Biomass:- Biomass is a complex term which consists of two subterms "bio and mass" "Bio" refers to the biological or living content of an organism volume, while mass refers to the existance of bulk amount of living organisms.

Biomass Energy :- Complex organic material obtained from the living or dead organisms such as plants animals and algae is usually referred to as "biomass". If the energy is obtained from such biomass, then it is called "biomass energy.

Difference between Biogas and Biomass

Biogas	Biomass
1) It is a low burning gas produced by digestion pyrolysis or hydrogenification	1) It is an organic matter produced by plants, animals and other living organisms.
2) It is obtained when Biomass is fermented anaerobically. Biogas mixture contains 55-66% methane, 30-40% CO_2 and other impurities like hydrogen sulphide and nitrogen	1) cattle dung, human, waste piggery waste, poultry droppings, kitchen waste, paper etc--, are different types of Biomass.
3) Biogas is clean and smoke-less. Hence, it is efficiency used for cooking, thereby reducing the demand for fire wood.	3) The different Biogas and Biomass resources are burnt directly to get the energy

Disadvantages of Biomass Energy

1) It may lead to soil infertility and erosion.
2) Low energy density, large land requirements, difficulty in transport and storage
3) Large scale agro-industry may be too complex for efficient operation

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4) Inappropriately designed and integrated systems may be produce water and air pollutions.

Advantages :-

1) The cost of fixed drum is low compared to floating drum type, as it uses only cement and no steel.

2) There is no problem of corrosion.

3) As it constructed beneath the ground, heat insulation is better and the temperature will be constant.

4) Cattle and human excreta and long fibrous stalks can also be fed.

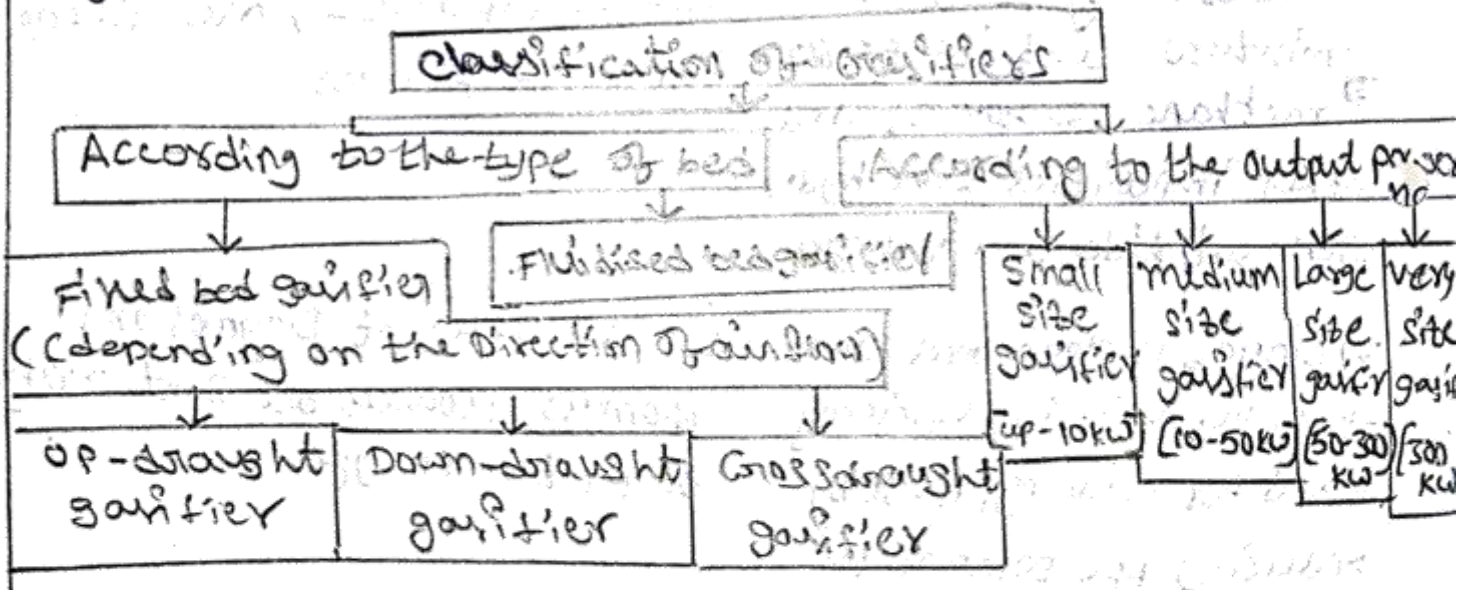
5) No maintenance

Disadvantages :- 1) The process of constructing the plant requires skilled personnel.

2) Gas production per cubic meter of the digester volume is less

3) It has variable gas pressure.

A gasifier is a chemical reactor in which of biomass into gaseous fuel takes place.



Figure

Present is satatus of Development of Biomass energy

Upto 1990-91 over 1.4 lakh size biogas plants were set up in the country by DAUNS. It is estimated that there is now an annual production of 1100 million cubic meter gas equipment 38.18 lakh tonnes a fuel wood per year valued at

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Rs. 152.7 crores per annum. The Department of non-conventional energy source has taken up projects worth 5mw aggregate capicity split into mechanical and electrical application system through gasifier or stirling engines working on biomass at various location in the country under a demonstration programme

Answer:- Geothermal energy is the heat derived from interior of the earth. It is recoverable in some form such as steam or hot water. Along the depth of earth's surface, there exists different temperature. The temperature increases with the increase in depth. Also there are some local hot spots below the earth's surface, which posses high temperatures. Thus when water comes in contact with temperature regions it get converted into steam.

Geothermal steam is of two kinds,

1) originating from the magma itself, called magmatic steam.
2) from ground water heated by the magma, called meteoritic steam.
3) The meteoritic steam in the largest source of geothermal steam.

Characteristics of Geoenergy

1) Geoenergy is a renewable thermal energy contained in the interior layers of earth
2) Thermal energy is avaiable in the form hot water, steam or geomatrial, geothermal brine.
3) It is obtained deep inside in earth ie more than 80km, hence difficult to extract.
4) Geoenergy can be obtained in the form of,
   i) Hot water springs, ii) Geysers gusher iii) Fumaroles iv) volcanic eruptions.

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Geothermal sites, earthquakes :- Earthquakes and volcanoes are related to geoenergy sites based on tectonic plate theory. The surface of earth is constitute of various individual plates which move in different at different at speed and also reshapes the outer layer of earth's surface. At time these plates collide one another. Due to this more amount of energy is generated in rocks and upon releasing of this energy vibrations occur which passes through rocks as a result of these temperature, earthquakes are produced when a tectonic plate falls into the mantle, it temperature becomes very high. Hence, rocks get melted in the earth. The melted rocks slowly moves up through through a series of rocks in the direction of earth's surface. Once it reaches the surfaces, it is known as lava and formation of layers of lava the result of volcanoes.

Prime movers used in geothermal energy conversion system are classified as

1) Impulse or Reaction machines

i) Axial flow - curtis and Rateau steam turbine

ii) Radial inflow - Rotating nozzle (pure reaction) and Curtis turbine.

iii) Radial outflow - Rotating nozzle.

iv) multiple disc Turbine - Bladness impulses (or) Reaction drag Turbine

2) positive displacement machines

i) Helical or screw expander

ii) Rotating oscillating vane machine

3) Impulse machine

i) Tangential flow pelton wheel or re entry types turbine

ii) Rotating, Axial flow turbine, de-laval turbine and curtis turbine

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Geothermal energy in India :- There is wide scope to develop geothermal power in India, but still development of geothermal field is in initial stage. About 300-304, 340 thermal areas are there in India, each represented by hot spring. And 113 spring are as, are discovered so far, where geothermal power is available. Among these, 46 systems are of high temperature type which could generate 1858 MW for a period of 30 years, 59 are intermediate temperature. However, one plant is in operation in Puga valley in Jammu and Kashmir having 20 MW capacity and another plant is under construction is Himachal pradesh and a cold storge based on geothrmal energy was under fabrication at the National Aeronautical laboratory, Bangalore.

Principle of ocean thermal Energy conversion

A sufficient amount of heat form the solar energy is collected by the upper surface of the ocean, which acts as a collector therefore the upper layer acts as hot temperature source and the inner deep layer act as low temperature source and the inner deep layer act as low temperature source. Hence, there exists a thermal energy or thermal gradient in the ocean. Therefore, this thermal energy can be used to generate electric power by utillising the high temperature water for evaportion of fluid, which in turn drives the turbine of power plant. And the low temperature water is used for condensation of the turbine exhaust thus the cycle continous and power is generated

Fundamental principle in energy conversion from ocean waves

ocean waves are created by the interaction of winds with the surface of sea. It contains both kinetic energy and potential energy. The energy of the wave depends on the wind speed, the distance it interacts water and its duration. The wave motion is horizontal and motion of water.

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In this, floats are used to convert water motion into mechanical power. A large float is driven up and down by water within stationary slides. This reciprocating motion is converted to mechanical and then to electrical power.

