OCH752 - Energy Technology.

UNIT - I :- Energy :-

Introduction to energy - Global energy Scence - Indian energy Scene - Units of energy - conversion factors, general Classification of energy, energy crisis, energy alternatives.

Unit - II :- Conventional Energy

Conventional energy resources - Thermal, hydel, nuclear reactors, thermal hydel and nuclear Power Plants, efficiency, merits and demerits of the above power Plants, Compution processes, fluidized bed combustion.

UNIT - III :- Non- Conventional energy

Solar energy, solar thermal System, flat plate collectors,

focusing collectors, solar water heating, solar cooling system, Solar pond, solar thermal power generation, solar energy application in India, wind energy, types of wind mills, wind rotors, wind power plant in India. OTEC system, Tidal energy Conversion, Geothermal energy.

UNIT-IV :- BIO-Mass Energy :-

Biomass origin - Resources - Biomass estimation. Thermochemical Conversion, Biological Conversion, Chemical conversion - Hydrolysis, hydrogeneration, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integerated gasification.

UNIT-V :- Energy - Conservation :-

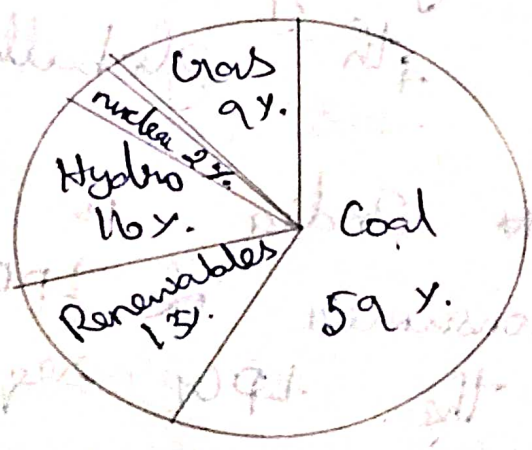
Energy Conservation - Act; Energy management importance - duties and responsibilities, Energy Audit, Benchmarking, material & balance.

India Energy Scenario:-

India is the world's third-largest energy consuming country, thanks to rising incoming and improving standards of living. The following is the explanation,

1) Based on Energy
2) Based on Different Sectors.

1.1 On the Basis of Energy :-



Coal :-

Nearly 60% of total electricity generated in India is from coal. Coal and lignite production was 731 million tonnes in the

Financial Year

Oil and Natural Gas:-

India was the top Crude oil consumer globally with 221 Mt in 2017. India was the second-top net Crude oil (including Crude oil Products) importer of 205.3 mt in 2019. India has 4.972 million barrels per day Crude oil refining capacity which is ranked 4th globally in 2017.

* India is second largest consumer of LPG globally. Most of the LPG requirements is imported.

Nuclear Energy:-

Nuclear Power is the fifth-largest source of electricity

in india after Coal, gas, hydroelectricity and wind Power.

As of november 2020, India has 23 nuclear reactors in operation in 7 nuclear power plants, with a total installed capacity of 7,480 MW. nuclear power Produced a total of 43 Twh in 2020-21, contributing 3.11 % of total power generation in india (1,382 Twh). 10 more reactors are under construction with a Combined generation Capacity of 8,000 MW.

Renewable Sources :-

Indian renewable energy Sector is the fourth most attractive renewable energy market in the world. India was ranked fifth in wind Power, fifth in

Solar Power and fourth in renewable Power installed Capacity, as of 2019. Biomass is a renewable energy source and its use for energy generation is mostly carbon-neutral fuel. Carbon di-oxide is first taken up by plants during Photosynthesis and later released when biomass is burned.

Hydro electric Power :-

India 5th globally for installed hydroelectric Power Capacity. As of 31 march 2020, India's installed utility-scale hydroelectric Capacity was 46,000 MW (or) 11% of its total utility Power generation Capacity. India's hydro electric power potential is estimated at 148,700 MW at 60% load factor.

Wind Energy :-

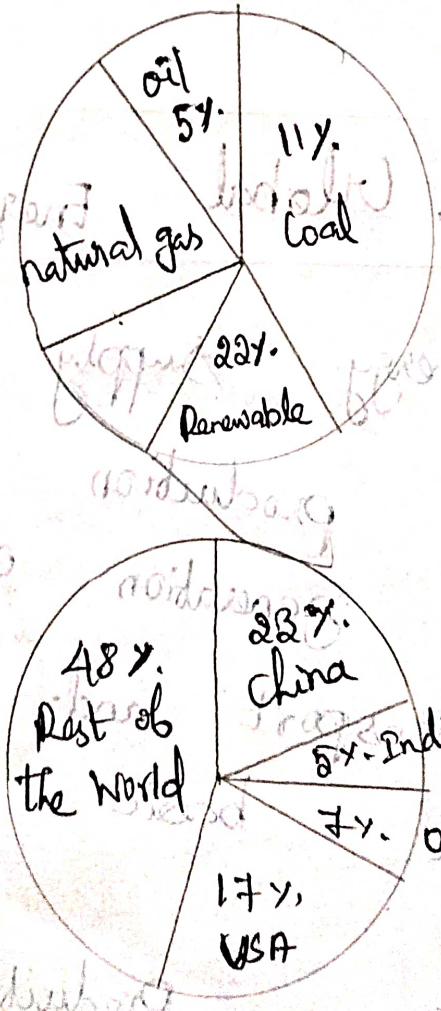
wind Power generation capacity in India has significantly increased in recent years. As of 28 february 2021, the total installed wind Power capacity was 38,789 GW, the fourth largest installed wind power capacity in the world. Tamilnadu wind power capacity is around 29 %. of India's total.

