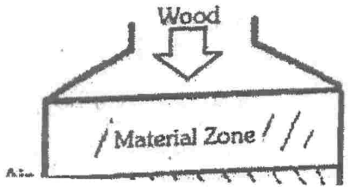
Disadvantages of updraft gas producer are excessive amount of tar in raw gas and poor loading capability. Hence it is not suitable for running vehicle. The updraft gasifier is suitable for low tar fuel such as charcoal and coke.

~~3.8.2~~ Downdraft Gasifier

The downdraft gasifier was developed to convert high volatile fuel (wood, biomass) to low tar gas and therefore has proven to be the most successful design for power generation. In this type of gasifier, air is introduced into downward flowing packed bed or solid fuels and gas is drawn off at the bottom (Fig. 3.2). A lower overall efficiency and difficulties in handling higher moisture and ash content fuel are common problems in small downdraft gas producers. The time (20-30 minutes) needed to ignite and bring plant to working temperature. it is appropriate design for running vehicle.



~~Fig. 3.2~~ Downdraft gasifier



Q.4 | Explain box type solar cooker. | 4M

~~6.4.2~~ Indirect or Box type Solar Cooker

Box type solar cooker is a typical example of solar energy devices, which demonstrate application of good reflector, absorber and transmitter.

In this type of solar cooker direct interception of solar radiation through glazing and indirect interception through reflection from plane mirror is made on the black body (insulated hot box) where raw material is placed for cooking. The insulated hot box may be square, rectangular or cylindrical in shape, which is painted black from inside with double-glazing for direct interception of solar radiation. The indirect entry of solar radiation through reflection is provided by single or multiple reflectors. Here the adjustment of cooker toward the sun is not so frequently required as in the case of direct type of solar cooker. It is slow cooker and takes long time for cooking and many of the dishes require roasting and baking can not be prepared with this cooker.

The commercially available box type solar cooker is illustrated in the Fig. ~~6.7~~. It has following important parts.

A. **The outer box :** The outer box of a solar cooker may be made of wood, iron sheet or fiber reinforced plastic having suitable dimensions, which accommodate black body (inner box) and insulating pads.

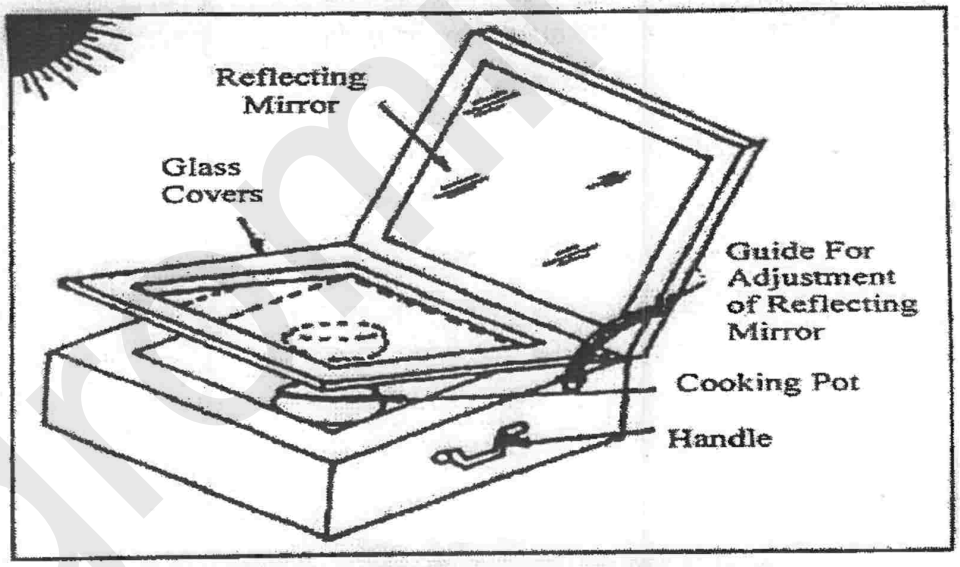


Fig. ~~6.7~~ Simple Box type Solar Cooker

B. **The inner box :** The inner box may be made from G.I. sheet or aluminum sheet. All the four sides and the bottom of the inner box, which are exposed to the sun, are coated with black board paint for absorbing maximum amount of solar radiations. In fact, it is acting as black body, which absorbs energy directly intercepting through glazing and secondary reflecting form the plane mirror.