Types of sites are considered:- The highest concentration of wave energy occurs between the latitudes 40° and 60° in each hemisphere. The latitudes of around 30° may suitable for exploitation of wave energy regular trade winds prevail around this latitude. Winds blowing for long distance over the Atlantic ocean can be generated tonnes of meters high with more than 100 meters between crests and many tonnes of water displaced in each wave. The west coasts of Europe and the United states and the coasts of New Zealand and Japan are particularly suitable for wave energy extraction. In India the annual wave energy along the coast is between 5kw to 15kw.

Progressive wave

Progressive wave is the wave that move from one point to another in the form of vibrating particles. They distributes energy to the surrounding area and propagates laterally. They are of two types namely.

i) Transverse waves :- These waves vibrate perpendicular of motion

ii) Longitudinal waves :- These waves are vibrate parallel to the direction of motion.

Q) Find the quantity of water to be pumped to OTEC plant working with surface water at 27°c and with cold water at 8°c. Depth of 600m from the surface to obtain 10 MW of thermal energy assume the density of ocean water as 1010 kg/m³ and the

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Given data

output power developed $P_o = 1\times10^7$ kW

surface water temperature $T = 27°C$

Temperature difference $\Delta T = 19°C$

Density of water, $\rho = 1010$ kg/m^3

Specific heat of water $C = 4.2$ kJ/kg/K

Efficiencies of Turbine and gene rator: $\eta_T = 0.75$, $\eta_G = 0.96$

(26)

Actual power to be developed

$$P = \frac{P_o}{\eta_T \times \eta_G} = \frac{1\times10^7}{0.75\times0.96} = 1.38 \text{ kW}$$

$$P = \rho C Q \Delta T$$

$$1.38\times10^3 = 1010\times4.2\times Q\times19$$

$$Q = \frac{1.38\times10^3}{1010\times4.2\times19}$$

∴ quantity of water to be pumped $Q = 0.017$ m^3/sec.

Origin of Biomass Energy

Biomass energy is produced by the green plants through the process of photosynthesis, as shown in the figure. photosynthesis is a process in which green plants absorb atom sphere carbondioxide, sunlight, water and produce Biomass and produce Biomass energy by utilizing internal constituents such as chlorophyll and moisture. This can be represented in the form of an equation. CO_2 + chlorophyll and moisture + sunlight → Biomass + CO_2. The produced Biomass is then stored in the form of complex organic compounds which are derivates of C; H_2 and N_2. After the consumption of biogas produced by the biogas plants the residues can be reutilized again for the consumption of Biomass energy. This can can be obtained by feeding the waste residues in a pond, containing alge. Alge by following the process of photosynthesis, feeds on the Biomass residues utilizes CO_2, photo energy sunlight from environment and produce methane biogas as their output. Alge contains organic which can be converted into methane By a process called anaerobic digestion. The biogas can be obtained on a large scale by cultivating large number of alge crops. organic matter important constituent of all live all living beings. However their sources of generation

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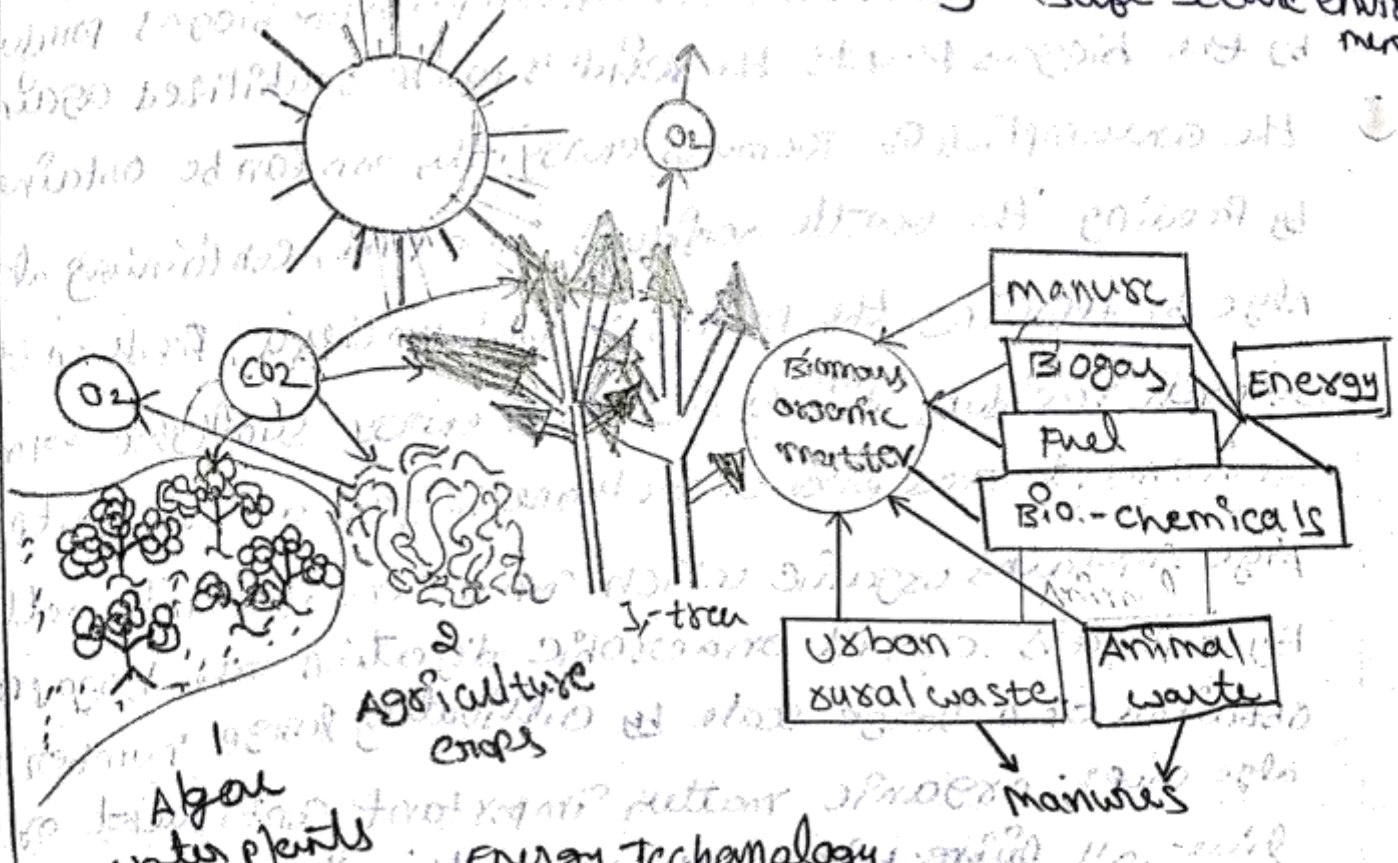
Differences In a green plants, it can be produced through the process of Photosynthesis, whereas micro organisms and other animals depend on the green plants. Terrestrial or aquatic plants animals, micro organisms, algae and their derivatives act as a source of biomass. However the Biomass can be also used for generating secondary or source energy such as heat, gaseous fuels and organic chemicals. There are various alternatives for a production such as heat, gaseous fuels and organic chemicals

Global potentials :-

1) It has been out that through the natural process of Photosynthesis, green plants enables processing of about 2x10^11 t of carbon per year with an energy content of 3x10^21 J.

2) Since, biomass is obtained from natural resources, through the process of Photosynthesis, it is significant in solving the further problems related with energy.

3) Biomass is produced by the degradation of complex organic waste, which helpful in maintaining a safe secure environment



Energy Technology

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Biomass Resources:- Biomass resources are classified into five types Forest, Agricultural wastes, Energy Crops, Aquatic plants, Urban waste

1. **Forest:-** Forests are the rich source of fuel, wood, charcoal and produce gas.

2. **Agricultural wastes:-** Crops residues such as straw, sick husk and waste wood are pressed to form lumps, known as fuel pellets sand are used as solid fuel

3) **Energy crops:-** Sugarcane, sweet sorghum, sugar beet, starch plants, cassava, oil producing plants are used in the used as bio-resources.

4) **Aquatic plants:-** The water plants which provide raw materials for producing biogas or ethanol are water hyacinth, kelp-seaweed and algae.

5) **Urban waste:-** Urban wastes are of two types
i) municipal solid waste (MSW) ii) sewage (liquid waste)

Methods of Biomass Energy Conversion

The different methods of obtaining energy from biomass are as follows
1) Direct combustion 2) Thermo chemical conversion 3) Bio-chemical

1) **Direct Combustion:-** Combustion is a process of burning the biomass, to generate heat which is used for cooking industries, generation of electricity and to obtain by products. Combustion of products of related to all the fuels i.e solids, liquids and gases but combustion of Biomass is difficult compared to other because of the moisture content present in it

i) **Incineration:-** The method of burning to ashes is called incineration. This method is especially employed for burning municipal solid waste, to reduce the volume of it and to generate steam and electricity.

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(i) Pyrolysis:- In this process, the organic material is converted into solids, liquids and gases by heating in the absence of oxygen at a temperature range of about 500°C-900°C. material like vegatable wastes wood dung etc is dried and burnt to provide heat or to change them into gases having low calorific values by the action of pyrolysis.

