



**WINTER– 15 EXAMINATION**

Subject Code:17611

**Model Answer**

**Important Instructions to examiners:**

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

**Q. No 1 a)**

**i) OPEC members / countries:( 02 marks)**

Algeria, Angola, Equador, Iran , Iraq, Kuwait, Libiya, Nigeria, Qatar, Saudi Arabia, UAE, and venezuala.

**Policies of OPEC: ( 02 marks)**

OPEC is an Organization of the Petroleum Exploring Countries . It was founded in 1960. The head quarter wasin Gineva , Switzerland, before moving to Vienna, Austria.

Its important policies are-

# OPEC is an international organization whose mission is to co-ordinate the policies of oil producing countries.

# The goal is to secure a steady income to member states and to secure supply of oil to customers.

# To decide upon common pricing & overheads in view of oil supply world wide



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**ii) Advantages of Nuclear Plants ( anyfour , 02 marks)**

1. No emission of pollutant gases (co<sub>2</sub> and others) that would be generated by burning of fossil fuels.
2. The amount of fuel needed is very small as compared to fossil fuels. This saves on raw materials and also in transport & handling.
3. Production of electric energy is continuous.
4. As an alternative to fossil fuels need not consume as much of carbon fuels like oil, so therefore the problem of global warming is reduced.

**Disadvantages of nuclear Plants ( anyfour , 02 marks)**

1. A major drawback is the generation of nuclear waste and the difficulty to manage and it takes many years to lose its radioactivity and danger.
2. Nuclear reactors, once constructed, have an expiration date. After this date, they must be dismantled
3. Nuclear plants have a limited life afterwards disposal is very tedious.
4. Current nuclear reactors work by fission nuclear reactions. These chain reactions occur so that if the control systems should fail every time more and more reactions would occur to cause a radioactive explosion that would be virtually impossible to control.
5. Shortage of trained technical manpower.
6. High capital cost.

**iii) : ( 02 marks each definition)**

1) **Declination angle ( $\delta$ )** : It is the angle between a line extending from the centre of the sun to the centre of the earth and the projection of this line upon the earth's equatorial plane.

2) **Solar Incidence angle ( $\theta$ )** : it is the angle being measured between the beam of rays and normal to the plane.



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**iv) Classifications of Wind mill : :( 04 marks)**

- a) According to their axis of rotation
  - 1) Horizontal axis wind mill
  - 2) Vertical axis wind mill
- b) According to size of capacity
  - 1) Micro size
  - 2) Small size
  - 3) Medium size
  - 4) Large size
- c) According to applications
  - 1) interconnection with utility grid
  - 2) connected to power backup
  - 3) pumping windmill
  - 4) grain grinding windmill
- d) Based on type of rotor
  - 1) Propeler type
  - 2) Multiple blade type
  - 3) Savonius type
  - 4) Darrieus type

**Q.1b i) Flat Plate Solar water heater as a Natural Circulation Solar water heater**

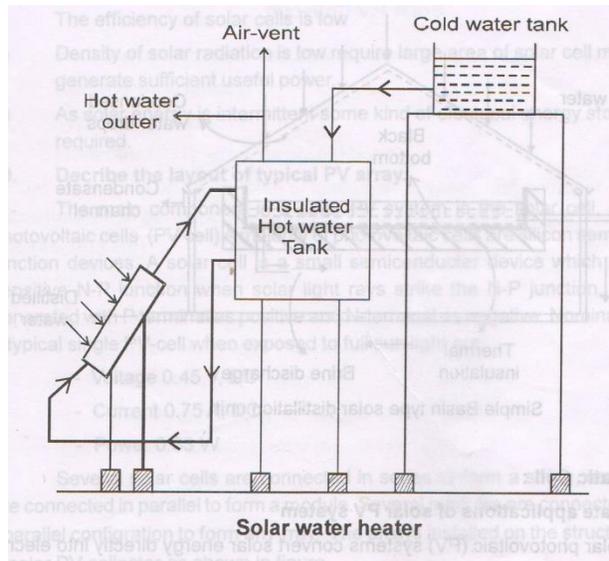
**(Three marks for sketch, three marks for explanation)**

Flat Plate Solar water heater: A tilted flat plate solar collector with water as heat transfer fluid is used in solar water heater system. A thermally insulated hot water storage tank is mounted above the collector. The heated water of the collector rises up to the hot water tank and equal quantity of cold water enters the collector. The cycle repeats, resulting in all the water of the hot water tank getting heated up. When water is taken out from hot water outlet, the same is replaced y cold water from cold water tank, fixed above the hot water tank.

