Module - 01

RAKESH R
Mechanical Engineering
RNSIT

Energy Resources:-

Introduction:-

About one hundred years ago. people would have completed their daily routine work without moving more than ten kelometers radius from the place where they use to live. The reason is obvious as the daily needs like cooking, lighting eating etc., were largely met from the resources within that radius. In todays era of information technology, the earth has been reduced to a global village where people from one remote corner exchange necessary information with friends, relatives & business partners situated several thousand kilometers across the globe.

Now a days even the most common people have started using cell phones, own vehicles, refrigetor, air conditioners washing machine, computer etc., which consumes energy. Everything what happens in the world is due to energy in one of its forms.

Energy is defined as the capacity to do work. It is one of the primary & most universal measure of all kinds of work, like air, energy is also invisible wealth of nature. Energy consumption is a measure of prosperity. The living standard of people of a nation is directly proportional to

per capita energy consumption. Life on planet earth is manifestation of energy. The origin of fire, heat & light is due to energy. Hence, energy has been recognized as a key input parameter in the development of a nation.

Forms of Energy :-

Although energy is physically invisible, its presence is always felt. Energy can exist in various forms such as

(i) Mechanical energy
(ii) Electrical energy
(iii) Chemical energy
(iv) Heat energy
(v) Nuclear energy
(vi) Sound energy.

Sources of Energy :-

Various sources [Renewable & Non-renewable] of energy that have been derived from the nature are,

(i) Fossil fuels
(ii) Hydro energy
(iii) Solar energy
(iv) Wind energy
(v) Tidal energy

Non-Renewable and Renewable Energy Sources

The energy sources are classified into two types

1. Non-renewable source of energy
2. Renewable source of energy

The source which are formed in the earth crust over millions of years & which get depleted with their use are known as non-renewable source of energy [Conventional Sources]
Example: Coal, Petroleum products, Nuclear fuels etc.,

The source which will not deplete with their use are known as renewable source of energy [Non-conventional source]
Example: Solar energy, Wind energy & Tidal energy.

Differences between Renewable & Non-Renewable source of energy:-

Renewable energy resource	Non renewable energy resource
1) These energy source are non-depletable with their use	1) These energy sources are depletable with their use.
2) These are pollution free [doesn't harm to the environment]	2) These Causes pollution [Hazardous to the environment]
3) These are available at free of cost	3) These are not directly available at free of cost.

4) Initial cost to extract the energy source is more, but the maintenance cost is less.	4) Initial cost is less but the maintainence cost is more.
5) The technology to extract the energy source is not yet completely developed.	5) The technology to extract the energy source is developed.
Examples: Solar energy, wind energy & tidal energy	Examples: Fossil fuels & Nuclear energy

Advantages & Disadvantages of Non-renewable energy sources

Advantages:-

1) There are traditional sources for which the technology of conversation is developed.
2) Initial cost is relatively low.
3) These resources have wide commercial application.

Disadvantages:-

1) These are exhaustible source of energy.
2) Causes pollution & leads to environmental impact.
3) These are not directly available at free of cost.

Advantages & Disadvantages of Renewable energy sources

Advantages.

1) The renewable energy sources are non-deplatable.
2) These energy sources can meet & match future energy needs
3) These are available at free of cost.
4) These are sources doesn't cause pollution, thus minimises environmental impacts.
5) Few renewable energy sources like wind energy will minimize the energy transportation cost as they can built close to site where the energy is required

Disadvantages :-

1) Their availability is non-continuous
2) Complete commertialization has been found to be not viable as on today. (feasible)
3) Initial cost of the setup to extract the energy source is high

Petroleum based solid fules :-

In refining proces of the oil, a solid by-product is obtained known as coke. It is the carbon solid residue that is left behind after the refining or cracking proces of oil into liquid fuels such as petrol & diesel.

Petroleum coke looks like coal and can be used as Coal [solid fuel]. It has high carbon emission than that of coal. The petroleum coke that is obtained in a refinery is termed as green coke. This can be used directly as a fuel. It is used as fuel in power generation plants, cement industries, glass factories & paper mills.

However, it is a low volatile fuel which makes it difficult to ignite. It is therefore blended with coal to that the burning coal ignites this easily like coal, this needs to be grounded into powder form before it is burnt. Petroleum Coke is much harder than coal & hence difficult to grind when compared to grinding of coal.

Petroleum based liquid fuels :—

Liquid fuels are generally found under earth's surface by drilling wells in the earth's crust. they are mineral oils known as petroleum which is considered as build up of organic compounds. The most important liquid fuels are crude petroleum & different oil residues obtained in distillation of petroleum. These fuels are easy to handle, burn & posses high calorific value. Due to this about 40% of the today's energy needs of the world are met by liquid fuels.

Important petroleum based liquid fuels are discussed here.

Petrol :— It is also known as gasoline. Petrol is a mixture of large number of hydrocarbons. It is the lightest & most volatile liquid fuel mainly used as a motor fuel. The crude petroleum is associated with natural gas which is compressed to produce volatile liquid known as natural gasoline. The gasoline obtained by distillation from crude petroleum is called as straight run gasoline. Petrol is mainly used in Spark Ignition [Petrol] engine.

Diesel oil:— The liquid fuel distilled after gasoline & kerosene is known as diesel oil. Suitable diesel oil may be obtained by straight distillation, by cracking or by blending of several oils. These fuels are used in diesel engines & a wide variety of operations. Diesel fuel vaporates more slowly when compared to petrol as it is heavier. It takes less refining process to produce diesel fuel & hence it is cheaper than petrol Diesel fuel is used to power a wide variety of vehicles & operations

Kerosene :— It is also known as paraffin oil. Kerosen is a combustable hydrocarbon liquid fuel. It is obtained from crude petroleum in the fractional distillation after obtaining petrol [gasoline]. It is heavier than petrol & less volatile than petrol. It is mostely used as domestic fuel for heating & lighting purpose

Petroleum based gaseous fuels :—

In the recent years gaseous fuel are playing predominant role in industrial & domestic applications Even in transportation sector the gaseous fuels are finding their application. Important petroleum based gaseous fuel are discussed here.

Natural gas :- It is extracted from particular locations & underneath the earth surface. Deep drilling is carried out in bringing out this gas.

Methane is the main constituent of natural gas & accounting for about 95% of the total volume along with other elements namely Ethane, propane, Butane, Carbon-dioxide & traces of other gases. Natural gas is a high calorific value fuel. It mixes with air readily & does not produces smoke. It is lighter than air & disperses into air easily in case of leakage. Natural gas has many applications like domestic, commercial, industry & in the transportation sector.

Liquefied Petroleum Gas :- Petroleum gas is a mixture of ethane, propane, & butane. The petroleum gas which is liquefied under pressure is called liquefied petroleum gas [LPG]. It is produced as a by-product of natural gas purification & oil refining. The liquefied petroleum gas Consists mainly of butane with a very small amount of ethane & propane. On compression, it easily changes

to a liquid state, which is a unique & a very special property of it. Due to this, it occupies a small space. Therefore, it is stored in cylinders & transported. In the cylinder it will be in liquid form & while using it will convert into gaseous state. The cost of LPG is less than that of petrol cost. It causes less pollution to the environment than petrol, as it releases less amount of carbon monoxide when compared to petrol.

It is extensily used as a domestic fuel & in transportation. LPG can be used in petrol engines with minor modifications. Also LPG is used to generate small amount of electricity for domestic & commercial establishments.

Compressed Natural gas [CNG]

CNG is basically natural gas which is obtained from petroleum products. It mainly consists of methane. These can be used in place of petrol Diesel fuel & LPG. It is also known as liquified Natural Gas [LPG] & Piped Natural Gas [PNG]. It is non-toxic, colourless & lighter than air. In case of any leakage as natural gas, as natural gas is lighter than air it disperses quickly. Hence, it is safer than other fuels.

It is more often used as a dual fuel for internal combustion engines. In general, engine will start on petrol/Diesel & on CNG. The main drawback of this fuel is, it requires heavy storage tanks in order to withstand high pressure

Further its availability is not sufficient for present day fuel needs.

Calorific Value :-

CV indicates heating efficiency of a fuel. The performance of a fuel is expressed in terms of its Calorific value. The amount of heat generated by complete Combustion of unit quantity of fuel is known as Calorific value of the fuel. It is an important parameter of fuel & is expressed in KJ/kg.

There are two kinds of calorific value, higher calorific value & lower calorific value.