2) Thermochemical conversion:- It is a process in which Biomass is decomposed at varying combinations of pressure and temperature. Chemical conversions are of two types

Gasification:- Gasification is achived by heating Biomass with a controllable amount of oxygen to produce to low heating value gas or by reacting the Biomass with steam and oxygen at high temperature and pressure to produce medium heating value gas. The resulting gas is called producer gas which is used in producing heat and steam and also used in generating electricity in IC Engines and gas turbines

(ii) Liquification:- Liquification is a process of pyrolytic heating of solid Biomass in the absence of oxygen to produce a liquid oil. The producer gas and the pyrolytic oil can be used as fuel fuels, as they are cheper and more efficient that the solid Biomass.

3) Biochemical Conversion:- Biochemical process involes conversion of Biomass to biofuels. It is a slow process as it is carried out at low temperature.

Two types of Biochemical conversions

(i) Anaerobic Digestion:- It is process in which the organic materials are broken down by microorganisms

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In the absence of oxygen. This process produces gas usually containing methane(CH_4) and carbon dioxide(CO_2) with minimum impurities. Anaerobic digestion is carried out at low temperature up to 65°c and requires a minimum of 80 percent moisture content. The gas produced by this process can be burned directly and can also be converted to synthetic natural gas by removing carbon dioxide and impurities.

(ii) fermentation :- It is a process of decomposition of organic matter by microorganisms like bacteria, yeast, enzymes etc in the absence of oxygen. This process is widely used for the conversion of grain and sugar crops to form ethanol. The residue of the fermentation process is rich in protein and is also used as cattle-feed supplement.

Wet fermentation :- Wet fermentation refers to the process consists of dry matter waste in large amounts

1) Anaerobic digestion :- In this process, the sugar solution is fermented by yeasts to obtain ethanol. The brew after the fermentation process consists of alcohol in small amounts which can be separated by distillation. Crops like maize and wheat grain sugar cane produced by vegetable starches and cellulose, potatoes etc are pulped and heated with enzymes and cellulose. starch for producing fermentable sugars fermentation of cellulose materials like wood straw, paper waste etc requires a pretreatment process and hydrolysis with hot acid. Among all the wet process of Biogas conversion chemical reduction is the least Developed.

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The Process generally consist of pressure cooking of animal wastes or plant slurry with an alkaline catalyst at Temperatures Between 250°c and 408c in the presence of carbon monoxide. with this, the organic matter is converted into a mixture of oils. with an increase in temperature and decrease in pressure, a high calorific value gas

Dry fermentation :- This process consist of Dry matter wastes water in considerable Amounts.

i) pryolysis ii) Liquefaction, iii) Gasification iv) steam gasification v) Hydrogenation.

i) pryolysis :- It is a process, which takes place under the Action of heat. This process is irreversible chemical process and also an occurs in absence of oxygen. The heat energy is used to split the chemical bonds. Reactions are complex and pryolysis of human and animal waste yields CH_4, C_2H_6, C_3H_8, CO_2, CO, H_2 etc. The process may yield solid liquid gas

Dry woody matters and wood chips can be pryolysed to produce a wide range of energy rich fuels. In this process heating of material is feed in pulverised from is carried out in reactor vessel in the absence of air with the rise in temperature of material, the lignin and cellulose present break down into simpler substance These are driven off leaving a char rich residue behind.

ii) Liquefaction :- In this; the feed stock is heated rapidly at low temperatures to maximize the yield. Due to Heating the vapour gets condensed from the gas stream and separates into two phases one is aqueous phase and the other is non-aqueous phase. Aqueous phase consist of a soup water soluble organic material.

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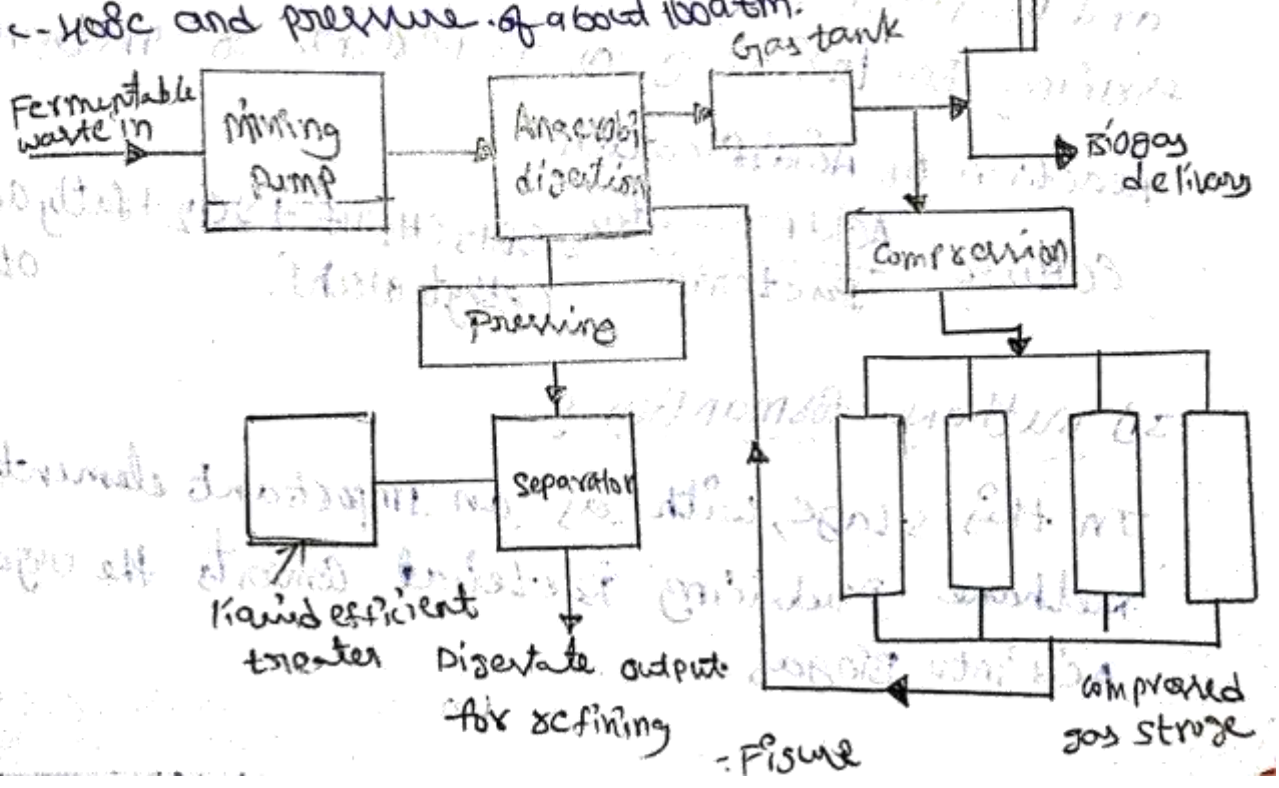
These crude product obtained can be profitably upgraded to premium fuels or can be burnt with some difficulty.

(29)

iii) **Gasification** :- To increase the Gas yield from pyrolysis of wet Biomass, small quantity of air or oxygen is blown into the reactor vessel and the temperature is increased beyond 100°c. Due to this increase in temperature, a part of feed is burned. The gas obtained from the the oxygen-feed system has a calorific value of 10-20 MJ/m³ and that from the air blows gasifiers has a calorific value of 5 MJ/m³. These gas thus obtained can be obtained can be burnt or can be converted into substitute natural gas.

iv) **Steam Gasification** :- By treating coal matter with hydrogen gas at high temperature and pressure, methane can be produced. The hydrogen required can be produced vessel itself carbon monoxide and steam. The energy yield around 55% can be achieved by this process

v) **Hydrogenation** :- It is process in which heavy oil are produced and refined to premium fuels by reacting steam and carbon monoxide with cellulose at temperature range 300°c-400°c and pressure of about 100atm.



- Figure

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Anaerobic Digestion :- Anaerobic Digestion is a bio chemical conversion At low temperature, the process of Biochemic conversion By micro organisms converting Bio-mass to bio-fuels is slow Biogas can be produced by anaerobic fermentation process i.e By fermentating organic materials in advance of air with the help of micro-organisms to Break to down, materials intermediatiate such as alcohol and fatty acids and finally carbon dioxide and water.

Anaerobic digestion takes place in three stages

1) Hydrolysis :- It is carried out By Breaking c.p lex compounds like facts, proteins and carbohydrates into small compounds with water and enzymes

Reaction of Hydrolysis

$$(C_6H_{10}O_5) + nH_2O \xrightarrow{Enzymes} n(C_6H_{12}O_6)$$

(cellulose + nutrients) (soluble glucose + nutrients)

2) Acidification :- The process of converting soluble glucose and nutrients into volatile fatty. Acids like acetic and propanic acid is called acidification. The Acid forming Bacterial gives 70 percent of methane by product

Reaction of Acidification

$$C_6H_{12}O_6 \xrightarrow[Bacteria]{Acid\ producing} 2CH_3CH_2OH + 2CO_2 + fatty\ acid + H_2 + other\ products$$

(ethyle alcohol)

3) methane formantion :-

In this stage, with as an Important element, the methane producing Bacterial converts the organic Acid into Biogas.