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**Model Answer**

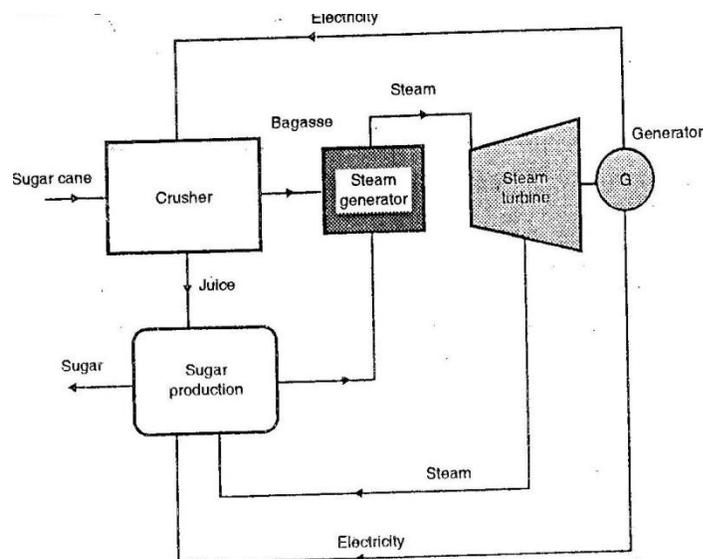
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**Q.No.1 b ii) Co-generation process in Sugar factory (Two marks each for figure and description)**

Co generation in Sugar factory: In sugar factory juice is extracted from cane and bagasse are burnt to generate steam. This steam is send to steam turbine to generate electricity. Extracted steam and low pressure steam from turbine is used in the process of sugar manufacturing.

In this way both electricity and steam, generated and used at the same place hence overall efficiency is increased.



**Co generation in sugar industry**

**Q.2 a (02 marks for each definition )**



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**Model Answer**

- i) **Solar altitude ( $\alpha$ ):** It is defined as the angle between the central ray from the sun , and a horizontal plane containing the observer is the Solar altitude angle. At the Sunrise and Sunset the solar altitude angle( $\alpha$ ) is zero
- ii) **Solar Zenith angle ( $\theta_z$ ):** It is complementary angle of suns altitude angle. It is a vertical angle between the sun's rays and a line perpendicular to the horizontal projection of the sun's rays.

**Q.2 b)** Advantages & Disadvantages of Concentrating collectors over flat plat collectors (02 marks for advantages and 02 for disadvantages)

Advantages :

- 1) High fluid temperatures upto 500 ° C
- 2) High collector efficiency
- 3) Reduced thermal losses
- 4) Low cost as less material required

Disadvantages :

- 1) Collects only beam radiations
- 2) Needs costly tracking device
- 3) Needs extensive maintenance
- 4) High initial cost
- 5) Non uniform flux on absorber plane

**Q.No.2c)** (One mark for each) (Any four)

Parameters of site selection of wind mill:

- 1) Availability of higher constant wind speed
- 2) Availability of wind at site through year
- 3) Altitude of the site
- 4) Availability of land
- 5) Connectivity to grid
- 6) Connectivity to the road
- 7) Easy access to locality/infrastructure
- 8) Ecology
- 9) Ground condition

**Q.No.2 d)** (one marks each)

**Benefits of Biomass as energy:**

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1) Biomass can be used for fuels, power production and products that would otherwise be made from fossil fuels.

2) Biomass can reduce dependence on foreign oil.

3) Biomass energy supports agricultural and forest-product industries.

4) The use of biomass energy has the potential to greatly reduce greenhouse gas emissions.

5) It is available in abundant quantity

6. It can be converted into several forms of energy

7. It is cheap compared to other energy sources

8. Unused agricultural land can be used

9. It is produced on a renewable basis

10. It is very low in sulphur

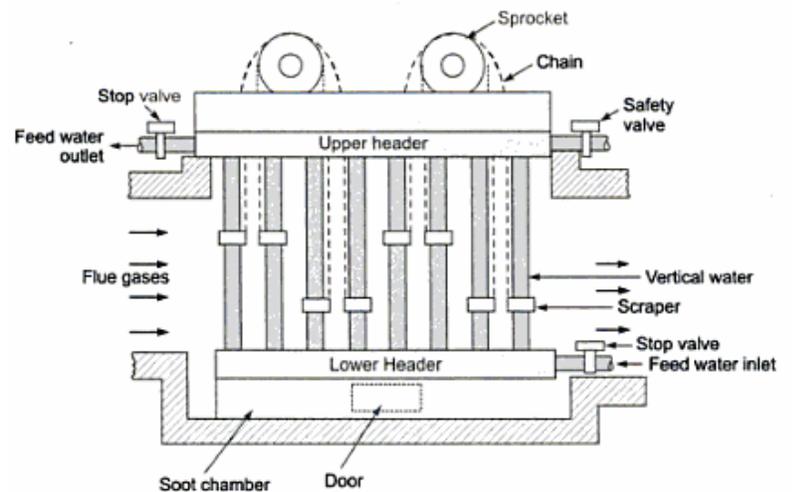
Q.No.2 e ) Economizer (02 marks for sketch and 02 for explanation )

An economiser is a heat exchanger used for heating the feed water before it enters the boiler. The economiser recovers some of waste heat of hot flue gases going to the chimney thus it helps in improving the boiler efficiency. It is placed in the path of flue gases at the rear end of the boiler just before the air preheater.