Higher or Gross calorific value [HCV]

It is the amount of heat energy liberated when unit quantity of fuel is burnt completely in air & the combustion products are cooled to the room temperature.

Lower or Net Calorific value [LCV] :-

It is the amount of heat energy liberated when a unit quantity of fuel is burnt completely in air & the products of combustion are released to the atmosphere

Calorific value of petroleum based fuels

Petroleum coke → 29,500 KJ/kg
Gasoline [Petrol] → 43,500 KJ/kg
Diesel → 42800 KJ/kg
Kerosene → 39500 KJ/kg
LPG → 46,100 KJ/kg
CNG → 48,900 KJ/kg

Combustion of Fuel :-

Combustion is a chemical reaction that occurs between a fuel & an oxidizing agent that produces energy usually in the form of heat & light.

Fuel + Oxidizer → Combustion products + Heat energy

Fuel contain combustion element such as carbon hydrogen & sulphur which readily combains with oxygen. It is always necessary to supply sufficient quantity of air for complete combustion of fuels. Hence it is necessary to calculate the mass of air required for the complete combustion of fuels.

The following chemical equations are used to calculate the amount of oxygen required & the amount of gases produced during the combustion of

carbon & Sulphur.

(i) When carbon burns in the presence of sufficient oxygen [treated as air] Carbon-di-oxide [CO_2] is produced & large amount of heat is released Combustion of carbon in oxygen is represented as $C + O_2 = CO_2$

(ii) When Sulphur burns in the presence of Sufficient Oxygen Sulphur di oxide [SO_2] is produced & large amount of heat is released combustion pro. of Sulphur in oxygen is represented as

$$S + O_2 = SO_2$$

When carbon burns in the presence of insufficient quantity of oxygen, then it produce carbon monoxide [CO] instead of carbon dioxide [CO_2]. Similarly Sulphur monoxide [SO] is formed instead of Sulphur dioxide [SO_2] when sulphur burns with insufficient quantity of oxygen.

The correct amount of air required for complete combustion of the fuel is calculated by using atomic & molecular weights of respective elements

Combustion products :-

Some fuels may not completely burn during combustion. Due to this, some amount of fuel will be released into the atmosphere along with the products

The products that are formed during combustion of a fuel are given below.

(i) Carbon Dioxide
(ii) Carbon monoxide
(iii) Sulphur dioxide
(iv) Nitrogen oxide
(v) Lead
(vi) Particulate matter.

Solar Power :-

Solar energy is the greatest potential energy source for the future. All forms of energy available on the earth are derived from the Sun.

It is the enormous heat energy directly obtained from the sun by intercepting the earth. Solar energy could be utilized directly as well indirectly.

1) Solar Radiation :-

It is the radiation or energy from the sun. Solar radiation is also known as shortwave radiation. It comes in many forms such as visible light, radio waves heat [infrared], x-rays & ultraviolet rays. Solar radiation

will be higher on clear, sunny day & usually low on cloudy days. When the Sun is down or there are heavy clouds blocking the Sun, Solar radiation is measured as zero

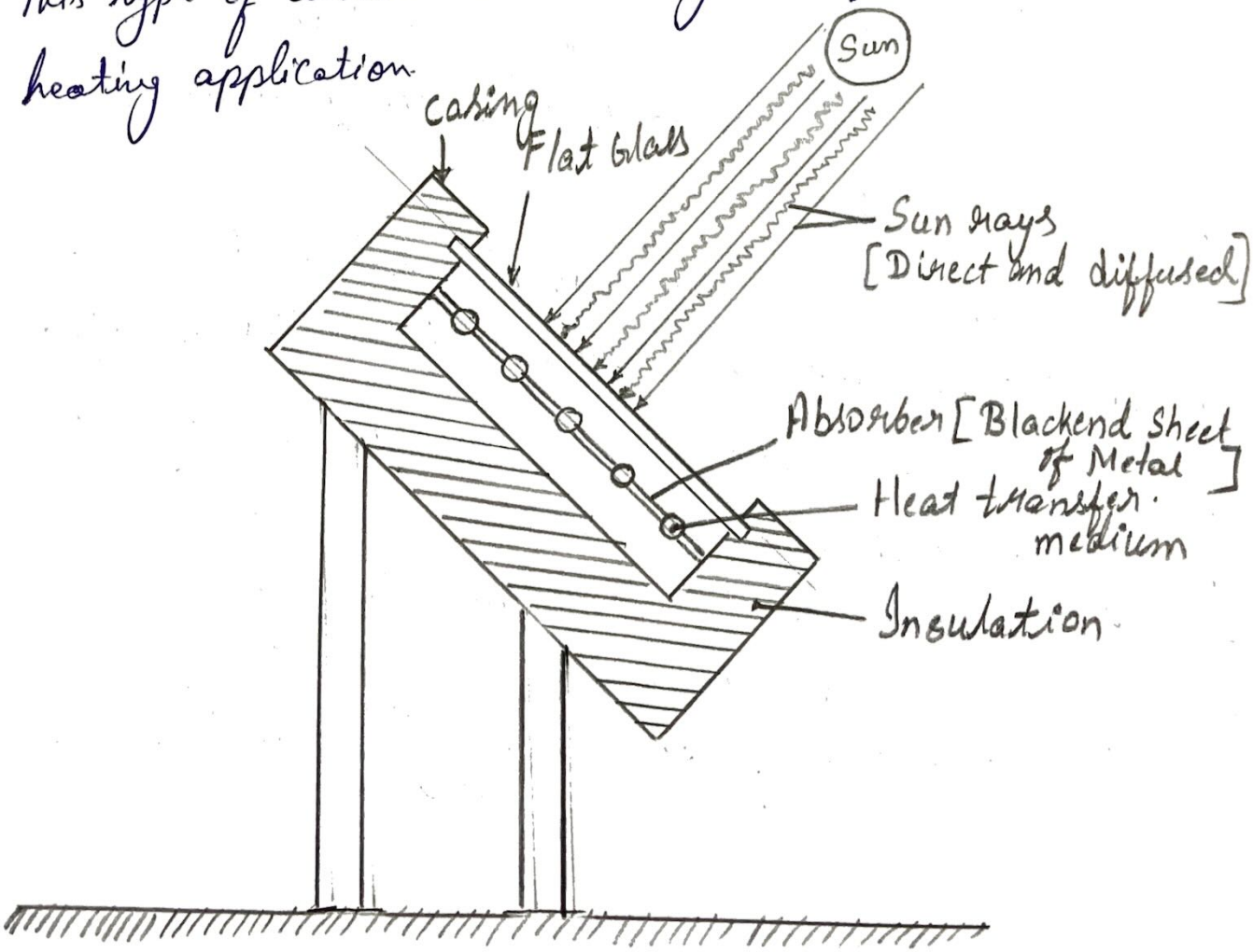
Solar radiation is the total frequency spectrum of electromagnetic radiation produced by the Sun. This spectrum covers visible light & near-visible radiation such as x-rays, ultraviolet radiation, infrared radiation, & radiowaves. The visible light & heat of the Sun makes life possible & is called daylight or Sunshine.

2) Solar Constant :- The amount of incoming Solar electromagnetic radiation per unit area is known as Solar Constant. It includes all types of Solar radiations & its average value is approximately 1.366 KW/m^2 This Constant may increases by only 0.2 percent at the peak of each 11-years Solar cycle. It is most accurately measured from Satillites where there will be no atmospheric effects.

3) Solar thermal Energy Harvesting :-

Radiant Solar energy is directly converted into thermal energy [heat energy] by using a collector. This process is called as Helio thermal process. The surface on which the Solar rays fall is called a collector. The Collector may be either flat plate collector or focusing collector.