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Aerobic Digestion:- Biogas technology is concerned with different types of micro-organisms like Bacterial, fungi, virues etc Bacterial which grown is presence of oxygen is called aero-bic. Aerobic fermentation can be used to decompose organic matter. Normally aerobic digestion produce CO_2, NH_3 and small amounts of other gases along with a decomposed mass and evolution of heat. Aerobic fermentation is used when the main aim is to produce the hygienic material and to recover

The techniques suggested for maintaing the biogas production gas are. i) Insulating the gas plant ii) Compos-ting iii) Hot water circulation iv) use of chemicals v) solar energy

1) Insulating the gas plant:- In this method, the outer surface of the digesters are coated by various materials like aluminimum flabbing, cladding, fibre, mineral, wool glass. straw etc-- to reduce the escape of Heat from the digester. A Janata type biogas plant is generally built

2). Compositing:- This method is performed to elevate the digester operating temperatures, by utilising the Heat produced during aerobic composting of agricultural residues In composting, the slurry is heated by exothermic of the compost During the process, the loss of relased Heat radiation from the top of the digester is restricted by insulting the top of the holder by thick paddy draw mat composting is consid-ered to the best most inexpensive method for producing large amount of biogas during water.

3) Hot water Circulation:- In this method, hot water is circu-lated through the system, In order to maintain the ferm-ented slurry temperature up to the require level. It is considered to be inexpensive method efficient process but the system of this process is high.

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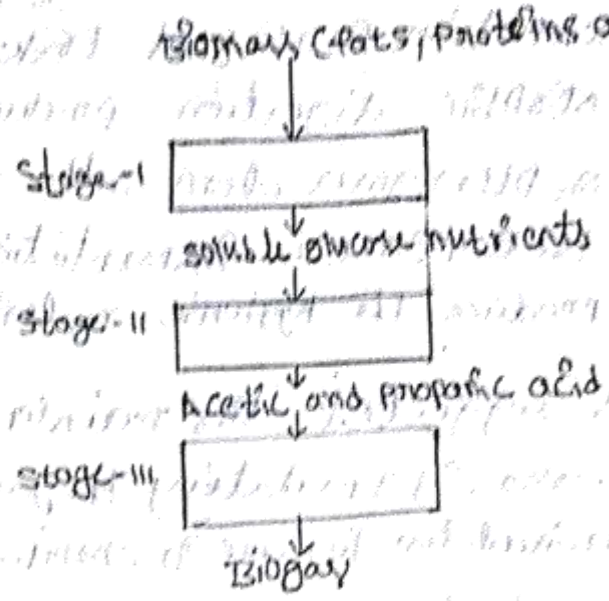
Reaction of methane formation

$2CH_3CH_2OH + CO_2$ · methane producing bacterial → CH_3COOH → $CH_4 + CO_2$ methane



Aerobic and anaerobic

Aerobic	Anaerobic
1) It requires oxygen or air for degrading available CO_2	1) It does not require oxygen or air for decomposition.
2) It requires of large quantity of air.	2) It does not pumping of air
3) Sludge has less fertility contents	3) It does not require pumping of air
4) The output is methane	4) sludge has high fertility contents
5) The output is methane	5) The output product is CO_2
6) Reaction rate is high, hence it requires long time	6) Reaction rate is low, hence it requires less time
7) odour emission is high	7) odour emission is low
8) High operating cost	8) low operating cost
9) low initial cost	9) It can work on dry waste and wet waste
10) it can work only on dry waste	10) It requires less area
11) Area required is large	11) It requires less area
12) Treatment o/p is not required	12) It requires post treatment

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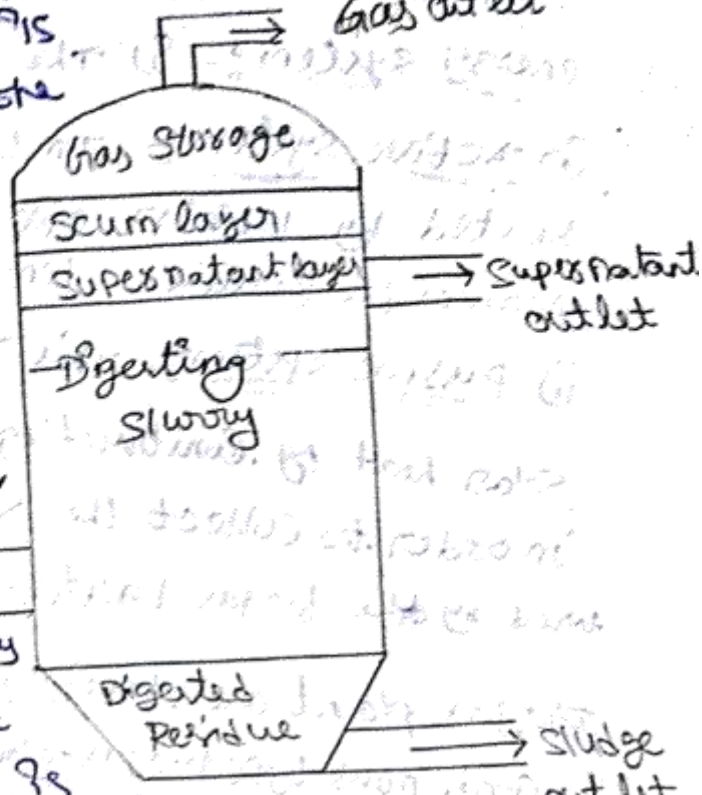
Continous Type of Biogas Plant :- In the continous type of plant, the raw material is charged regularly in a single digester and the process continous without and obstruction. In this, the raw material is efficiently blended with the mass and gass production is maintained properly. This process can be completed in one-or-two stages.

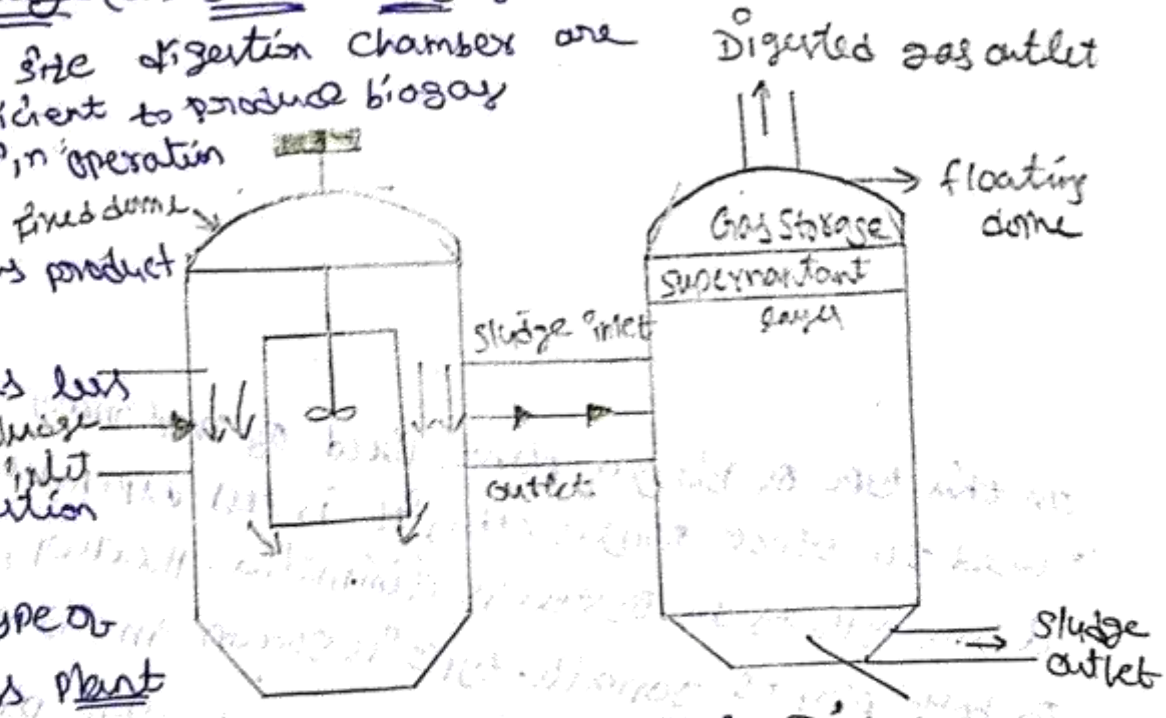


fig(1)

One stage :- In this process, the conversion of organic compounds into biogas out in single out in a single chamber. The raw material is feed regularly in the chamber, while the water move out from the outlet.

Two stage (or) Double stage :-

1) small size digestion chamber are sufficient to produce biogas
2) Easier in operation
3) Continous production
4) Requires less time. for digestion



Batch type of Biomass Plant

In batch biogas plant, the feeding out in intervals. Hence the plant is periodically charged and emptied the digesters which are charged with time time urea etc produce gas about 40-50 days. After the completion

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4) Use of chemicals :- Chemicals like urea and urine are used to increase the Digester temperature. for example animal urine is used to improve the biogas production

energy system :- i) The Active system ii) The passive

i) Active system :- In this the Digester feed is directly heated by the solar energy during the day and once it achives the required temperature, the feed is feed to the digester

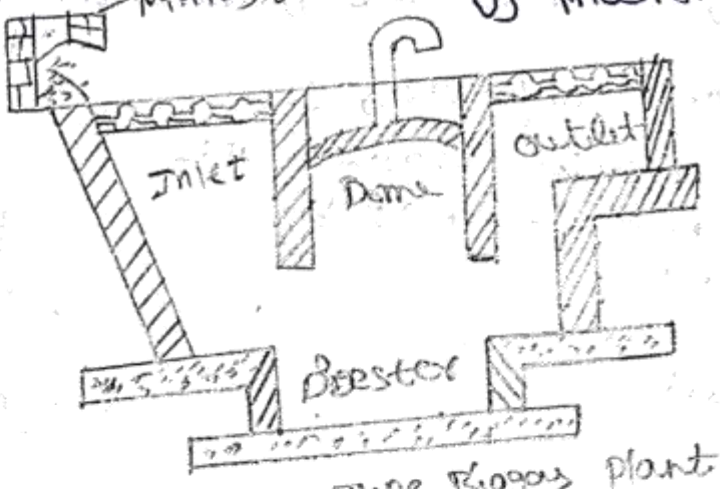
ii) passive system :- This is indirect method of utilizing solar heat by constructing a green house around the digester in order to collect the radiant heat energy which is further used by the biogas digester.