The most popular economiser is *Green's economiser* and it is shown in Fig.

Green's economiser consists of a set of vertical cast-iron pipes joined with horizontal lower and upper headers. The cold feed water flows through the vertical pipes via the lower header. The hot flue gases pass over them transferring heat to the water. The heated water is supplied to the boiler via the upper header. The scrapers are provided on pipes, which move up and down slowly by means of chains and sprockets to avoid the soot deposition on the pipe surface. The soot collected in the soot chamber can be removed from the door.

Each economiser is equipped with a safety valve, a drain valve, a release valve, pressure gauge and thermometers.





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**Model Answer**

**Q.No.2 f )Biomasses, Algae & its advantages (04 marks )**

Any organic matter formed directly or indirectly by virtue of photosynthesis is called as bio mass. Biomass can be converted to other usable forms of chemical energy carriers like methane gas or transportation fuels like ethanol and biodiesel. Rotting garbage, and agricultural and human waste, all release methane gas—also called landfill gas or biogas.

Crops, such as corn and sugar cane, can be fermented to produce the transportation fuel, ethanol. Biodiesel, another transportation fuel, can be produced from left-over food products like vegetable oils and animal fats.

- Crop residues
- Forest residues
- Agro industrial residues
- Animal waste
- Aquatic plants
- Purpose grown trees

Algae fuel or algal biofuel is an alternative to liquid fossil fuels that uses algae as its source of energy-rich oils. Several companies and government agencies are funding efforts to reduce capital and operating costs and make algae fuel production commercially viable/ feasible. Like fossil fuel, algae fuel releases CO<sub>2</sub> when burnt, but unlike fossil fuel, algae fuel and other biofuels only release CO<sub>2</sub> recently removed from the atmosphere via photosynthesis as the algae or plant grew.

The energy crisis and the world food crisis have ignited interest in alga-culture (farming algae) for making biodiesel and other biofuels using land unsuitable for agriculture.

**Advantages:**

Among algal fuels' attractive characteristics are that they can be grown with minimal impact on fresh water resources.

They can also be produced using saline and wastewater.

They are bio-degradable and relatively harmless to the environment.

**No.3 a )Need & future prospects of alternate energy sources (04 marks for need and 04 for prospects )**



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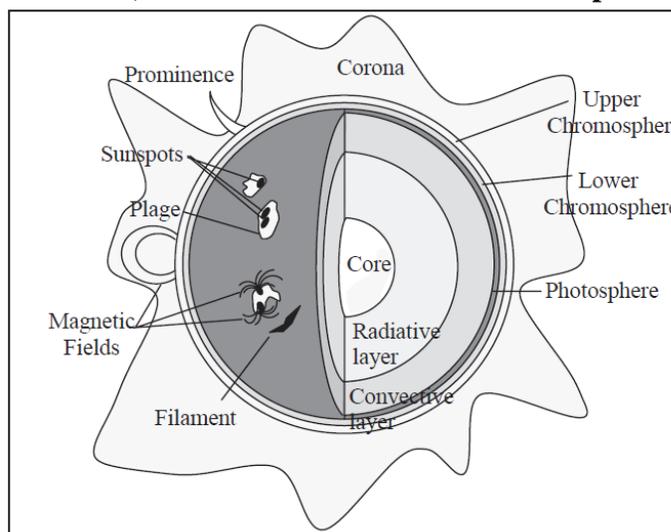
**Model Answer**

Because of the following reasons there is a need of developing, tapping, using the different alternate energy sources from future demand point of view..

1. The supply of crude oil will fail to meet increasing demand.
2. Demand for energy is continuously growing. To meet this alternate energy source is essential
3. Coal reservoirs are unable to fulfill the energy demand
4. Nuclear energy, hydroelectric energy, wind energy, solar energy sources are utilized but they are also unable to meet energy demand.
5. India is blessed with a variety of renewable energy sources, the main ones being biomass, biogas, the sun, wind and small hydro power.
6. Municipal and industrial wastes can also be useful sources of energy, but are basically different forms of biomass. Biogas plants, improved wood stoves, solar water heaters solar cookers, solar lanterns can be used at large.
7. Different forms of biomass such as municipal and industrial wastes are the useful sources of energy. New technologies such as biogas plants improved wood stoves, solar water heater, solar cookers, solar lanterns, street lights; pumps wind electric generators biomass gasifiers are becoming commercially available.