C. **Insulation** : The hot box must be thermally insulated so that heat gain through solar radiation be effectively used for cooking purpose. Therefore, the space between outer box and inner box must be filled with a quality insulating material such as glass wool, thermocole etc. A suitable thickness of good quality insulating materials maintained the temperature of inner box.

D. **Double Glazing** : A double glass cover is provided on the top of the inner box. These covers have length and breadth slightly greater than the inner box and can be fixed in a wooden frame maintaining a small spacing between the two glasses. This air cavity between glazing act as a insulator, which prevent heat losses from the inside box to top of the surface.

E. **Plane Mirror** : A plane mirror is attached to the cooker, so that it enhances the entry of solar radiation by about 50 per cent in the inner box. In fact plane mirror acts as reflector and it increases the radiation input on the absorbing surface.

F. **Cooking containers** : These containers with covers are made of aluminum or stainless steel and having dull black paint on their outer surface so that maximum amount of radiation can directly absorbed.

Q.5 What is solar water heating? Explain direct natural circulation type solar water heater 4 M

~~6.7~~ Solar Water Heater

Water heating is one of the simplest applications of solar energy. Hot water is requirement of domestic activities as well as industrial activities. Hot water in household in not only required for takeing both, but also used for cleaning utensils, washing cloths and floors etc. It has been observed that 100 litre solar water heater can saves about 2000 units of electricity annually if used for different application in a house hold or in industrial unit. Solar water heater offers a number of advantages such as:

1. Simple in construction and installation.
2. Almost no maintenance and operating cost.
3. It saves time and also energy for heating water.
4. Easily retrofittable to existing houses as per requirement.
5. Economically viable as compared to electric water heater.
6. Moderate temperature required, domestic affairs could easily achieved.

There are two basic types of solar water heaters: -

(a) Collector coupled to storage tank.
(b) Collector cum storage system.

First type of solar water can extract heat from solar collectors in two ways, namely through natural convection (also known as thermosyphon effect) and through a forced flow of water using an electrically operated pump. Collector coupled to storage tank type

of water heater is used, as domestic solar water heater where the maximum temperature required is not more than 70°C. A typical system consists of solar collector (front glazing), metallic absorber, back insulation and collector box, insulated storage tank (with or without heat exchanger), piping, controls and pump.

Here heating is accomplished by collection of solar radiation with flat plate collector mounted on south facing roof or walls. The collector is usually placed below the storage tank, cold water from the storage tank flows down to the inlet of the collector, gets heated in the collector and rises to the tank by thermosyphonic effect. A density difference created by the temperature gradient causes the fluid to flow up in the collector by the thermosyphonic effect (Fig. 6.11).