Biogas plant are classified as,

i) Continous type biogas plant, ii) Batch type plant

iii) Floating drum type plant iv) fixed dome type plant

v) modified biogas plant.



Fixed Dome Type Biogas plant (Janata type)

In this type of Bio gas plant, fixed of masonary construction is used to store Biogas. Thus it is less expensive that floating drum type as the Digestor is eliminated. However, the working of both plants Janata type is shown in figure is fixed dome type of Biogas plant. Deebandhu plant also in this category. The gas stored in the dome posses variable pressure. This plant requiring skilled personnel to construct the dome to ensure efficient operation.

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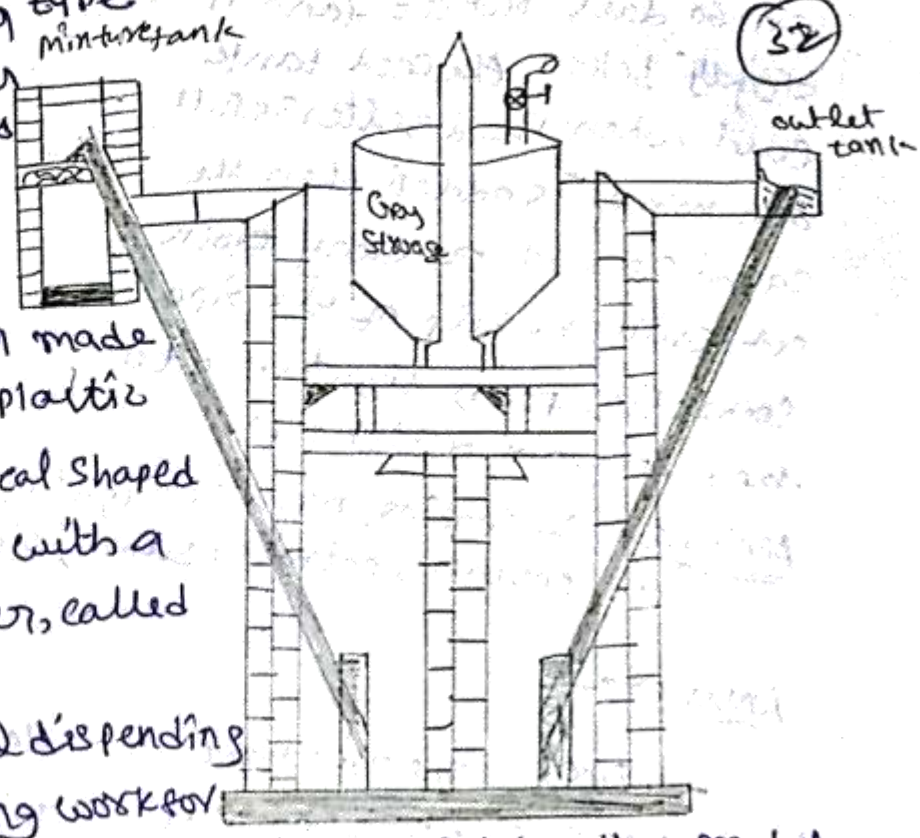
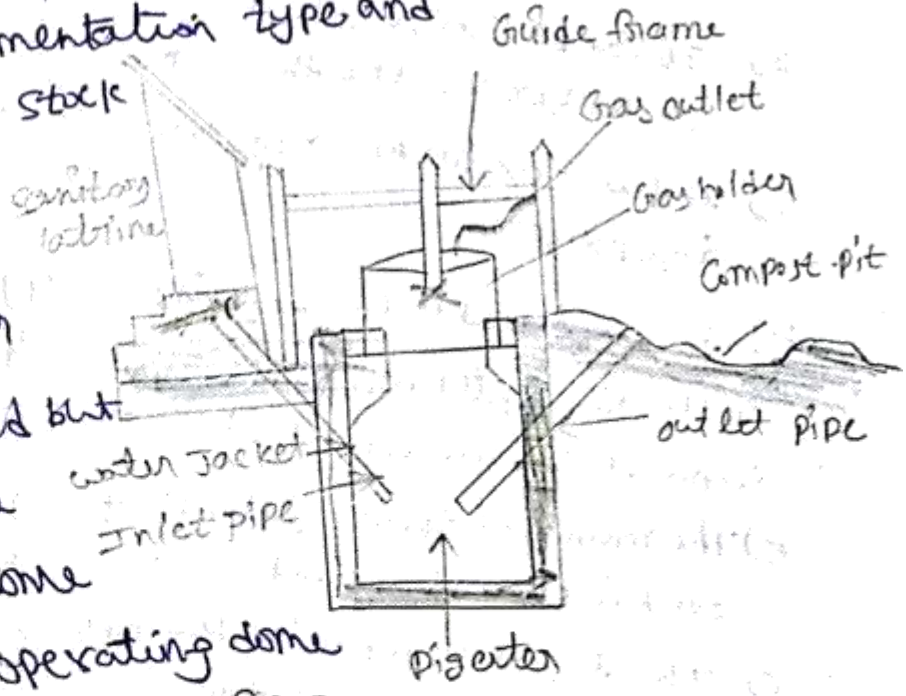
Biogas plants used in India :- 1) Floating gas holder type
2) Fixed dome type
3) Floating gas holder type plant having digester made of pre-fabricated ferro cement segments
4) Floating gas holder type plant gas holder made of fibre glass reinforced plastic
5) A plant having conical shaped base shell digester with a provision of gas holder, called Poragathi model.
6) Fixed dome model depending with the shuttering work for construction of dome position called Deenbandhu model.

(32)



KVIC type gobar gas plant

Biogas plants in India are primarily semi-continuous fermentation type and the most common feed stock is cattle dung. Night soil, poultry droppings, water hyacinth or other livestock etc also used but soil based plants are becoming popular. Some farmers have been operating dome plants on a mixture of cattle dung and organic refuse scraps collected from kitchen. The common size of plants vary from 1m³ to 10m³ of gas production, temperature of 25°C to 38°C for 25 kg dung collectable from 1 or 2 cattle heads



figure

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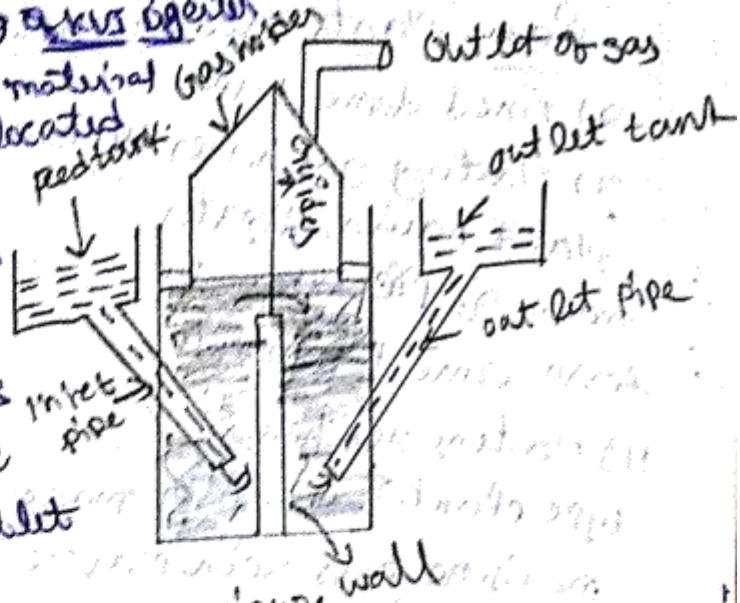
Construction, Details and working of KVI Digester

The Digester can hold the raw material for 60 days. Outlet tank is located slightly below the feed tank level. When the digester is full and more is added, then the equal amount of slurry flows out with the help of the pipe connecting from digester to outlet tank known as outlet pipe.



Figure

Application:- Cooking, Domestic lighting and heating, fuel cells IC Engines, petrol Engines, Diesel engines.