In view of the above, we need to reduce our dependency on oil ,coal and nuclear fuels and their imports. Therefore we need to increase our oil and gas production and look for alternate sources energy for our power needs.

**No.3 b )Structure of a sun (04 marks for sketch and 04 for explanation )**





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**Model Answer**

Figure shows structure of sun with all its layers and parts. In studying the structure of the Sun, solar physicists divide it into four domains: the interior, the surface atmospheres, the inner corona, and the outer corona. The Sun's interior domain includes

- i) Core
- ii) The radiative layer, and
- iii) The convective layer.

The core is the source of the Sun's energy, the site of thermonuclear fusion. At a temperature of about 15,000,000 K, matter is in the state known as a plasma: atomic nuclei (principally protons) and electrons moving at very high speeds.

Above the radiative layer is the convective layer where the temperature is lower, and radiation is less significant.

The solar surface atmospheres are composed of the photosphere and the chromosphere. The photosphere is the part of the Sun that we see with our eyes—it produces most of the visible (white) light.

**Q.No.3c )Biomass & Energy extraction methods from it (04 marks for explanation and 04 for methods )**

Any organic matter formed directly or indirectly by virtue of photosynthesis is called as bio mass. Important organic matter that is used as a biomass..

- Crop residues
- Forest residues
- Agro industrial residues
- Animal waste
- Aquatic plants
- Purpose grown trees

Various methods for obtaining energy from biomass are listed as below

- I. Combustion
- II. Anaerobic digestion
- III. Pyrolysis
- IV. Hydrolysis and ethanol fermentation
- V. Gasifier

**Q.4 a i) (Two marks for principles and two for components )**

**Photovoltaic materials :**



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**Model Answer**

Photo-voltaics (PV) comprises the technology to convert sunlight directly into electricity. The term “photo” means light and “voltaic,” electricity. A photovoltaic (PV) cell, also known as “solar cell,” is a semiconductor device that generates electricity when light falls on it. While most PV cells in use today are silicon-based, cells made of other semiconductor materials are expected to surpass silicon PV cells in performance and cost and become viable.

**Types of PV cell materials**

PV cells are made of semiconductor materials. The major types of materials are crystalline and thinfilms, which vary from each other in terms of light absorption efficiency, energy conversion efficiency, manufacturing technology and cost of production. The rest of the paper discusses the characteristics, advantages and limitations of these two major types of cell materials.

**Single-crystal silicon**

Single-crystal silicon cells are the most common in the PV industry. The main technique for producing single-crystal silicon is the Czochralski (CZ) method. High-purity polycrystalline is melted in a quartz crucible. A single-crystal silicon seed is dipped into this molten mass of polycrystalline.

**Polycrystalline silicon**

Consisting of small grains of single-crystal silicon, polycrystalline PV cells are less energy efficient than single-crystalline silicon PV cells.

**Gallium Arsenide (GaAs)**

A compound semiconductor made of two elements: gallium (Ga) and arsenic (As), GaAs has a crystal structure similar to that of silicon. An advantage of GaAs is that it has high level of light absorptivity.

**Thin Film Materials**

In a thin-film PV cell, a thin semiconductor layer of PV materials is deposited on low-cost supporting layer such as glass, metal or plastic foil.

**Amorphous Silicon (a-Si)**

Used mostly in consumer electronic products which require lower power output and cost of production.

**Cadmium Telluride (CdTe)**

As a polycrystalline semiconductor compound made of cadmium and tellurium, CdTe has a high light absorptivity level -- only about a micrometer thick can absorb 90% of the solar spectrum.

**Q.4 a ii) (04 marks)**

**Magnus Effect** : Magnus effect is the phenomenon where by a spinning object flying in a fluid creates a whirlpool of fluid around itself and experiences a force perpendicular to the line of motion. The overall behavior is similar to that around an aerofoil with a circulation which is generated by the mechanical rotation, rather than by aerofoil section. This principle has been used in many cases but it is not generally employed.

**Q.No.4 a iii) .Biodiesel& its Applications 02 marks for definition and 02 for applications )**



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- Biodiesel is used as fuel in diesel engine driven automobile vehicles like cars , trucks and buses. It is mixed in petroleum diesel in suitable proportion like B10 or B20 and used in engine.
- Biodiesel is used as fuel in Diesel railway engines. It is mixed in petroleum diesel in suitable proportion like B5 or B10 and used in engine.
- Biodiesel is used as an alternative fuel in oil fired boilers where conventionally furnace oil or diesel are used.
- Biodiesel is used as an alternative fuel in diesel engine pump sets used in farms.
- Biodiesel is used as an alternative fuel in diesel engine Generator sets used for electricity generation.
- Biodiesel is used as an alternative fuel in farm tractors used in farms.