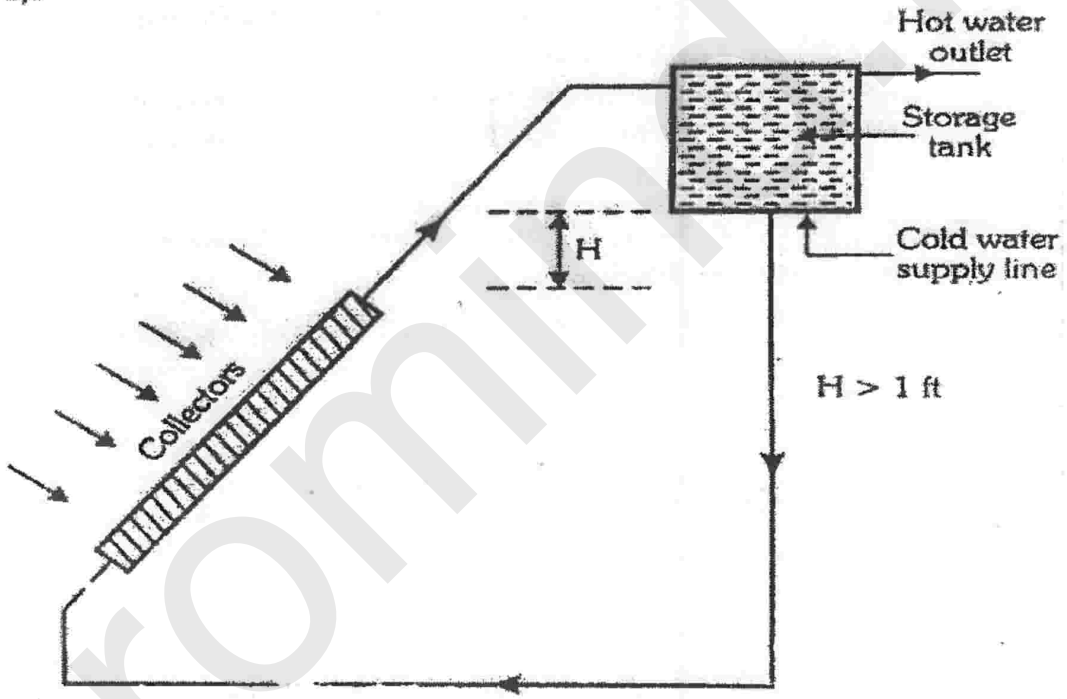


Fig. 6.11 Thermosyphon type Solar Water Heater (Direct Natural Circulation type)

Q.6	Discuss working of solar still.	4M

6.6.2 Operation of Simple Solar Still

In the solar still the incident solar radiation is transmitted through the glass cover and is absorbed as heat by a black surface in contact with the water to be distilled. The water is thus heated and

gives off water vapour. The vapour condenses on the glass cover, which is at a lower temperature because it is in contact with the ambient air, and runs down into a gutter from where it is fed to a storage tank. Here condensation is not drop wise, where as it is film wise, therefore condensed water along the glass cover is allowed to trap in a channel fixed at its bottom.

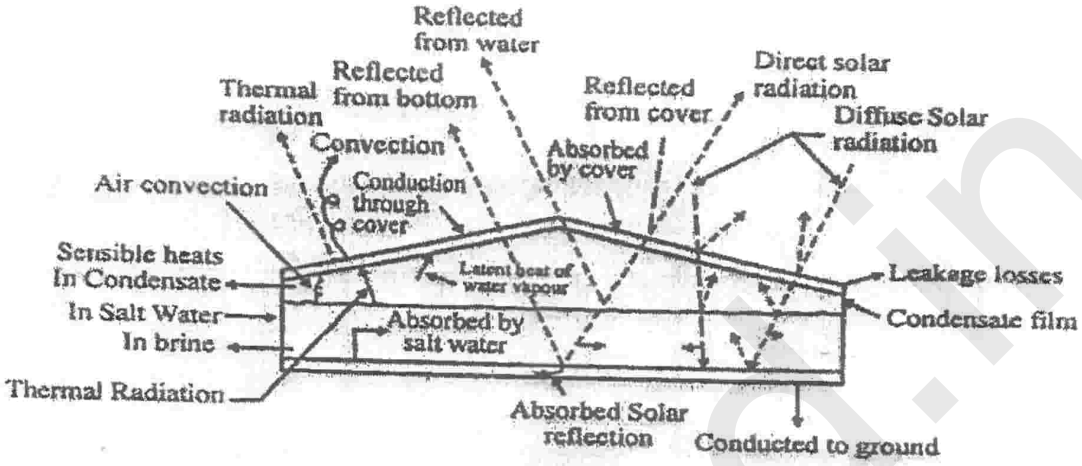


Fig. ~~6.10~~ Solar Still

For high efficiency the solar still should maintain:

- a high feed (undistilled) water temperature
- a large temperature difference between feed water and condensing surface
- low vapour leakage.

A high feed water temperature can be achieved if:

- a high proportion of incoming radiation is absorbed by the feed water as heat. Hence low absorption glazing and a good radiation absorbing surface are required
- heat losses from the floor and walls are kept low
- the water is shallow so there is not much heat required for evaporation.

A large temperature difference can be achieved if:

- the condensing surface absorbs little or none of the incoming radiation

Q.7 What is solar drying? Enlist different type of solar dryers. 4 M

~~6.5~~ Solar Drying

Drying is a universal method for preserving the food and thereby helps in storage and easy transportation, because food becomes lighter due to moisture removal. Dried product not only increased shelf life but also reduces cost of transportation and

enclosure for keeping the products to be dry with a transparent cover placed over the enclosure. The internal surfaces of the enclosure are painted black. The evaporation of moisture from the