'Flat plate Collector:- Solar energy can directly converted into heat energy by using a flat plate collector figure shows a schematic representation of flat plate collector which consists of a glass plate an absorber plate & water tubes provided with insulation. In this a black plate [absorber plate] is used to absorb the sun light as it can absorb maximum sun light falling on it. The heat generated is transported to the point of use through the tubes provided Insulation is done to minimize the heat losses this type of collector is commonly used for solar water heating application



Flat - Plate Collector

Solar Ponds:-

A natural or artifical body of water for collecting & absorbing solar radiation energy & storing it is known as a solar pond. Solar ponds are large shallow & human made bodies of water lined with dark material

Principle of operation :—

Fluids such as water & air rise when they are heated. This natural principle is used to store thermal energy in a solar pond. The pond has three main water layers. From top to bottom, these layers are called the surface zone, the gradient zone & the storage zone. The salt content of the pond increases from top to bottom

As solar radiation is absorbed water in the gradient zone cannot rise due to its lesser density. Similarly cooler water cannot sink due to its higher density Hot water in the storage zone is piped to a boiler where it is heated further to produce steam which drives a turbine. These are used for heating & cooling of buildings, production of power, drying crops on farms etc.,

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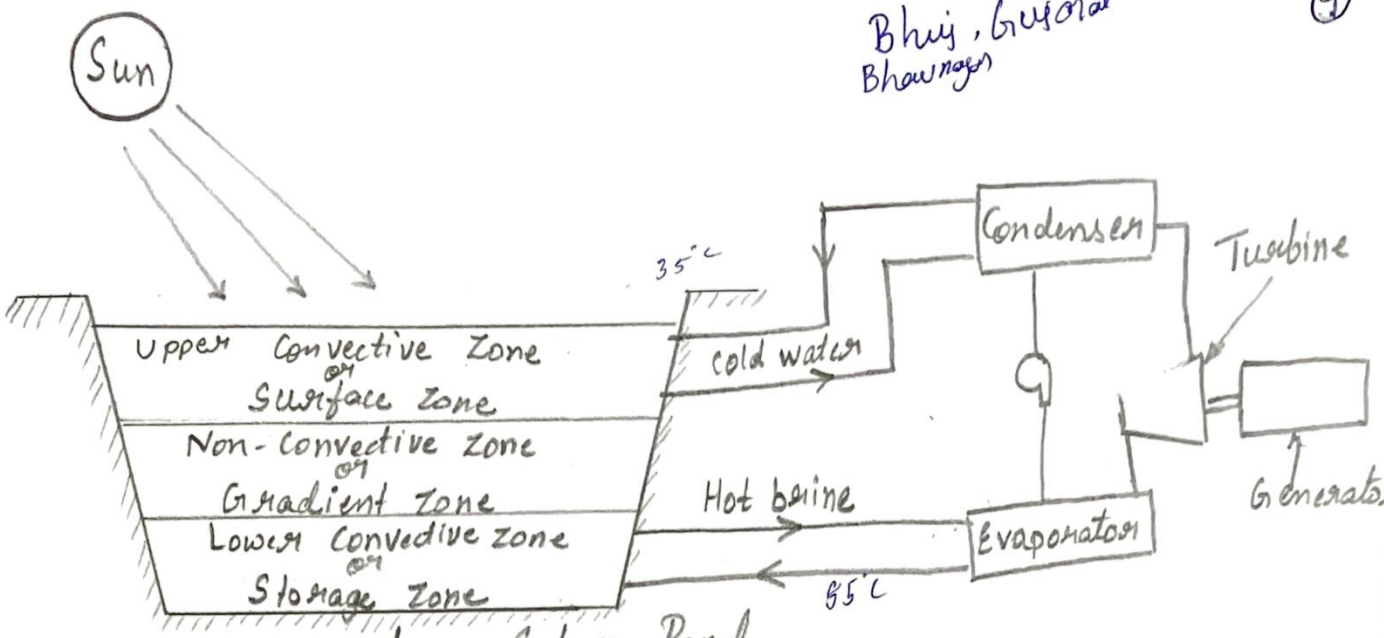


fig: Solar Pond

Solar Photovoltaic Principal:—

Solar cells are devices that convert sunlight directly into electricity. Solar cells are made of layers of semiconductor materials similar to those used in computer chips. When sunlight is absorbed by these materials, it causes electrons to flow through the material & produces electricity

The solar cell is composed of a P & N-type semicondu-ctors. when a P-N junction of a semiconductor is exposed to sunlight, its P-region becomes positively charged & the n-region becomes negatively charged. If an external load is applied, this charge difference will drive a current through it till the sunlight is effective. This principle is used in developing solar cell.

1 solar cell = 0.5V

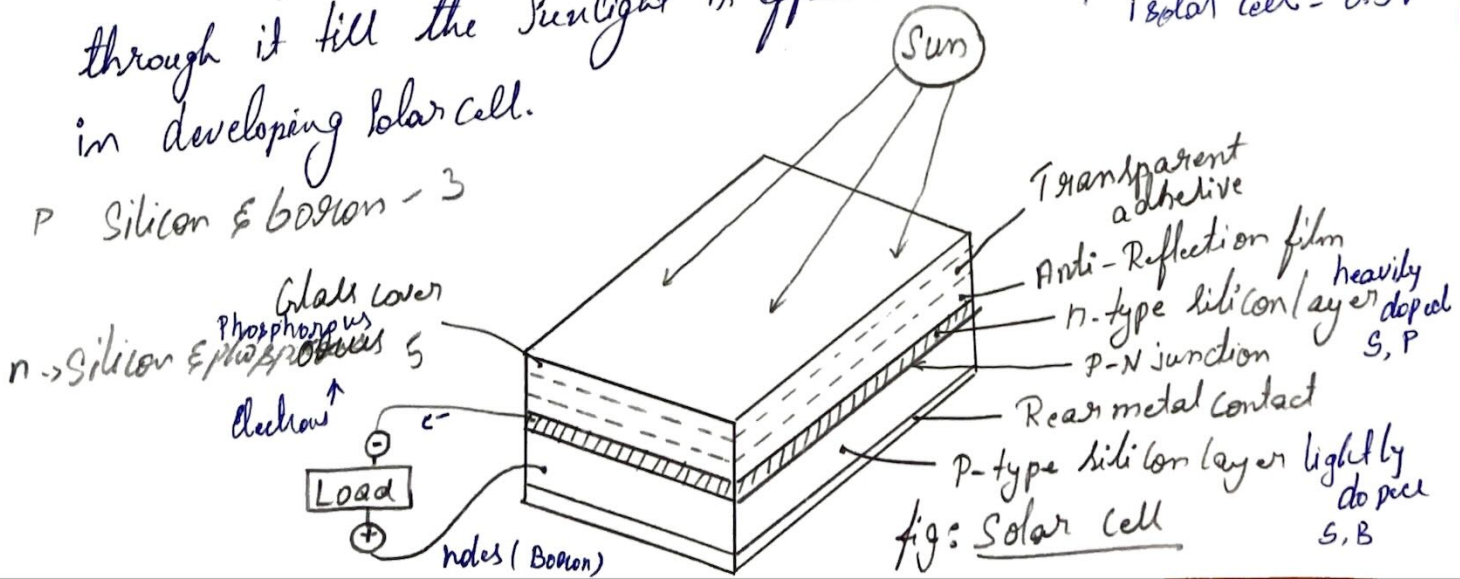
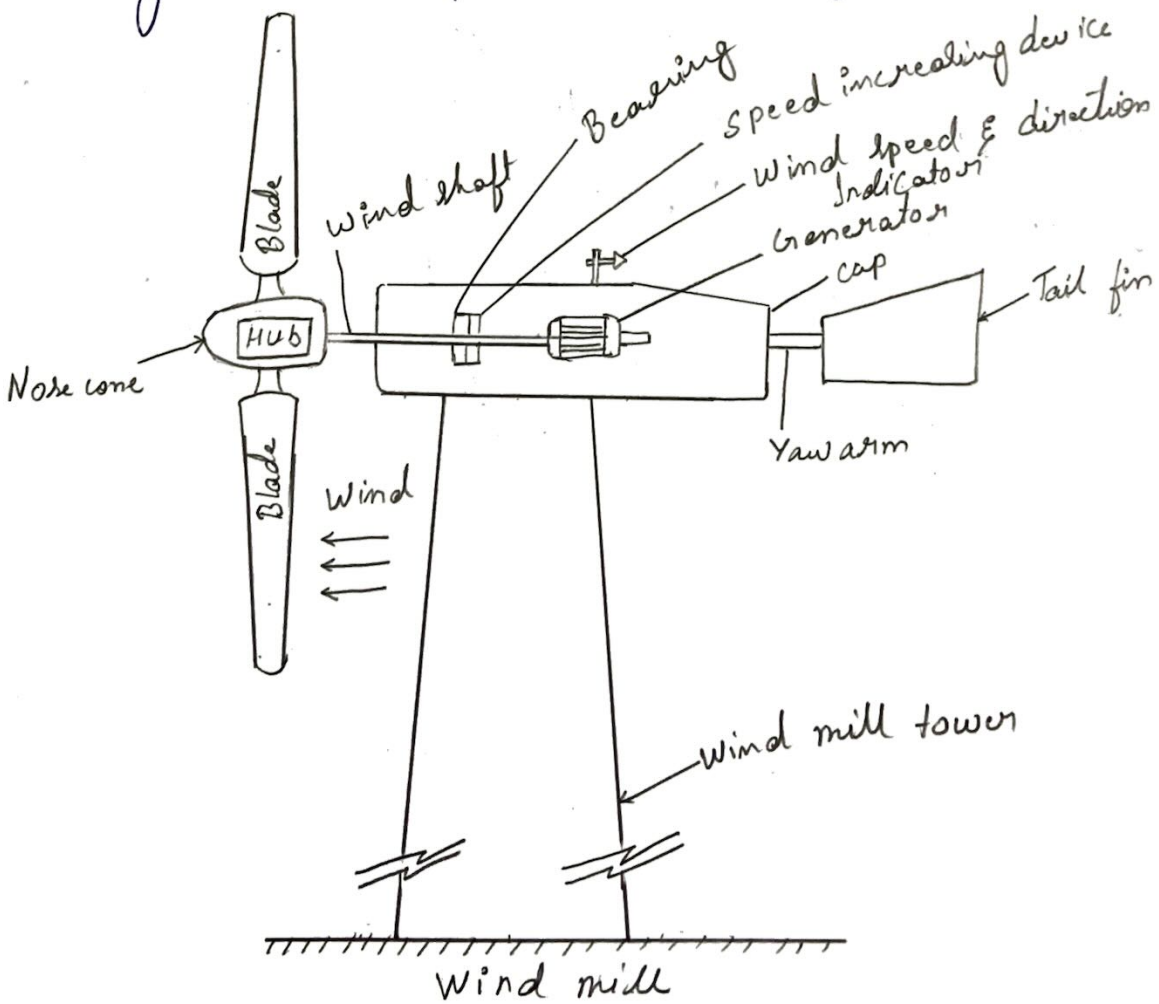