**Q.No.4 a iv) .(02 marks for explanation, 01 for advantages and 01 for disadvantages)**

The payback period & its advantages, limitations

Payback period:

The payback period, in business and economics refers to the period of time required for the return on an investment to repay the sum of the original investment. It initially measures how long something takes to pay for itself shorter payback periods are obviously preferable to longer payback periods.

Advantages Of Pay Back Period (PBP)

1. Pay back period is simple and easy to understand and compute.
2. Pay back period is universally used and easy to understand.
3. Pay back period gives more importance on liquidity for making decision about the investment proposals.
4. Pay back period deals with risk. The project with a shortest PBP has less risk than with the project with longest PBP.
5. The short term approach of pay back period is an added advantage of calculation of capital expenditure.

Disadvantages Of Pay Back Period (PBP)



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1. In the calculation of pay back period, time value of money is not recognized.
2. Pay back period gives high emphasis on liquidity and ignores profitability.
3. Only cash flow before the pay back period is considered. Cash flow occurred after the PBP is not considered.

**Q.No.4 b (06 marks )**

**i)The classification of hydroelectric plants based upon :**

- (a) Quantity of water available (b) Available head (c) Nature of load

The classification according to **Quantity of water** available is

(i) Run-off river plants without pondage : These plants does not store water; the plant uses water as it comes. The plant can use water as and when available.

(ii) Run-off river plants with pondage : In these plants pondage permits storage of water during off peak periods and use of this water during peak periods. Depending on the size of pondage provided it may be possible to cope with hour to hour fluctuations.

(iii) Reservoir Plants :A reservoir plant is that which has a reservoir of such size as to permit carrying over storage from wet season to the next dry season.Water is stored behind the dam and is available to the plant with control as required.

The classification according to availability of **water head** is

(i) Low-Head (less than 30 meters) Hydro electricplants : "Low head" hydro-electric plants are power plants which generally utilize heads of only a few meters or less.

(ii) Medium-head(30 meters - 300 meters) hydro electricplants :These plants consist of a large dam in a mountainous area which creates a huge reservoir.

(iii) High-head hydro electricplants : "High head" power plants are the most common and generally utilize a dam to store water at an increased elevation. The use of a dam to impound water also provides the capability of storing water during rainy periods and releasing it during dry periods.

The classification according to nature of load is



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(i) Base load plants :A base load power plant is one that provides a steady flow of power regardless of total power demand by the grid. These plants run at all times through the year.

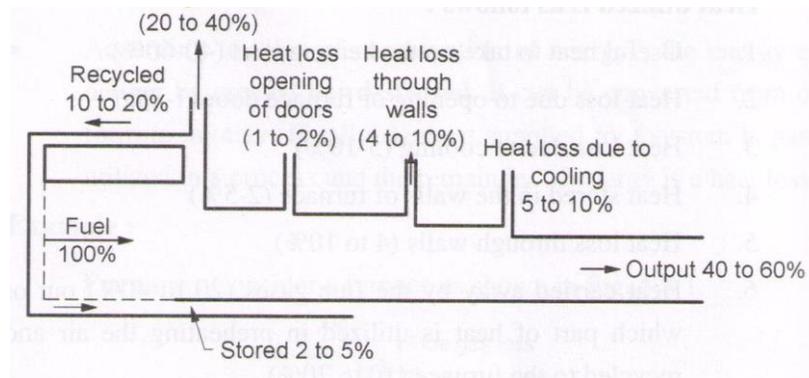
(ii) Peak load plants :Power plants for electricity generation which, due to their operational and economic properties, are used to cover the peak load. Gas turbines and storage and pumped storage power plants are used as peak load power plants.The efficiency of such plants is around 60 -70%.

**Q.No.4b ii) Sankey Diagram for Boiler plant & Furnace**

( Correct Description – 02 Marks, one for each diagram and explanation)

Sankey diagrams are specific types of flow diagrams used to represent flow of quantities like energy, fluid flow, mass flow , material flow etc. Sankey diagrams are represented by arrows with varying widths. Width of arrows are proportional to flow quantity. Sankey diagrams are used to visualize flow of energy or mass in a process. They are helpful in locating a dominant flow quantity in a process.