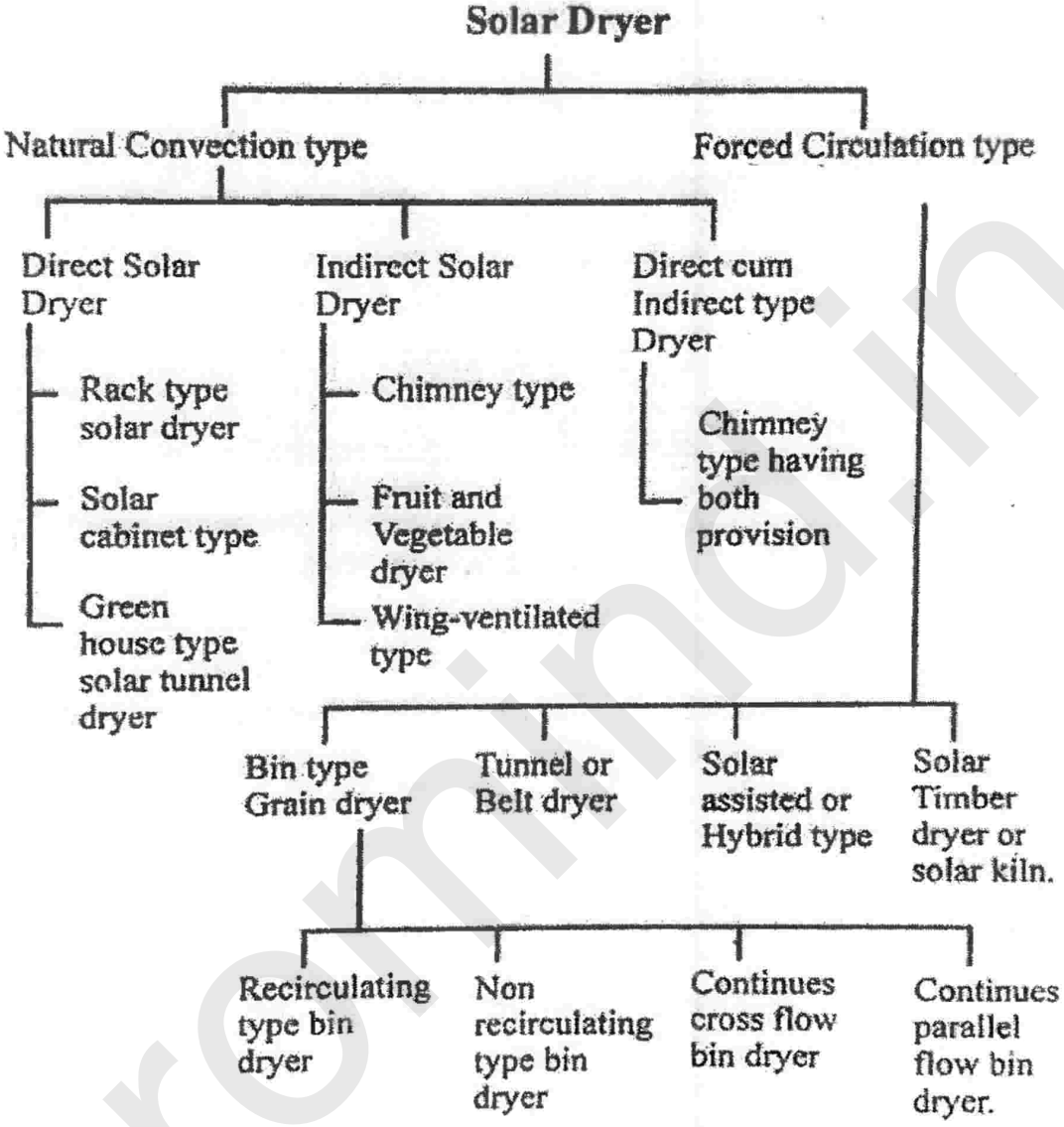


Fig. 6.8 Different type of Solar Dryer

product takes place due to direct absorption of solar radiation by the product as well as transfer of heat by the internal surface, which get heated by the radiation incident on them. Here, ultimately removal of moisture takes place through naturally created draft. In the forced circulation type solar dryer, air is heated through collectors and is forced on to the drying material. Such dryers are comparatively efficient, faster and can be used for drying large agricultural products.