fig: Solar cell

Wind Power :-

The kinetic energy of moving air over the earth surface can be used for the generation of electrical energy wind energy is an indirect source of solar energy & can be utilized to produce electricity.

When the wind blows, a pocket of low-pressure air forms on the downwind side of the blade. The low-pressure air pocket then pulls the blade towards it. This causes the rotor to turn & it produces force called as lift. This force is stronger than the wind's force against the front side of the blade [drag force]. The combination of lift & drag causes the rotor to rotate like a propeller & the turning shaft rotates a generator to produce electricity.



The Schematic representation of a wind mill is shown in fig It consists of a rotor fitted with blades. As the air current flows over the blades, the rotor rotates & produces energy by coupling to a generator. wind energy is also used for grinding grains, pumping water etc.,

Merits :-

1) Wind energy is non-depletable source of energy
2) Wind energy is a cheaper source of power.
3) Doesn't cause any pollution, thus it is environmental friendly source of energy.
4) Best source to generate energy in remote areas.

Demerits :-

1) Only in selected places it can be harnessed
2) Fluctuating source of energy as it depends on velocity of the wind.

Hydro Power :-

It is an indirect source of solar energy. The water from the earth's surface gets evaporated by solar heat & forms as clouds. This in turn results in rainfall Hydro-electricity is generated from running water. Dams are built across a lake or river to trap the water. A long pipe known as penstock is used to draw the water from the reservoir as shown in figure below.

fig in page no (13)

The rain water flowing as rivers can be stored behind dams & released in a regulated way to generate hydro-power. The potential energy of water stored at a height is converted into mechanical energy into electrical energy. After doing useful work water is discharged from the turbine to the rivers through a water ways to the tail race. through a draft tube.

Merits :-

1) This can be used for power generation in large scale.
2) Environmental friendly source of energy.
3) As water is natural resource, it is the energy available at free of cost.

De-Merits :-

1) It is expensive to build the dam
2) By building a dam, the nearby area may be flooded & this could affect near by wildlife & plants.
3) During Summer the water may not be sufficient to produce electricity.

Nuclear Power :-

It is known from the modern theories of atomic structure that matter consists of minute particles known as atoms. These atoms contains enormous amount of energy. Nuclear energy is the chemical energy released during the splitting or fusing of atomic nuclei.

The amount of heat liberated due to nuclear fusion or fission may be utilized for the generation of steam. This steam may then be used to drive to generate electrical energy.

From the heavy unstabe atom such as Uranium, Thorium or very light atoms like hydrogen & its heavy isotopes the enormous energy can be produced through nuclear reaction process.

Fission uranium & plutonium
2hydrogen atoms fuse one helium

Principles of Nuclear power plants :-

Most of nuclear power plants are based on the fission of nucleus of U_{235} atoms. This nucleus is relatively unstable & can split into two or more fragments when struck by a neutron. The splitting or fission yields energy together with emition of more neutron. These neutron in turn can cause further splits in other nuclei producing more energy & more neutrons [chain reaction]

There are mainly two types of nuclear power plants namely

Boiling water reactor: The water that cools the nuclear fuel is boiled, turns into steam & drives a steam turbine.

Pressurized water reactor: The water which cools the nuclear fuel will be at a higher pressure. Due to this higher pressure, water reaches higher temperature & converts it into steam. This steam in turn is supplied

to the steam turbine to generate electricity.

Merits

1) More amount of heat is produced, even if small quantity of fuel is burnt.
2) Small area of storage is sufficient.
3) Can be used as alternate fuel to liquid, gaseous fuels

De merits

1) Disposal poses serious problems
2) Storage involves much risk
3) Causes environmental pollution.

Bio-fuels :—

The substance formed by living stock is known as bio mass which is mainly due to plants & animal. These Organic elements which have high content of carbon react with Oxygen & produces a fuel which is known as bio fuel

The principal organic matter forms of bio-mass re-news naturally in a very short span of time [a year or even less]. This is the significant factor which has classified bio-mass as a renewable source of energy. It is also a derivative of solar energy as Sun's energy is utilized indirectly in growing plants by photo synthesis

The simple block diagram of the process is

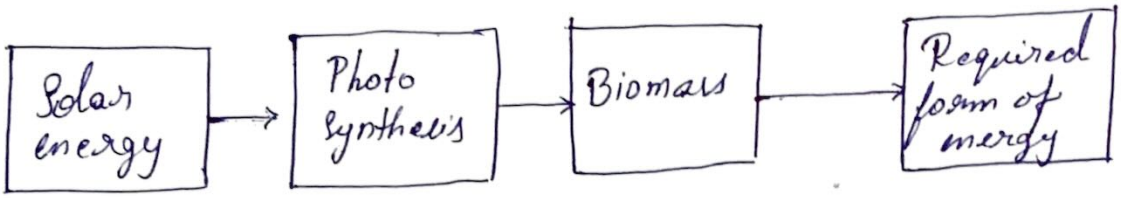


fig: Block diagram of Biomass energy

The biomass energy can be used for bio-fuels. Biofuels have increased in popularity because of rising oil prices & the need for energy security. Vegetable oil react with alcohols such as methanol & ethanol in the presence of a catalyst to produce bio-diesel. It can be mixed with the diesel or the vehicle can be run independently after a small modification in the engine. Example of various bio fuels are: bio-methanol, bio-ethanol, biodiesel, biogas & producer gas.

The danger of explosion of biogas is also less since it contains CO_2 which acts like a fire extinguisher. Bio fuel can be used as a fuel for transportation, cooking & in small scale industries.

Emission of Bio fuels :- Biodiesel plays a vital role in reducing emission of many air pollutants. The emission of Carbon monoxide [CO], Sulphur oxides [SO_x], Nitrogen oxides [NO_x] etc., is lesser than those of petroleum fuels. & thus they are eco friendly

Calorific value of Bio-fuels :- Calorific value of bio-fuels will be considerably lesser than that of petroleum fuels.

Merits:

1) It is a kind of renewable energy source
2) Energy is generated from the waste [which other wise poses disposal problem]
3) Substitution source of energy of fossil fuels.

Demerits

1) Requires more land area
2) Collection & transportation is expensive.

Types of Bio fuels :-

1) Solid biofuels

These are biomasses that are burnt directly for energy Eg: wood, charcoal.

2) Bio diesel

* Domestically produced, renewable fuel that is produced from vegetable oils, animal oils, waste cooking oil, recycled grease etc.,
* These oils are converted to biodiesel by a process known as trans-esterification.
* Biodiesel is essentially free of sulphur & aromatics
* This should be stored in clean, dry, dark environment & storage tanks may be of aluminium steel etc.,

3) Bio ethanol / ethanol :-

It is an alcohol produced by fermentation, majorly from carbohydrates produced in sugar or starch crops.