The representation of energy input and output losses in the furnace can be shown on sankey diagram as shown in the figure



Sankey diagram for Furnace

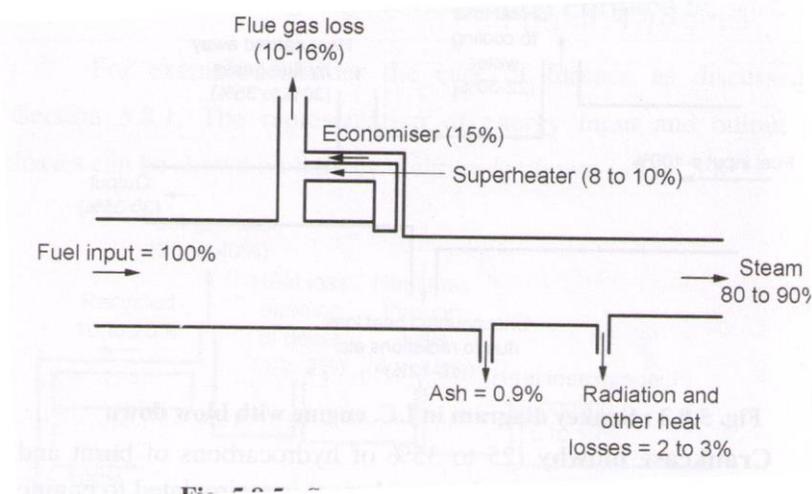
Boiler efficiency can be improved by using the heat in flue gases to superheat the steam in the superheater, to heat feed water in economizer and preheat the air in preheater before discharged to the atmosphere through chimney. Sankey diagram for boiler plant is shown in figure.



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Sankey diagram for boiler plant

Q.5 a) Effect of cooling towers on environment : ( 04 marks )

The evaporative cooling towers use the latent heat of evaporation of water to exchange heat from the process and the air which flows within the tower. This kind of tower emits into the atmosphere large quantities of vapour and water drops of different sizes (drift). The water drops contain, with varying concentrations, the same impurities contained in the cooling water, hence they are potentially dangerous when they deposit on a surface.

For example, if sea water is used for cooling, the drift water will contain salt. Therefore the greater drops, which will fall close to the tower, will be dangerous for the industrial plant, since they can generate corrosion of the equipments or short-circuit in the electric plants. On the other hand, the smallest drops, which will fall far from the tower, can be dangerous for the coltures. Other environmental impacts of the cooling towers are due to the huge vapour quantity emitted into the atmosphere. The production of a large visible plume induces a decrease of the solar radiation below the plume itself, with possible damages for the coltures. The fog episodes can also increase, so as the episodes of ice formation on the roads.

Q.5 b) (04 marks)

Acid rain : Acid precipitation is the return to earth of the oxides of sulphur and nitrogen in the acid form. It may be in the form of the acid rain or acid snow.  $SO_2$  emitted by power plant combines with water to form  $H_2SO_4$  and  $NO_x$  combine with water to form  $HNO_3$ . During rainy season it falls on the earth surface in the form of acid rain. It affects the life of fishes causing death , fertility of soil, damages national monuments and buildings.

Acid rain describes any form of precipitation with high levels of nitric and sulfuric acids. It can also occur in the form of snow, fog, and tiny bits of dry material that settle to Earth.



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Rotting vegetation and erupting volcanoes release some chemicals that can cause acid rain, but most acid rain falls because of human activities. The biggest culprit is the burning of fossil fuels by coal-burning power plants, factories, and automobiles.

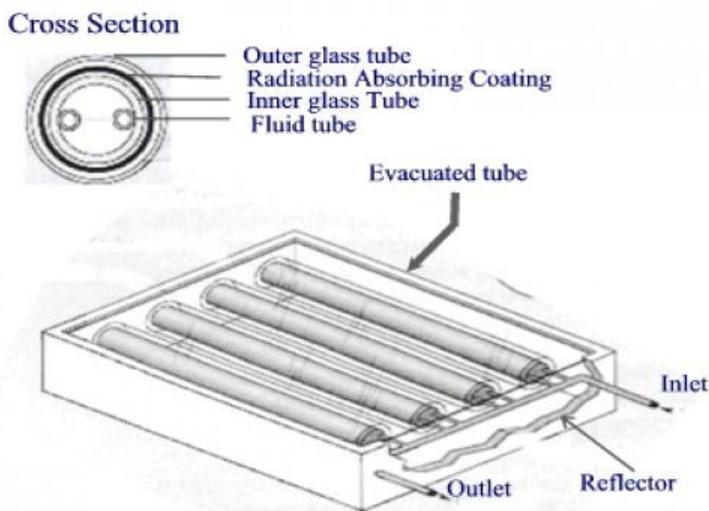
Acid rain has many ecological effects, but none is greater than its impact on lakes, streams, wetlands, and other aquatic environments. Acid rain makes waters acidic and causes them to absorb the aluminum that makes its way from soil into lakes and streams. This combination makes waters toxic to crayfish, clams, fish, and other aquatic animals.

Q.5 c) Solar Evacuated Tube collector: (ETC):

ETC evacuated tube solar collectors convert energy from the sun into usable heat in a solar water heating system. This energy can be used for domestic and commercial hot water heating, pool heating, space heating or even air conditioning.