Q.8 Discuss the application of solar photovoltaic system. 4M

~~7.8~~ Applications of Solar Photovoltaic

The electricity generated by solar photovoltaic system can be utilized for the following applications: Telecommunication, Railway signaling, Cathodic protection, Navigational aids, Traffic warning light, Remote instrumentation, Crop spraying, Water pumping,

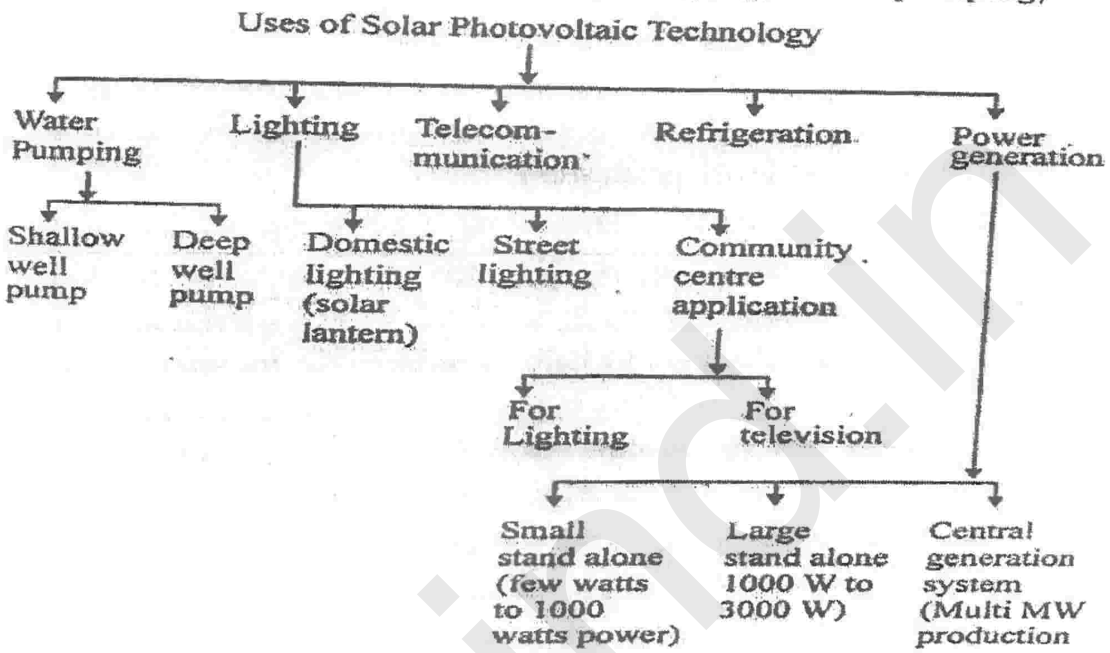


Fig. ~~7.8~~ Application of Solar Photovoltaic System

Vaccine refrigeration, Lighting system, Battery charging, Consumer products, Educational kits, Entertainment, Offshore application, Space applications, Rural electrification, Grid connected houses, Hydrogen production and alarm systems etc.

Solar photovoltaic system are used for meeting out various essential requirement, which are given in Fig. ~~7.8~~.

Q.9 Give the uses of wind energy system. 4M

~~8.7~~ Uses of Wind Energy Systems

Wind energy systems are a very reliable and versatile technologies which have been used for hundreds of years for different purposes. The various potential uses are as under

(a) **Water Pumping** : The wind has been used as a reliable and inexpensive power source for water pumping. Either a mechanical or electric water pumping system could be ideal for rural and remote locations to supply livestock, a household or even a small community (Fig.8.5).

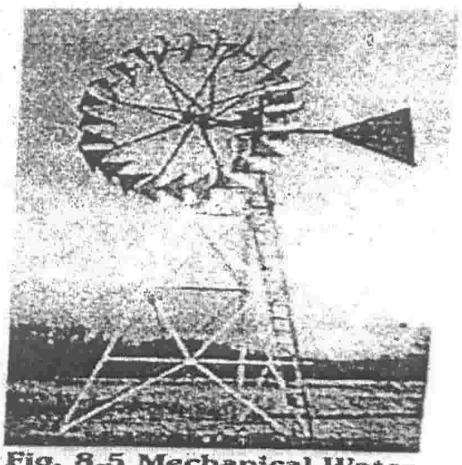


Fig. 8.5 Mechanical Water Pumping System

(b) **Remote Communities** : In remote communities where diesel generators often supply electricity, the use of wind energy not only makes environmental sense, it makes economic sense as well. Larger wind energy systems can reduce reliance on expensive and greenhouse gas-producing generators.