4) Gaseous biofuels :-

There are biofuels used in gaseous form

Eg:- Biogas, which is essentially methane gas, produced from biodegradable waste or energy crops.

Application of Biofuels :-

1) Biogas is cheap & sustainable fuel used in lighting, cooking or generating electricity.

2) Biodiesel finds its use in automotive industry mainly in cars & trucks.

3) Small engines, seen in lawn mowers & chainsaws can utilize ethanol blends upto 10% without problem.

4) Bio fuels finds it application in aviation industry & flights are already tested to run with 20% blend of bio fuels in its engine.

5) The marine industry also uses biodiesel in suitable blend mixtures to be used in recreational boats, Inland commercial ships, research vessels etc.,

Comparison of Bio fuels with petroleum fuels :—

Factor	Bio fuels	Petroleum fuels
Calorific value	Calorific value is low & varies from 30 to 37.27 MJ/kg	Calorific value is high & varies from 43 to 48 MJ/kg
Emission	Green house gas emission are less in bio fuels	Green house gas emission are more in petroleum fuels
Biodegradability	Biodegradable	Non biodegradable.
Renewability	It is a Renewable fuel	It is Non Renewable fuel
Toxicity	Non-toxic	It is toxic & crude petroleum oil can be carcinogenic
Safety	It is safe to produce bio fuels	It is not safer.

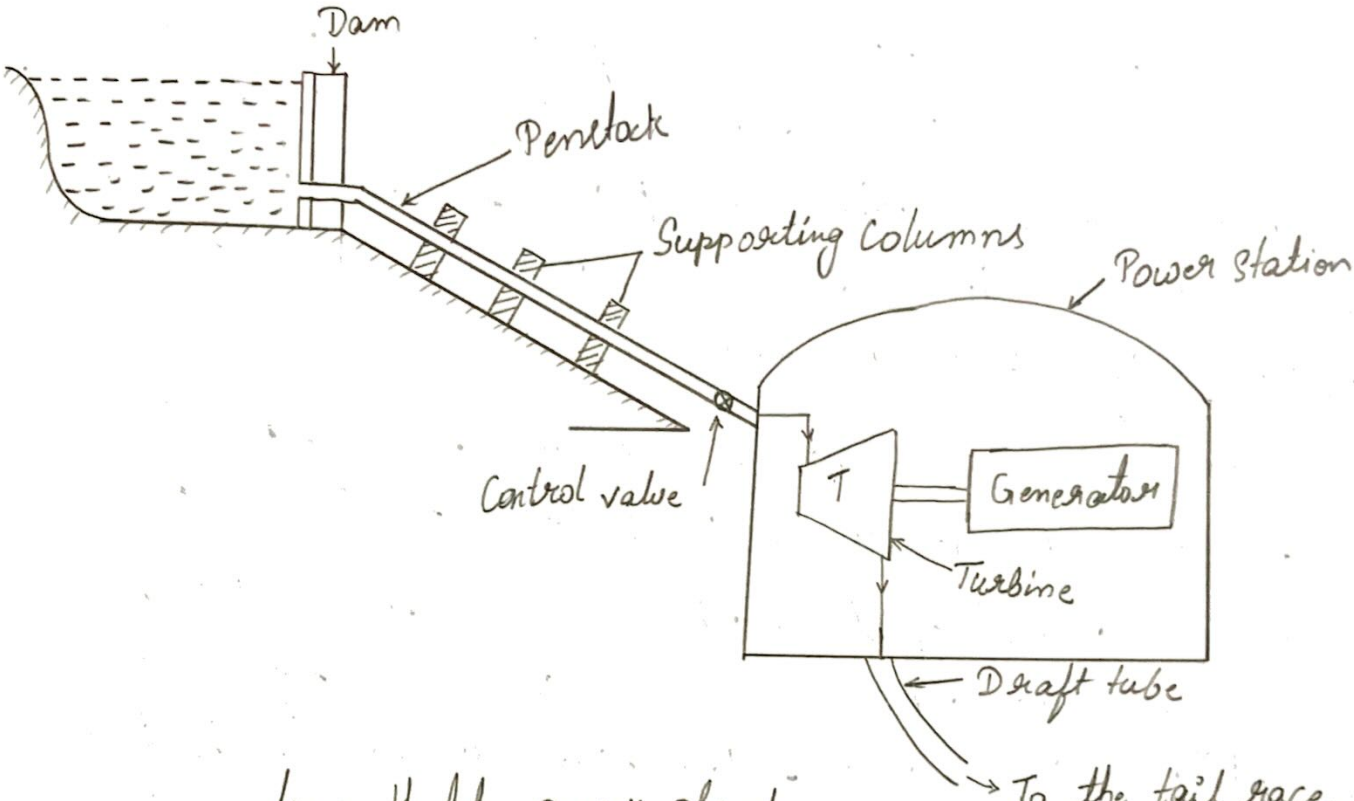


fig: Hydel power plant

Nuclear Power Plant

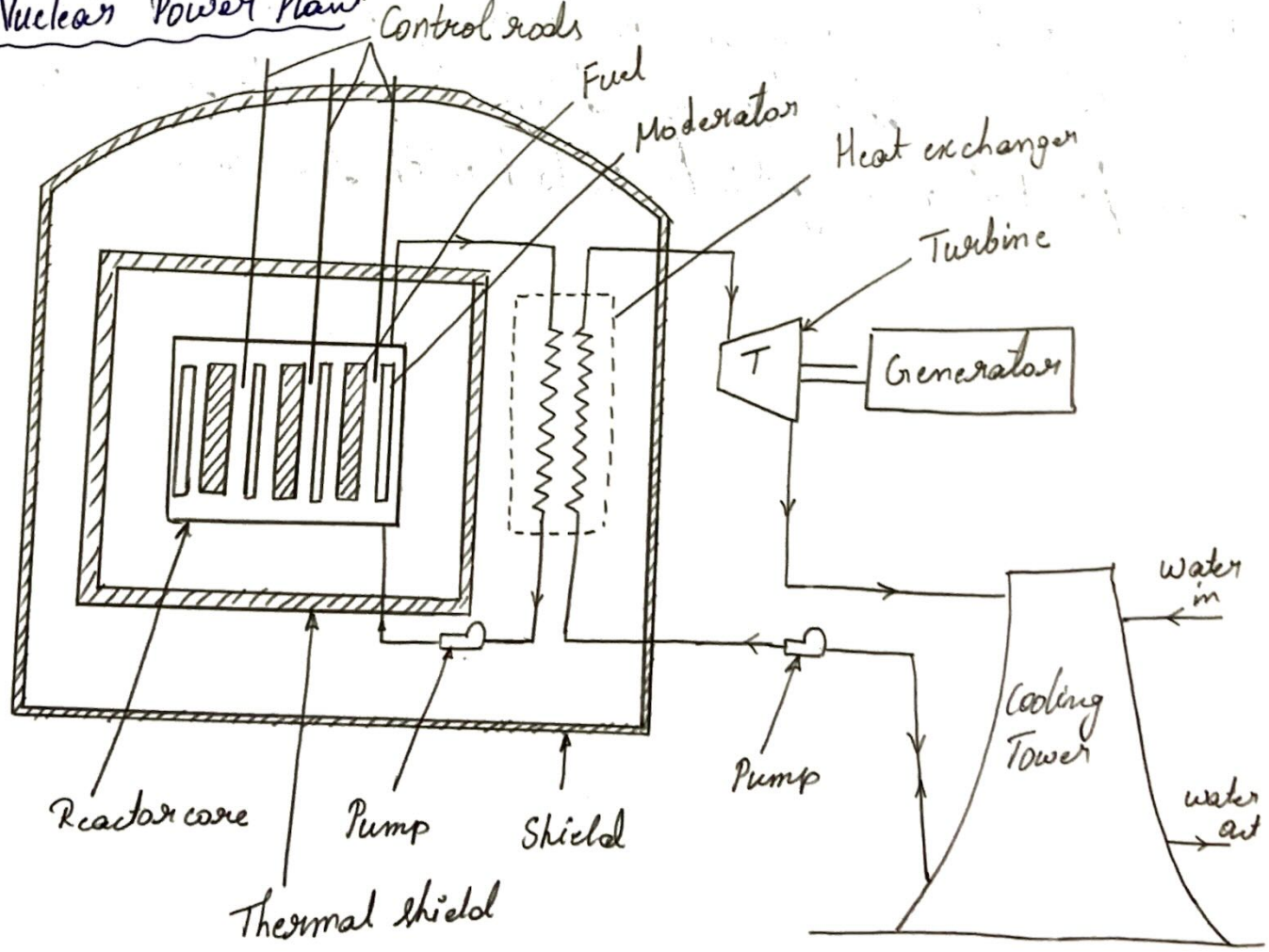


fig: Nuclear Power Plant

Figure shows the schematic diagram of a Nuclear Power plant. It essentially consists of a Nuclear reactor, a steam generator, a cooling water condenser, a coding tower, turbine & a generator. Control rods & are housed inside the reactor vessel. These rods are used to control the splitting of uranium atoms.