**Construction:**

The ETC solar collector is comprised of four main parts:



**Evacuated Tube (ET)**

Absorbs solar energy and converts it to usable heat. A vacuum between the two glass layers insulates against heat loss.

The Heat Transfer Fin helps to transfer heat to the Heat Pipe.

**Heat Pipe (HP)**

Copper vacuum pipe that transfers the heat from within the ET up to the manifold.

**Manifold**



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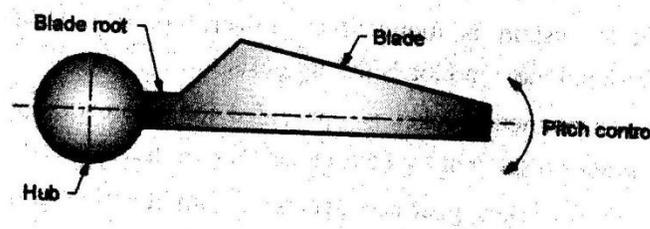
Insulated box containing the copper header pipe. The header is a pair of contoured copper pipes with dry connect sockets that the heat pipes plug into.

**Mounting Frame**

Strong and easy to install with a range of attachment options.

Q.5 d) Pitch control mechanism for wind turbine blade (02 marks for sketch and 02 for explanation)

The pitch of the blade is controlled by pitch control mechanism, thereby the power and speed of the wind turbine shaft is adjusted to match with the generator speed and its electrical output. The mechanism is shown in the figure.



The mechanism is provided through the hub of the rotor using hydraulic jack in the nacelle. The controller continuously adjusts the pitch to obtain the optimum performance.

**Q.5 e) (02 marks for advantages and 02 for disadvantages)**

Advantages of fixed dome type biogas plant:

- 1) less cost of plant
- 2) less cost of heat
- 3) no corrosion
- 4) maintenance free

Disadvantages :

- 1) needs skilled labor to operate
- 2) gas production / m<sup>3</sup> of digester volume is less
- 3) gas is produced at variable pressure

**Q.5 f) (Two marks for definition and two for factors )**

Various biomass routes are as follows.



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- a. Combustion
- b. Anaerobic digestion
- c. Pyrolysis
- d. Hydrolysis and ethanol fermentation
- e. Gasifier

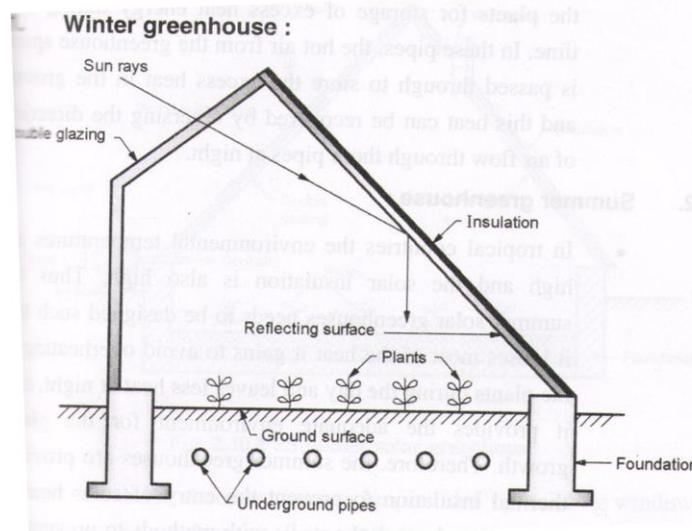
**Anaerobic digestion:** Anaerobic digestion is a biochemical process in which the particular kinds of bacteria digest biomass in an oxygen free environment. The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria.

Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, carbon dioxide, hydrogen, ammonia and sulfides. This stage is called hydrolysis.

Next, acetogenic bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide. Methanogenic bacteria then convert these products into biogas. The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam. After filtering and drying, digester gas is suitable as a fuel for an I.C. engine, which combined with generator, can produce electricity.

**Q.No 6 a ) Winter & Summer Green house** (Two marks for figure and description each)

1) Winter greenhouse : In cold countries where ambient temperature is low, the greenhouse are so designed that it supplies additional heat to maintain the required temperature and the environment for the growth of plant since the solar insulation is low.