(c) **Recreation** : Using the wind as an energy source for your cottage or boat could be efficient and inexpensive when

compared to fossil fuel generators. An environmentally friendly wind energy system could power lights, radios and small appliances and many other recreation purpose.

(d) **Farm and Ranch :** Wind energy at farm level can not only used for water but it can do much more for a modern agricultural operation. Because they are ideal where remote, low voltage power is required, wind energy electrical generators are used for such farm systems as electric fences and yard lights and other on farm application.

(e) **Home Use :** There are good potential to integrate wind energy uses for rural homes for meeting essential energy requirement such as lighting and power generation. Rural home owners who want to help to reduce the environmental impact of their energy use can reduce their reliance on grid power with a wind energy system. Even a mini wind energy system saves electricity generated from fossil fuels or nuclear energy.

(f) **Battery charger and other application :** There are several types of wind energy systems which can be used for charging batteries. There are stand-alone systems which provide power solely from the wind. A stand-alone system may have a method for storing energy when wind conditions are not good. Usually, batteries are used for storage. There are hybrid systems which use another source of power, perhaps solar panels or a diesel generator, to supplement the energy provided from the wind. Often, a switching mechanism starts the generator remotely when the wind turbine cuts out.

There are also mechanical systems which are used to aerate ponds or pump water for livestock, irrigation or household water supplies. More than a million mechanical systems are said to be in use in the world today, most of them on farms.

Q.10

Compare conventional and non-conventional energy sources. 4M

The comparison of Conventional and Non-Conventional Energy sources is given Table 1.2.

Table 1.2: **Comparison of Conventional & Non-Conventional Energy Sources**

S. No.	Parameters	Conventional Energy Supplies	Non-Conventional Energy Supplies
1	2	3	4
1.	Source	Static Stores in Earth	Natural Sources
2.	Examples	Coal, Oil, Gas Biomass, Tidal	Wind, Solar,
3.	Nature of occupancy	Static Store of energy	A current of energy
4.	Normal State	Remain in bound position	Continuously or Repetitively released
5.	Initial Intensity	Released@100 kW/sqm & more	Low intensity, dispersed 300 W/sqm or less
6.	Life time of supply	Finite	Infinite
7.	Cost at Sources	Increasingly expensive	Free
8.	Conversion process/ Utilization device/ Transmission & Distribution media	Established / Commercialized	Under R&D stages, certain items are established
9.	Cost equipment	Moderate	Quite high in present context
10.	Variation & Control	Steady, best controlled by adjusting source with feed back control	Fluctuating, best controlled by change of load using feed forward control
11.	Location for use	General use	Site & location specific
12.	Scale of Production	Large scale	Small scale
13.	Skills or Production	Strongly available	Under R&D stage
14.	Skills for utilization	Strongly available	Under R & D stage
15.	Context of utilization	Urban, Centralized	Rural, Decentralized
16.	Dependence	System dependent on outside inputs	Self-sufficient encouraged
17.	Safety	Most dangerous when faulty	Usually safe when out of action
18.	Pollution & Environmental Damages	Environmental pollution common	Usually little harmful to the environmental especially at moderate scale
19.	Ecology Damage	Permanent damage common from Mining	Hazards from excessive wood burning/ soil erosion from excessive biofuel use.
20.	Esthetics	Small structure may produce little aesthetic difficulty.	Local perturbations may be serious.
21.	Economics	Availability is costly, but harnessing is within economic limit	Availability free, but harnessing is quite costly.
22.	Over benefit in present context	Finite source, may not remain in future	Infinite, locally available. No danger on source availability

SECTION 'B'			
Q.11		Define the following term	
	1)	Anaerobic digestion: Anaerobic digestion is the decomposition of wet and green biomass through bacterial action in the absence of oxygen to produce a mixed gas output of method and carbon dioxide known as biogas.	
	2)	Gasification: Gasification is a form of pyrolysis, carried out with more air and at high temperatures in order to optimize the gas production.	
	3)	Hydraulic retention time : The number of days the feed materials is required to remain in the digester to begin gas production.	
	4)	Solar cell: Solar cells are often referred to semiconductor device that convert sunlight in to direct current (DC) electricity.	
Q.12		Fill in the blanks	
	1)	Heat losses	
	2)	Earth planet	
	3)	4713	
	4)	South	

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