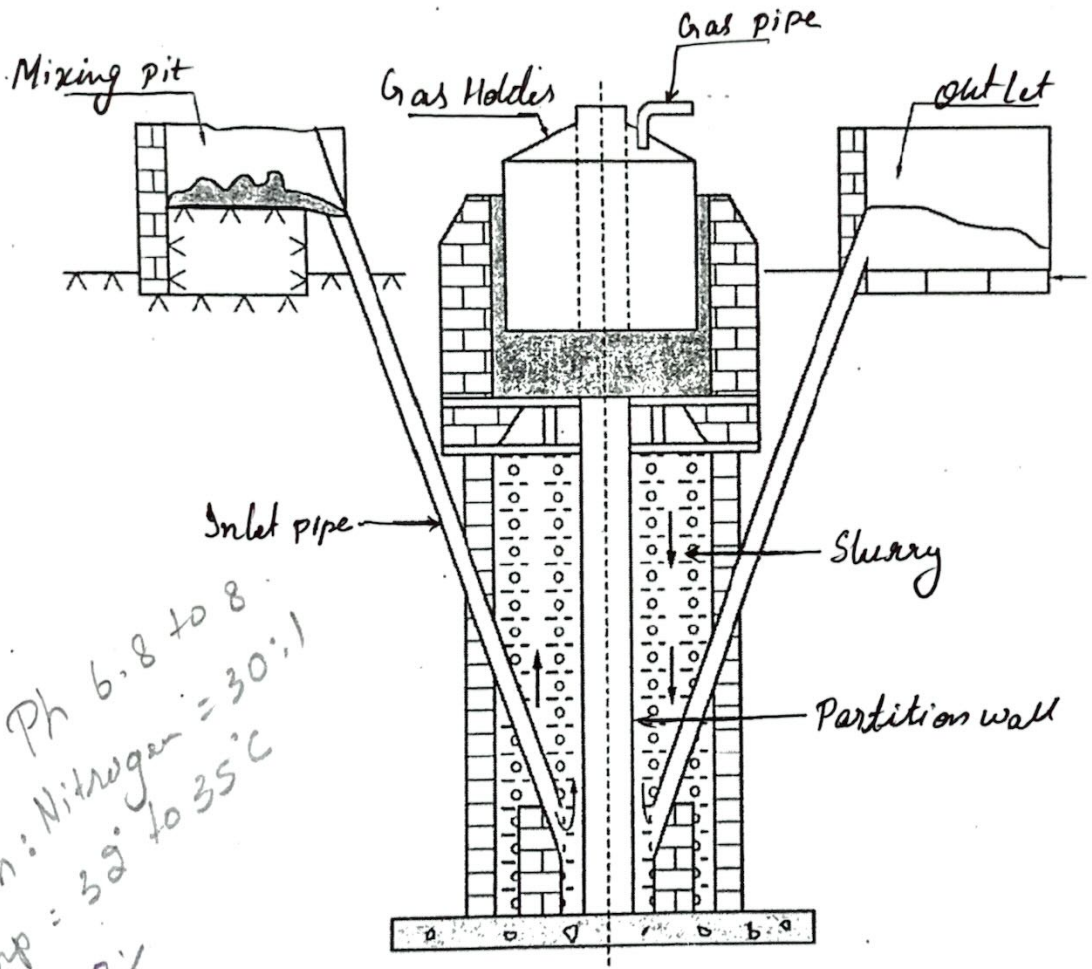
The reactor & steam generator are housed inside a containment structure. The nuclear reaction produces enormous amount of heat, which is transferred into a steam generator where steam is produced by reaction of heat with cooling water. This steam is led to the turbine using a steamline & steam is utilized to drive the turbine & hence generate power using a generator. The advantage of this type of design is that the radioactive steam & water never get into contact with the turbine

Types of Biogas plant

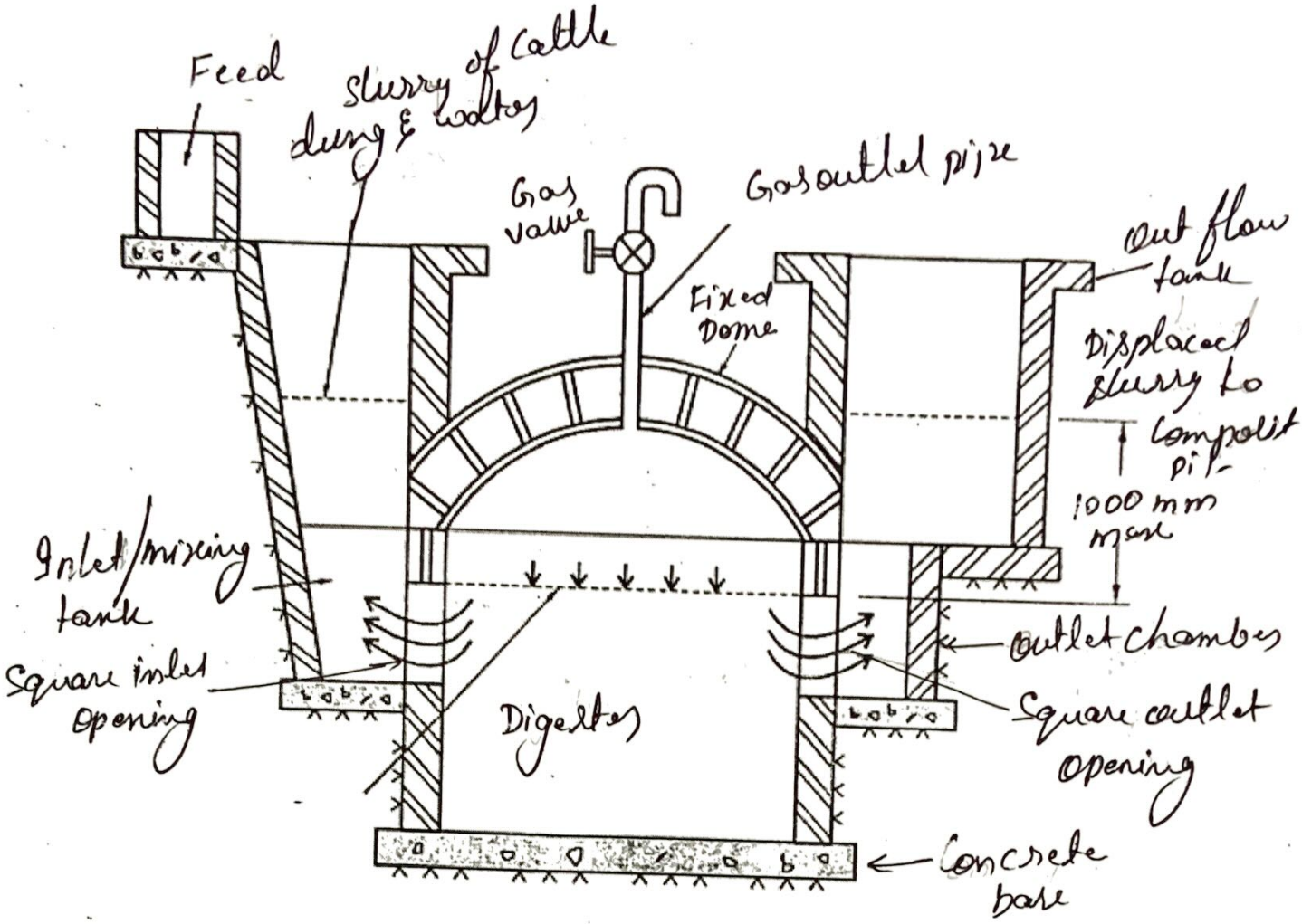
The biogas plants are classified into

1) Floating gas holder plant
2) Fixed dome digester plant

In India, biogas plants are again classified into KVIC [Khadi Village Industries Commission] model & Janata model.