Answer:-

Fixed Dome Type Plant	Floating Drum Type Plant
1) This type of plant is known as Janata model or Chinese model plant	1) This type of plant is also known as KVIC Plant
2) It can be constructed above or under neathe the ground	2) It can be build only below the ground level
3) It has regular and irregular discharges	3) It has regular fillings and regular discharges
4) The material used in construction of this system are bricks, cement sand, steel, lime, cement etc.	4) The materials used in construction of this plant are concreate bricks, sand, lime etc--
5) The main cost factor of this plant on bricks and cement	5) The main cost factor of this plant bricks, cement and steel.
6) The digestion period for this type of plant is about 30-60 days	6) The digestion period for this type of plant is about 30-60 days
7) It is cheaper in cost	7) It is expensive due to steel.
8) For this type of plant, special treatment is required to the gas stroge the system	8) There is no need of such treatment for type of plant

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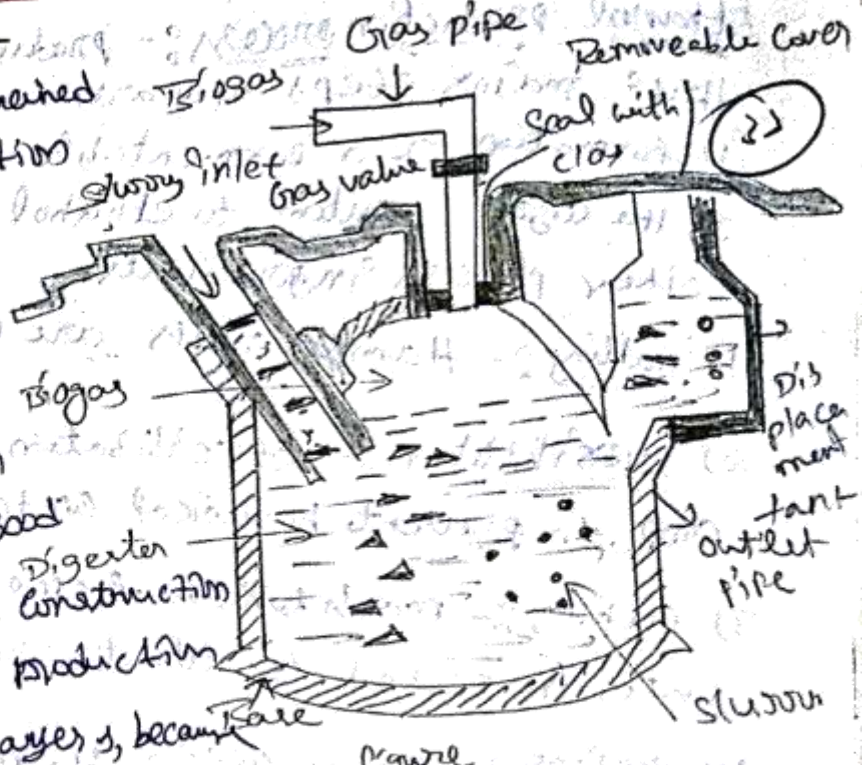
Chinese Biogas Plant :-



figure

1) Requires skilled and trained personal for the construction and regular maintaince of the plant

2) leakage of biogas may occur, due to the lack of skill and precision

3) Proportionable main good quality has to be used in construction for 'impermeable' biogas production

4) Requires extra plaster layers, because RCC or brick masonry construction is not completely gas proof.

5) Brick masonry construction is at a risk, where soil-sweel shrink are caused these develop on the construction

Combustion Characteristics of biogas

Biogas is a mixture of methane and carbondioxide with trace of hydrogen sulphide. methane content verious between 50%-70% depending on source which has two third of energy content of natural gas.

Chemical Composition :- methane (CH_4) = 55% - 60%, carbondioxide (CO_2) = 35% - 40%, Hydrogen (H_2) = 5%, H_2S and S = Trace

Combustion Characteristics :- 1) It is higher calorific value at about 20 MJ/m3

2) Biogas can be compressed and stood about 115 atomsphere pressure

3) Biogas is obtained by a process of anaerobic digestion

4) minimum ignition temperature is 290°C.

5) The moisture content is 10-30%

6) The combustion energy content is 45 MJ/kg to 7 MJ/kg of raw material

7) Density of Biogas is 150 kg/m3

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Ethanol production process:- production of Ethanol consist of three major steps they are,
(i) formation of a fermentable sugar solution, (ii) fermentation of the sugar solution to ethanol (iii) separations of ethanol from other process ingredients.

1) **milling:-** Hammer mills are used to convert feed stock into the powder

2) **sterilization:-** sterilization facilities are used for damaged crop, to prevent biological contamination.

3) **cooking:-** mash which formed by combining enzymes and water is cooked for about 30 minutes.

4) **cooling:-** After cooking, the mash is removed and cooled. The secondary enzyme is added to convert the liquified mash to fermentable sugars

5) **fermentation:-** fermentation takes place by adding yeast to the mash thus producing ethanol and carbon dioxide

6) **Distillation:-** the fermented mash containing alcohol is heated to a temperature higher than the boiling point of alcohol Alcohol is vaporized and passed through

7) **Dehydration:-** The Alcohol obtained from the above process contains 5 percent of water.

8) **Denaturing:-** Ethanol that will be used for fuel is then denatured with a small amount (2% - 5%) of some products, like gasoline to make it unfit for human

9) **Fuel:-** After denaturing, the ethanol is blended with non-leaded gasoline at the ratio of 10 per cent.

10) **Co-products:-** the two co-products that are obtained during the production of ethanol are distillers grain and carbon dioxide

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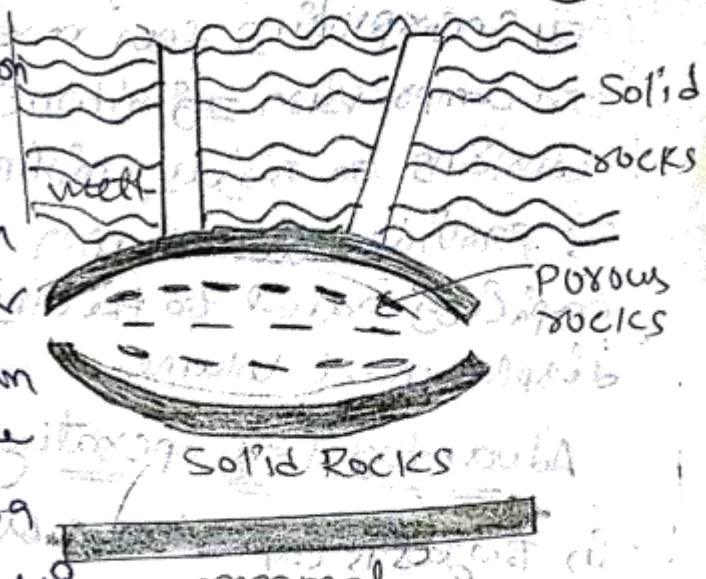
Hydrothermal Resources

(34)

It is a reservoir containing steam or hot water under pressure upto about 350°c. The cross-section of the hydrothermal resource is shown in figure. If the temperature obtained is high enough water or steam can be used for power generation or else it can used for space heating. As the density hot water compared to water it tends to rise. By this a large reservoir of the water and rocks formed is vented to the surface.



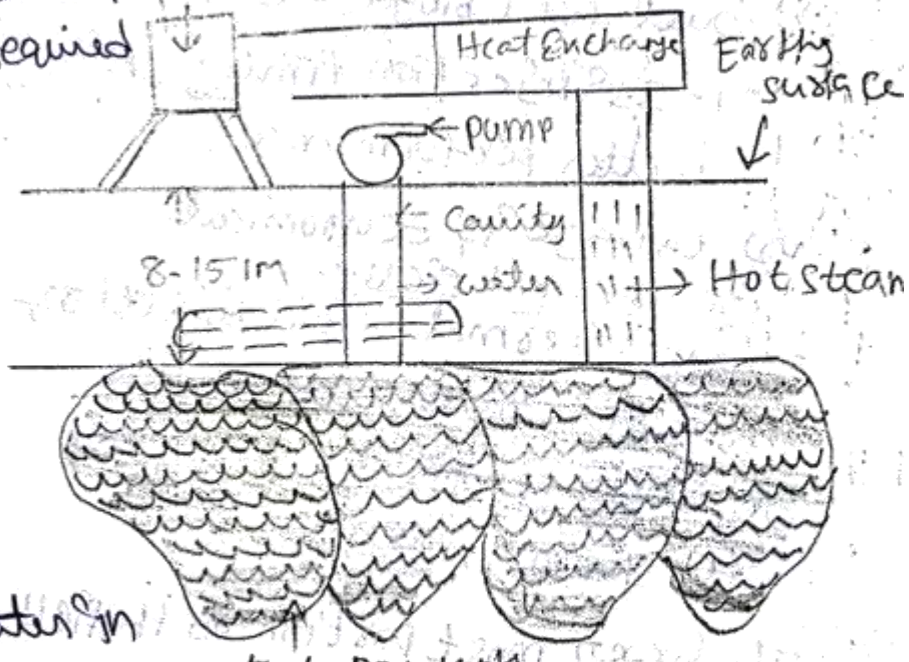
Hot Dry Rock

Advantages:- (i) The process is flexible and can be easily used

(ii) steam can be produced in larger amount

(iii) The life of system is 10 to 30 years

(iv) By varying the water supply, the steam required can be regulated.