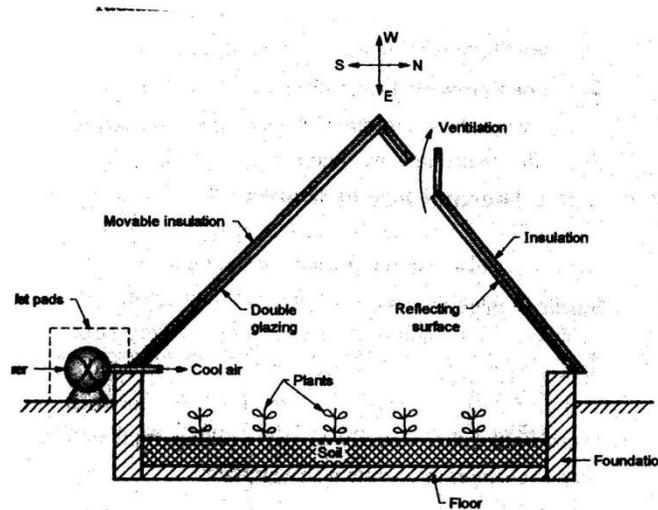
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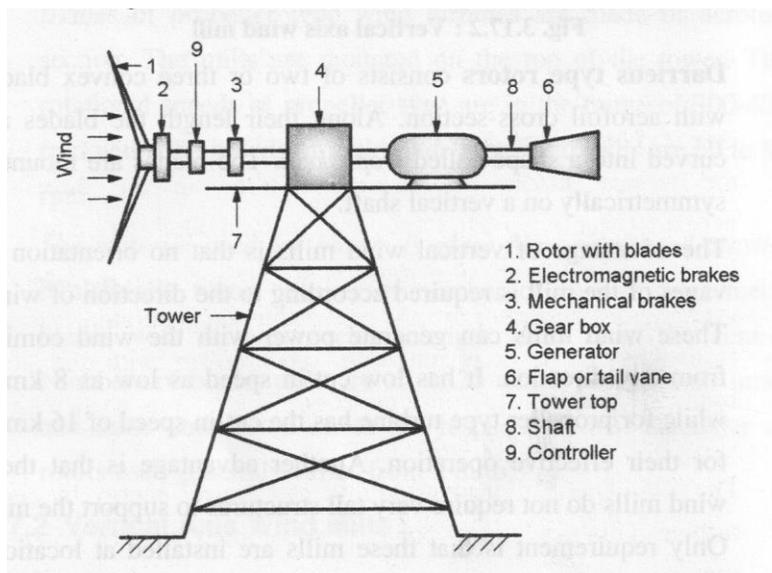
The interior surface is painted white or other reflecting material to reflect solar radiation on the plants .

2)Summer green house : In tropical countries the environmental temperatures are high and the solar insulation is also high. Thus greenhouses should be such that it loses most of the heat it gains to avoid overheating of the plants during the day and leaves less heat at night. Figure shows summer green house.



Q.6 (b) (three marks for figure and two for labeling and three for explanation)

Components of Wind mill.



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Wind mill: Basic structure of windmill consists of the following components.

- i) Rotor blades: The rotor blades extract the wind energy and converts it into rotational form
- ii) Gearbox: It converts the rotational speed from low speed shaft and transforms it into faster rotation on the high speed shaft
- iii) Hub: It is the connection point for the rotor blades and low speed shaft
- iv) Mechanical brake: It is a disc brake used for repairs and maintenance of the wind mill.
- v) Generator :It converts the rotational speed of high speed shaft to electrical energy
- vi) Yaw mechanism. This mechanism keeps the rotor blades parallel to the flow of wind
- vii) Anemometer and wind vane: They are the instruments for measuring wind speed

**Q. No 6c)** Energy Audit: An energy Audit is the first step in energy management programme. It shows how efficiently energy is being used and highlights opportunities for energy cost savings. It also shows ways to improve productivity.

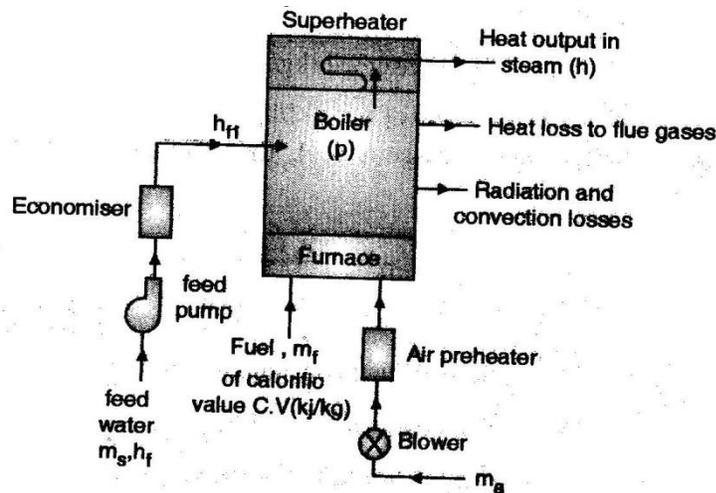


Figure shows energy audit in boilers. The various accessories used to improve efficiency are

- 1) Superheater
- 2) Economiser
- 3) Air preheater
- 4) Boiler efficiency