Ph 6.8 to 8
Carbon : Nitrogen = 30 : 1
Temp = 32° to 35°C
Solid 8%



The KVIC model biogas plant shown in fig uses floating gas holder design. A masonry well contains raw material slurry. The digestion occurs in this well & the gas formed will be collected & taken out from the top. As the drum floats, this design is called floating gas holder type

The fixed dome digester plant is also known as Janata model or chinese plant & is similar to KVIC plant except that the masonry fixed dome replaces floating steel drum.

Foundation: It is made of cement, concrete & brick ballast The plant should provide stable foundation to the digester walls & should bear full load of slurry filled in the digester. In order to avoid water leakage, the foundation is made water proof

Digester: The digester is a cylindrical chamber made of bricks, sand & cement constructed under the ground where fermentation of dung takes place. The slurry flows in & out of digester through rectangular openings provided

Dome: The roof of digester is shaped hemispherical & is called Dome & it is fixed type. The gas collected in the dome space exerts pressure on the slurry in the digester.

Inlet chamber: made of bricks, cement & sand & is provided with an opening at ground level. A sloppy wall at the outlet ensures easy movement of the cattle dung to the digester.

Outlet chamber: The digested slurry moves out of the digester at a pre-determined height through outlet chamber. A small rectangular opening is provided at the bottom & larger area is provided at top to a pre-defined height. It is also provided with opening at the ground level

Mixing tank: It is the chamber in which slurry is formed. & is then enters into the inlet chamber.

Gas outlet pipe: The Dome is fitted with a gas pipe to convey the gas to use. The gas flow is regulated by valve provided at the end of gas pipe.

Working:

The slurry of dung & water [1:1] is filled in the digester up to the level of cylindrical portion. The gas generated due to fermentation gets accumulated in the dome & exerts pressure on the slurry. The slurry in the digester pushed to inlet & outlet chambers. Hence slurry level falls in digester & rises in outlet chamber. The slurry level continues to fall till the level reaches upper edges of inlet & outlet gates. There after, the gas accumulation would exert pressure & gas escapes to atmosphere through gates. The bubbling & froth formation of the slurry in inlet & outlet chambers indicates escape of gas to atmosphere. By knowing increase in slurry volume in these chambers, the quantity of usable gas can be calculated. When gas is supplied for usage, the slurry level in the digester increases & that of in inlet & outlet chamber decreases. During the process, an equivalent amount of digested slurry is discharged from outlet chamber & the fresh slurry enters & settle down in the digester.

Biomass Gasification :-

This process converts almost all the forms of biomass or solid fuels, such as agricultural residues, corn-waste rice-husks, woods, wood-wastes etc., into a combustable gas mixture which is normally called producer gas. The producer gas is comprised of CO, H_2, CO_2, methane & nitrogen. This process of conversion is typically used for various biomass materials & it partially limits the combustion of such biomass during the process. The partial combustion

occurs when the intake air supply is controlled & its less than adequate quantity is fed into the system for the combustion for biomass. The gasifier essentially acts as a reactor where various complex physical & chemical processes take place. Biomass gets dried, heated, pyrolysed, partially oxidized & reduced in this reactor during the process as it passes through the Gasifier, which ultimately yields the produced (inflammable) gas as a ~~un~~ usuable product

processes that take place in a gasifier

1) Drying:

All moisture must be removed from the wood chips in order to successfully produce wood gas. while all water in the wood will be vaporized eventually by heat of pyrolysis combustion, & reduction, failure to remove moisture from the wood before hand results in the inability to produce clean fuel. Therefore, in an ideal gasifier, some of the heat produced during combustion is used to completely dry the wood. ~~Since the lack of clean gas could be catastrophic to our project~~

2) Pyrolysis: pyrolysis occurs when the wood chips are heated without oxygen to burn. Fast pyrolysis does not begin until the wood has reached a minimum temperature of about 550 K. This causes the wood chips to decompose into tars & charcoal. The tars are burned off, leaving charcoal with high carbon content. This charcoal is integral for the reduction process

3) Combustion:

It is the exothermic combustion of hydrocarbons with oxygen. The heat for all processes is generated from combustion of the tars produced during pyrolysis. In addition, combustion products CO_2 & H_2 gas, which will become reactants in the reduction step.

4) Reduction:

Reduction reverts complete combustion hydrocarbons into a form that can be used as fuel. Note that reduction is the opposite of combustion - it is the endothermic removal of oxygen from hydrocarbons. Typically combustion & reduction exist in equilibrium in any burning process. Reduction in a gasifier occurs when CO_2 & H_2O vapor flows through heated charcoal. The heated carbon removes the O_2 from both CO_2 & H_2O vapours. The O_2 is spread to the carbon atoms, forming covalent bonds in the form of CO. O_2 has a higher affinity for carbon than either H_2 or itself this leaves the remaining H_2 atom to form their natural diatomic. Therefore, two reactions occur from the addition of carbon & heat: CO_2 is reduced to CO & water vapours is reduced to diatomic Hydrogen & Carbon monoxide

Global Warming:- Warming of the earth's climate change due to thermal pollution is called global warming It causes to raise the earth's average temperature. The climatic change is due to the increased volumes of CO_2 & green house gases released by the burning of fossil fuels, land clearing agriculture & other emission created by humans activity that have occured over the past 50 years. The phenomenon is called anthro-pogenic global warming.

The gases form a layer in the atmosphere & trap the sun's radiation which in turn makes the planet warmer. The changes resulting from global warming may include ~~rai~~ rising sea levels due to the melting of the polar ice caps & increase in storms, droughts & other severe weather events

Causes for global warming

→ Burning the fossil fuels
→ Deforestation
→ Cement Production
→ Gas flaring
→ Calcination of limestone during clinker production

Methods to control Global warming

→ By reducing the emission of greenhouse gases
→ By designing advanced carbon sink to absorb green house gases
→ By useage of renewable energy

Ozone Depletion :-

Ozone or Trioxygen (O_3) is a pungent pale blue gas. It is formed from dioxygen by the action of UV light & electrical discharge with the earth's atmosphere. Ozone present in its highest concentration covering the second layer of Earth's atmosphere called Stratosphere. This covering layer is known as Ozone layer or Ozone shield. It absorbs most of the Sun's UV radiation. reflects a few of them back & the rest of Sun's UV radiation, ~~reflects~~ a few of ~~them~~ back & unabsorbed part of UV-B radiation reaches the ground. The reduction in ozone's UV absorbing capicity is called ozone depletion. The severe depletion of the Antarctic Ozone is called as Ozone hole

During combustion of fossil ~~fu~~ fuels a group of pollutants called ozone precursors will be emitted to the atmosphere causing ozone depletion happens because of two main things

→ Man made ozone depleting substance
→ Natural source substance

The man made ozone depleting substance are the chlorofloro carbons & halons released to the atmosphere, the UV radiation from the sun causes them to break apart & release chlorine & bromine atoms. These react with ozone & destroys them hence ozone depletes.

The natural substance are the oceanic & terrestrial ecosystem these emit only a few halogen source gases. But they are short lived gases & their effect is less compared to man made ozone depleting substance, more over they can be substantially destroyed before reaching the first layer of atmosphere by dissolving in water or ice

Effect of Ozone depletion :-

→ It affects eyes & respirating system leading to types of cancer.
→ It causes damage of DNA both plants & animals
→ It creats Global warming.

Causes of Ozone depletion :-

→ Combustion of fossil fuels
→ Gases like halons, methyl chloroforms etc.,
→ Increasing Concentration of CFC's & organic molecules & gases
→ Reactive gases like chlorine monoxide & bromine monoxide.

Methods to Control Ozone depletion :-

→ CFC contained products like hair sprays deodorants & house hold chemicals have to be avoided.
→ Methyl bromide treated timber, wood & plywood products.
→ Eating excess meat
→ Excess driving, transported goods etc.,
→ Disposing old refrigerators, cooling appliances & electronic equipments.
→ Using public transport, Electric or hybride car.
→ Avoiding usage of harmful chemicals in products
→ Active ingredients in fire extinguishers.