Disadvantage

(i) Initial cost for setting the system is very high due to

(ii) The leakage of water in the cavity is unpredictable

(iii) The gases from the earth surface can damage the components of the system

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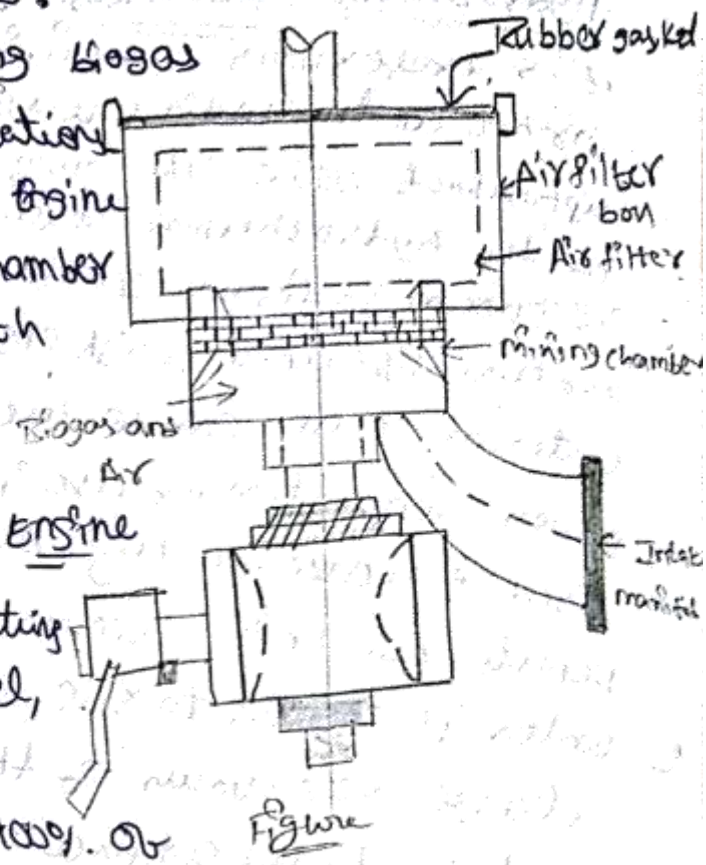
CI Engine working of Biogas :-

CI engine can be operated using biogas by incorporating few modifications. In compression ignition (CI) engine working on biogas, a mixing chamber is provided air cleaner with capacity equal to the engine displacement volume.



figure

Advantages of operating CI Engine

i) Biogas is capable of substituting other engine fuels such as diesel, petrol etc---,

ii) Biogas can substitute about 100% of petrol and 80% of diesel

iii) C.I engines operated on biogas posses high efficiency (η)

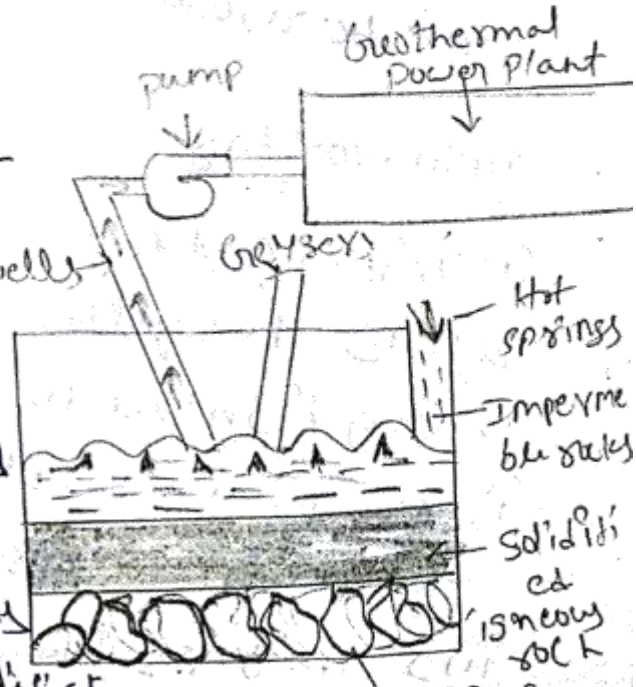
iv) Engine performance can be improved by reducing amount of CO_2 in biogas

v) Dual fuel (biogas + diesel) operated CI engine can give 31-35° injection timing prior to TDC, which represents better performance

vi) Usage is economical.

Geothermal field :-

The geothermal field consist of magma, rocks, reservoir geysers, springs, fissures, wells etc shown in figure



figure

The lower most portion of the field is magma hot molten rock. Above magma there are igneous rocks which were formed due to the solidification of magma.

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Advantage of Geothermal Energy :-

1) Geothermal energy is highly flexiable
2) It is less costlier, than the energy derived from the fossil fuels
3) High energy content can be obtained
4) The annual load factor of geothermal power plants is very high about 85% and 90%, It cause less pollution
5) The energy density is high; As it's highly responsive and controllable, it can be used in wide range of applications

Disadvantages of Geothermal Energy

1) It has less overal efficiency in power production that about 15% where as the fossil fuel plants possess an in wide efficiency of 35 and 40%.
2) It may causes surface settlement, as large quantities of steam and water are extracted from the hydrothermal reservoir
3) As the steam and water coming out of earth contains harmful gases like H_2S, CO_2, NH_3 and other gases it may result in air pollution if they are released into atmosphere.
4) The extraction of energy requires drilling operation which very costly
5) Since, most of the energy is diffused, it requires larger areas for utilisation.

The Applications of geothermal energy can be seen in the following

1) Space Heating :- Geothermal energy is used for the purpose of heating the building. This can be done by utilising the heat of geothermal fluids. temperature about 60 to 150°C.

2) Agriculture :- Geothermal energy is used in Heating green House in many countries. Some of the crops produced in these Heated green Houses are cucumber tomatoes and seedling. Also the Heat from the Geothermal fluids utilised in animal husbandry

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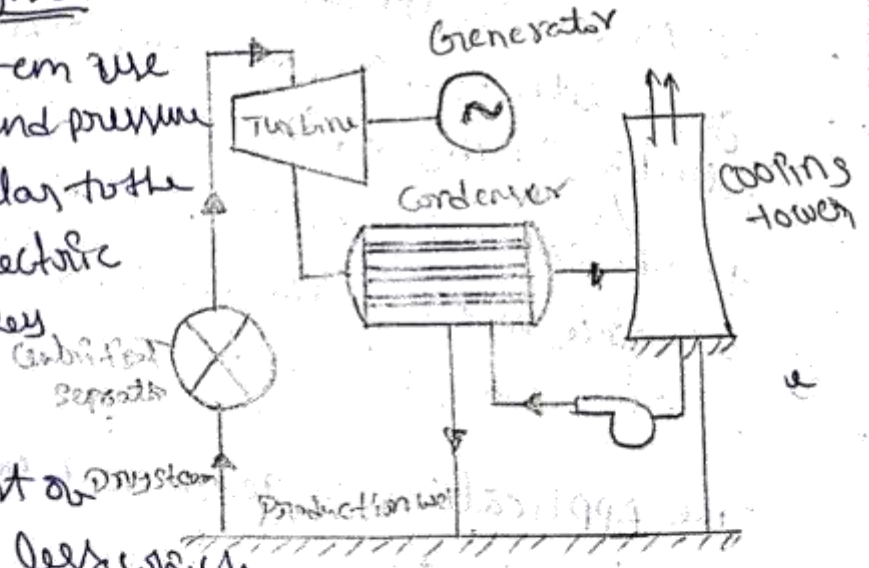
3) Climate Independent :- Geothermal energy can be used in many applications even if there are climate variations. In case of shortage of fossil fuel, this energy can be used for generating electric power. It is also used for Heating purpose, in colder climatic conditions.

4) Drying :- The Heat from the geothermal well, which is obtained in the form of steam or hot water, is used for drying purpose. It is used in drying seaweeds grass timber paper fam etc.

5) The energy contained in the geothermal fluids is used for Heating seat at high temperature. Thus by the process of evaporation any and crystallisation, salt is produced.

Vapour Dominated system

vapour dominated system use dry system at 200c and pressure limited to 8 bar. Similar to the steam used in turbo electric power plants. Hence, they are also known as dry steam fields. The cost of power generation is less which is the major advantage of this system. But there exist some



During its working dry is extraced from the reservoir and passed into the centrifugal separator through the production well. In centrifugal, the solid particles and impurities present in steam is removed. Then, this steam enters the turbine. water it expands over the turbine blades to run the and should be [illegible]