Introduction to Mechanical Engineering (BESCK204D)

MODULE 1:

Introduction to Mechanical Engineering:

Introduction: Role of Mechanical Engineering in Industries and Society- Emerging Trends and Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Energy: Introduction and applications of Energy sources like Fossil fuels, Nuclear fuels, Hydel, Solar, wind, and bio-fuels, Environmental issues like Global warming and Ozone depletion

1 Role of Mechanical Engineers in Industries and Society

- Mechanical engineering is the branch of engineering which deals with the design, manufacturing, maintenance and testing of machines. It is also considered as one of the most diverse and versatile disciplines of engineering. Mechanical engineering also includes the application of mechanics, material science, applied mathematics and physics.
- With the rise of modern technology, mechanical engineering has witnessed new found importance with more and more students opting to learn less explored domains of robotics, mechatronics, nanotechnology, etc.
- Mechanical also developed machine and tool that produce product that range from sport equipment to pharmaceutical devices, medical devices, personal computers, humidifiers, dehumidifiers, automobile engines, robotic arms, electrical power plants and solar driers. Mechanical engineer usually touches all section of life.

2 Emerging Trends and Technologies

2.1 Biotechnology.

Including biopharma; tissue engineering/regenerative medicine; synthetic biology; and bio-inspired manufacturing using self-assembly.

2.2 Nanotechnology.

Including carbon nanotubes; Nano composite structural materials; Nano electronics; nanotechnology-based coatings; nanoparticles; and Nano-tagging.

2.3 Micro technology.

Including micro tooling (for replication) manufacturing and micro-systems in machine tools and products.

2.4 Information and communication technology (ICT) in manufacturing systems.

Including intelligent mechatronic systems for automation and robotics (e.g. self-adapting components) and advancement of grid computing for manufacturing.

2.5 Advanced materials.

Including advanced composites and “meta materials”.

3 Role of Mechanical Engineers

3.1 Materials and metals industry –

This job role demands the design, development and testing of a wide variety of complex mechanical system. This will include the entire life cycle maintenance of the mechanical items that are used in the plant. A few of those are gas and steam turbines, pipework, valves, fans, coals mills and so on.

3.2 Rail industry –

The overhead line systems need specifications to be written, designs to be reviewed and technical queries to be answered which falls in the interest of mechanical engineers. Some of them diversify and become track engineers which entails the same functions, but the focus shifts to the track systems.

3.3 Chemical industry –

The main function of mechanical engineers in the chemicals industry is to deliver improvements in reliability, offer technical support that include a variety of automated production equipment such as conveyors, pipework, robotics, pumps, industrial ovens, valves and so on.

3.4 Construction industry-

The role of mechanical engineers in this sector is the designing of the ventilation, smoke ventilation systems, heating, and air conditioning systems that are installed in buildings. The range of their projects can include offices, shopping malls, universities, railway stations and hospitals. They take on additional technical discipline responsibilities in coordination with the requirements of the clients.

3.5 Electronics industry-

The role of mechanical engineers in this industry is primarily concerned with designing machines that produce power. The types of machines are internal combustion engines, steam and gas turbines, electric generators. The power consuming machines such as air conditioners and refrigerators are also included. The elevators and escalators that are used inside buildings are designed by mechanical engineers.

3.6 Biomechanical engineering-

In this field, the musculoskeletal system of the human body is viewed as a mechanical structure that can undergo certain motions and stresses. The principles of force, energy and motion are being concern, mechanical engineers use their knowledge of design, manufacture,

and operational processes to advance the world around us, improve safety, ability to manage economic with strength and enjoyment throughout the world.

4 Different sectors in Mechanical Engineering

4.1 The Energy Sector

- It is one of the major inputs required for economic development of any country and in developing countries, the energy sector assumes a critical importance in view of the ever-increasing energy needs requiring huge investments.
- Mechanical engineers in the energy industry to design and operate fossil fuel, hydroelectric, conventional, nuclear, and cogeneration power plants. They are involved in all aspects of the production and conversion of energy from one form to another.
- Mechanical engineers can work in every stage of renewable energy development and distribution. Research different materials and study material interactions for use in renewable energy, potentially leading to the development of new systems, technologies and infrastructure for generating and distributing power.

4.2 The Manufacturing Industry

- Internet of things in manufacturing- The Internet of Things (IoT) is a network of physical devices that are embedded with sensors and, software that make them the “eyes and ears” in a vast range of use cases. From home automation (intelligent thermostats, connected doorbells, smart coffee makers) to industrial automation (electric vehicles, robotics, medical imaging) IoT is everywhere, talking to each other, receiving and sharing data amongst themselves without any human or computer interaction.
- Big data- Some examples of different types of big data in manufacturing are productivity data, sensors on machines and power consumption information from different machinery. It can also be integrated from outside partners or vendors. Big data in manufacturing becomes valuable only if one centralized view can be created. This is the “hub” into which all data must flow.
- Automation and Artificial Intelligence in manufacturing- Manufacturers are already deploying automation on the factory floor as well as in their offices. We will continue to see the expanding usage of artificial intelligence in manufacturing for productivity improvements. AI will power demand planning, inventory planning, logistics and production scheduling.
- Additive manufacturing or 3D printing- Additive manufacturing, so-called because it adds material in layers to create an object, uses CAD software or 3D object scanners for digitally 3 d printing machine parts. It deposits material in layers, in precise geometric shapes. Parts can then be stored as design files in virtual inventories to be produced whenever needed, which is known as distributed manufacturing. Transportation distances and costs are reduced and inventory management is simplified by storing digital files.
- Augmented Reality: Touchless Service Model- With the manufacturing sector beginning to explore VR, the potential for this manufacturing technology, in assembly processes, maintaining equipment and improved decision making is huge. For instance, factories could use augmented reality (AR) glasses to project data such as layouts, assembly guidelines, possible malfunction sites, or serial numbers for parts, enabling faster and easier workflows.

4.3 The Automotive Industry

- This industry is one of the fastest growing and has therefore opened up numerous job opportunities. The role of a mechanical engineer spans the design, manufacturing and maintenance of motor vehicles. With the advancement in technology when breakthrough ideas like driverless cars, pod-based transportation systems, bullet trains, are being considered. Top companies and automobile brands are investing a lot on research and recruiting skilled and passionate mechanical engineers.
- The need to replace various composites, plastics and aluminum alloys with sheet-metal steel, which is essential to the torque of an electric motor and minimizing the overall loss of its energy as heat.
- The increased demand for lithium-ion (Li-ion) batteries. Navigant Research estimated the market for vehicle-specific Li-ions at $7.8 billion in 2015 and projected it would reach $30.6 billion in 2024.
- The design, testing and installation of the different infrastructures supporting EVs. For example, mechanical engineers may contribute to the roadside charging stations necessary for recharging an EV on the go.

4.4 The Aerospace Industry

- ***Aerospace industry –*** This industry has witnessed a lot of innovations and discoveries. Flying cars to reusable satellites, rockets are now not unheard of as technology is progressing so is the demand for newer inventions. Numerous job roles are being offered here ranging from design, to manufacture to testing to R&D. The mechanical engineers get a chance to employ the principles of physics to aeromodelling and dynamics to improve the design and efficiency in systems.
- Additive Manufacturing Consolidates and Lightweights Aerospace Parts. Autonomous Flight Systems Will Be the Future of the Aerospace. Industry Advances in materials have led to a variety of possibilities for aerospace companies. The majority of this has been seen through the increased use of carbon nanotubes and graphene, providing several benefits.
- The most notable of these have been seen by making planes more efficient by reducing weight and less fuel consumption. As a result, there can be a lower cost associated with traveling.
- 3D Printing: The cost reduction seen with 3D printers; companies can see significantly less time spent on the R&D phase. By doing so, firms will reduce the time it takes to design a product and release it to the market.

4.5 The Marine Industry

- Mechanical engineers in this industry design and build or operate and maintain equipment and marine vessels. These engineers design, install, or maintain engines, shafts, boilers and propellers. They could be a part of the team that enforces regulations for air and sea pollution or be a part of designing futuristic cleaner ships. Marine engineering is a specialized branch of mechanical engineering devoted to the design and operation of systems, both mechanical and electrical, needed to propel a ship.
- The complex mechanical systems are designed, developed and tested by the mechanical engineers in this sector. This is done through the use of 3D modelling and a variety of analysis tools, that ensure that the thermal properties, manufacture, mass, structural integrity, cost of

the equipment and its assembly are in accordance with the operating environments of land, air and sea.

- Advances in shipbuilding, propulsion, smart shipping, advanced materials, big data and analytics, robotics, sensors and communications in conjunction with an increasingly skilled workforce are all having monumental shifts in how the maritime industry are approaching new challenges and opportunities.