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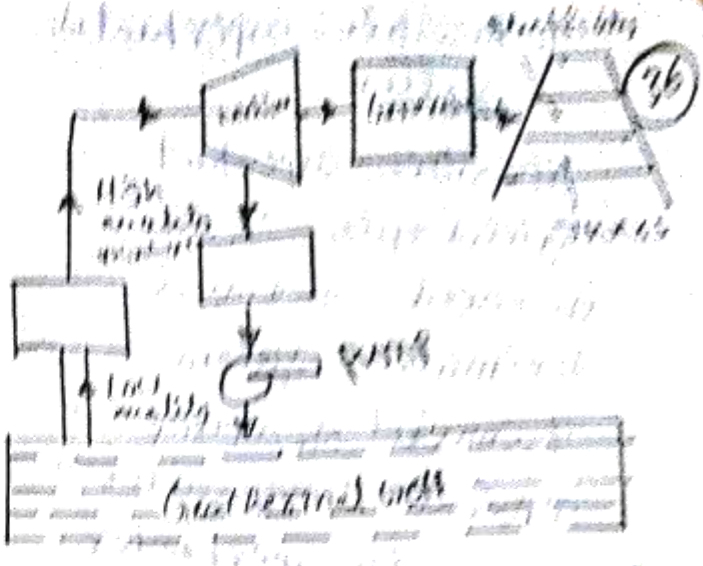
Liquid - Dominated system

a) The Flash steam system
b) The Binary system
c) The total flow system

a) Flash system
i) single-flash system
ii) double-flash system
iii) multiple-flash system



ii) Binary cycle system :- A binary cycle system is used widely instead of flash system because of its characteristic property of the working fluids. The working fluids are isobutane, freon 12 etc. These fluids are environmental friendly and causes no pollution. The system works on the principle of closed Rankine cycle. Basically the system consists of a Heat exchanger, turbine, pump, generator, condenser, cooling etc---

iii) Total flow system :- The total flow system is based on the principle of lysholm machine as known as mixed phase expander. The system consists of a Turbine, condenser, cooling tower, generator, pump etc. In this system the hot brine from the geothermal well is made to pass through the turbine using throttling valve. In turbine the low quality mixture of steam and liquid gets expanded since it is mixed phase expander the blades of the turbine gets rotated and results in formation of electricity in generator. The efficiency of Turbine generator depends on the properties of mixed phase expander. The mixed phase expander should be corrosion resistant and should be able to resist thermal

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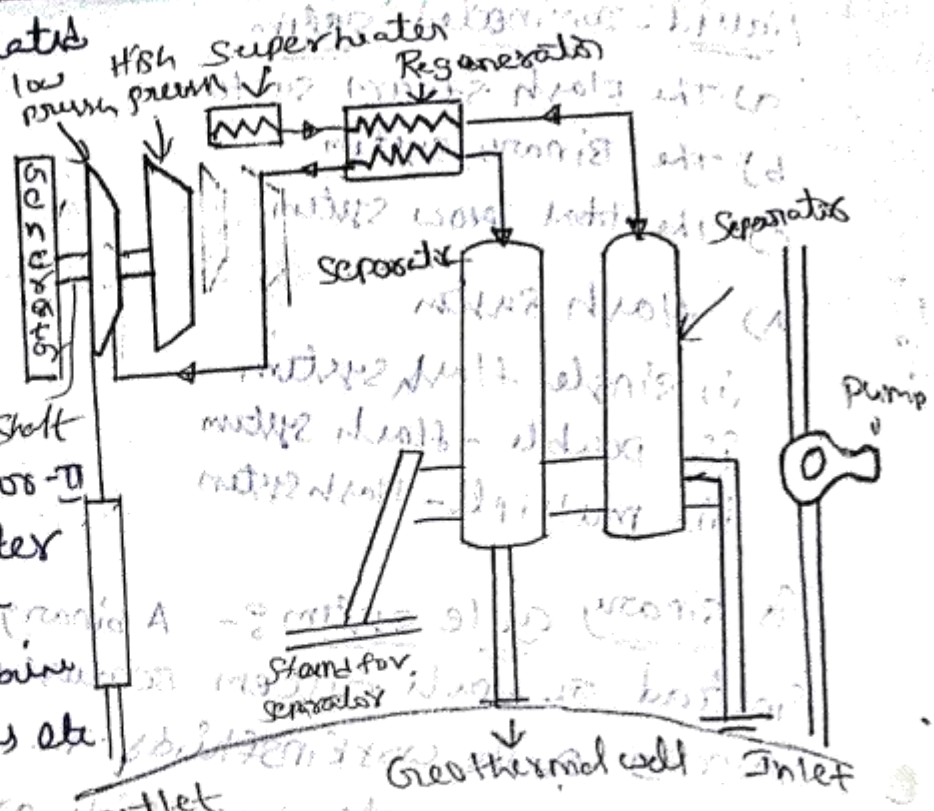
(i) Fossible - superheated system

A fossible superheat hybrid system is an advanced or liquid dominated system. It consist of a pump shaft separator-I, separator-II regenerator, superheater high pressure turbine lowe pressure turbine generator, condensers etc as shown figure.



Advantages

(i) The system is environmental friendly and produce no harmful gases during the process

(ii) The system is reliable during the long run operation

(iii) The heat energy from low temperature can also be utilized using system

(iv) The system is a closed system and the steam produced by it can be used for various applications

Disadvantages :-

(i) The Initial cost of the system is more compared to other geothermal system

(ii) The system cannot transfer the Heat for long distance

(iii) The geothermal system.

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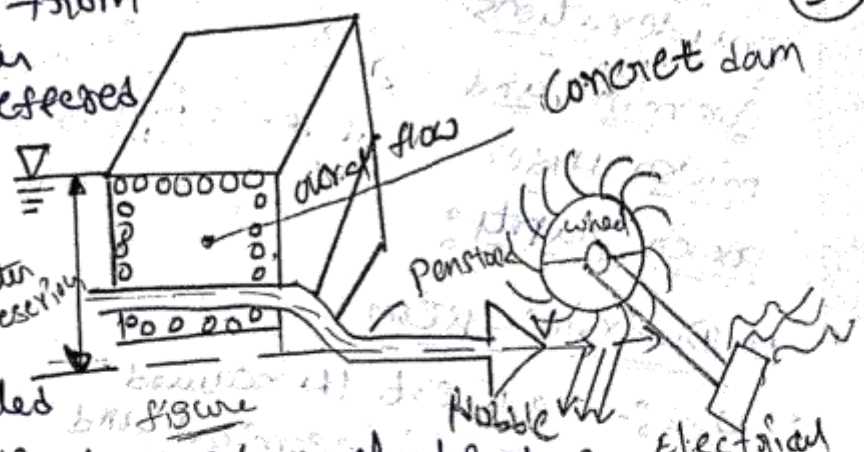
Principle:- The shaft power is generated from water head of water stored in dam is referred as potential energy to convert shaft power through hydraulic turbines which are coupled to electrical generator to produce electricity. It is a renewable source of energy. power generated by turbine is equal to the rate of potential energy lost by the falling fluid. i.e. $P = mgH$ (watts) $= \rho Q g H$



figure

where, m = mass flow rate (kg/sec)

ρ = density of water

g = Acceleration due to gravity = 9.81 m/sec²

H = vertical component of water (i.e head of water)

Potential energy of water in the reservoir is changed into kinetic energy of one or more jets. Each jet hits a series of buckets or cups placed on perimeter of wheel, as shown in above figure. The resulting deflection of fluid i.e water constitutes a change in momentum of water. The tangential force applied to the wheel cause it to rotate, thus produce rotational mechanical power and when coupled to electrical generator produce electricity. The shaft is generated from falling water head of water stored is dam is used as potential energy to convert shaft power

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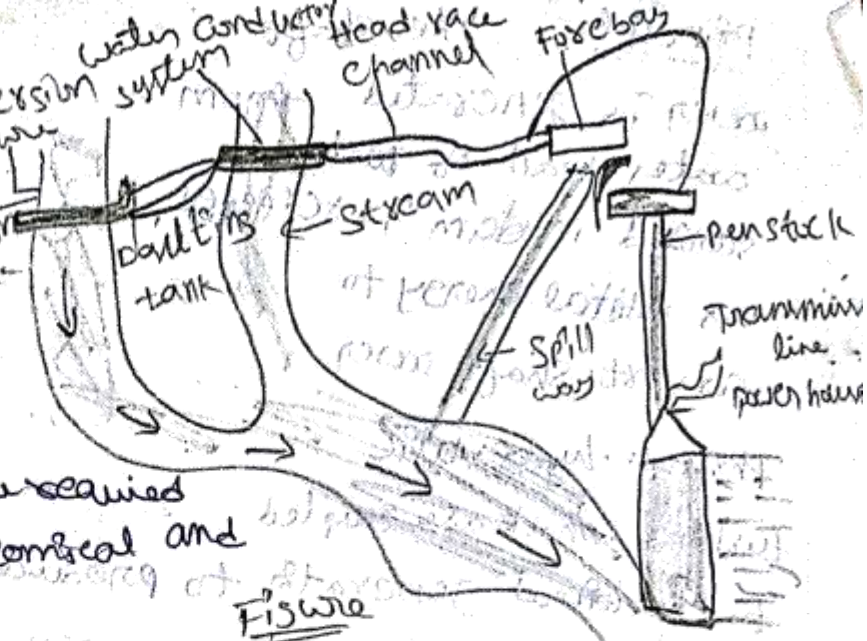
Civil works Design Considerations for mini and micro Hydel power plants :-



Figure

1) Diversion system

Use :- To divert the required must be simple, economical and maintenance free

a) Boulder weir :- i) Cheper Construction ii) preferred where there is rock beneath the river bed
iii) construction is at risk during flood season

b) Trench type weirs :- Constructed using reinforced concreate or masonry
It consist of (i) A trapezoidal channel beneath the river bed with its top at riverbed level
(ii) A gated at end to release water any required limit

2) Water Conductor system

Use :- To minimize the Head loss and water loss caused due to seepage

Design :- * Construction must a give a minimum head loss
* velocity of flow must be sufficient enough to avoid silt accumulation
* It has a trapezoidal channel section

Design :-
Size of silt particals to be trapped
i) for medium head powerstation it is 0.2 to 0.5 MM
ii) for high head it is 0.1 to 0.2 MM

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