2. Global Energy Scenario :-

Wind energy supply and consumption is global production and preparation of fuel generation of electricity, energy transport and energy consumpt It is a basic part of econom activity.

Energy production is 80 %. fossil. Half of that is produced by China, the united states and the

of the Persian Gulf. The Gulf
States and Russia export most of
their production, largely to the
European union and China where
not enough energy is produced
to satisfy demand. Energy production
increases slowly, expe except for
solar and wind energy, which
grows more than 20% per year.



Coal Energy :-

Coal Plays a vital role in electricity generation worldwide. Coal-fired powder plants currently fuel 41% of global electricity and figures from the IEA show that coal will still generate 22% the world's electricity in 2040, retaining Coal's position as the single largest source of electricity worldwide. China is now the world's largest consumer of energy, the largest Producer and Consumer of coal, and the largest Producer and coal

Renewable energy :-

Renewable energy is useful energy that is collected from renewable resources. which are naturally replenished on a human

including carbon neutral
like sunlight, wind, rain, tides.
waves and geothermal heat. Th
type of energy source stands i
contrast to fossil fuels, which a
being used for more quickly
than they are being replenished.

Based on 2017 report,
renewables contributed 19.3% to
human's global energy consumptio
and 24.5% to their generation
of electricity in 2015 and 2016.

Nuclear Energy :- -:

Nuclear Power is the
second-largest source of low-
carbon electricity today, with
452 operating reactors Providing

1. India Energy Scenario :-

2700 Twh of electricity in 2008, (or) 10 %. of global electricity supply.

Global Energy Users :-

25 %. of world wide primary Production is used for conversion and transport, and 6 %. for non-energy Products like lubricants, asphalt and petrochemicals. 69 %. remains for end-users. Most of the energy lost by conversi occures in thermal electricity plan and the energy industry ocon use.

3. Energy units Conversion Fac

The most common energy unit is the kilowatt hour. However, different units are us in energy statistics.

J (Joule) and Ws (Watt Second) are the valid SI units for energy. Nevertheless, in the energy sector a lot of other units are used. This overview describes the most important units of energy and their conversion factors:

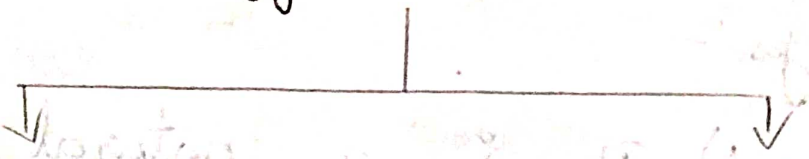
1 kg	-	1
1 kcal	-	4.1868
1 kwh	-	3.600
1 kg SKE	-	29.308

1 kg of oil - 41.868

1 m^3 natural gas - 31.736.

4. classification of Energy Sources.

Energy Sources.



conventional Sources of energy (or) non-Renewable Sources of energy

non-conventional sources of energy (or) Renewable Sources of energy.

Solar Energy :-

Sun is the Primary Source of Energy. Sunlight is a clean, renewable source of energy It is sustainable resource,

meaning it doesn't run out, but can be maintained because the Sun shines almost every day. Coal (or) gas are not sustainable. (or) renewable. Once the are gone. there is none left.

Advantages :-

1) It is a natural source and free.

2) It is available in plenty

3) It is non-polluting.

4) It does not emit any green-house-gases.

Dis-advantages :-

1.) Dependent on change in seasons.

2) Require high initial investment for productive use.

Wind Energy :-

Wind is the natural movement of air across the land (or) sea. The wind when used to turn the blades of a wind mill turns the shaft to which they are attached. India now has the 4th largest wind power installed capacity in the world. which has reached 37756.85 MWp (as on may, 2000). Private agencies own 95% of the wind farms in India.

Advantages :-

1) It is environmental friendly
2) It is freely and abudantly available.

Disadvantages :-

1) High Investment require.

Bio mass and Bio-fuels :-

The Plants fix solar energy through the process of photosynthesis to Produce biomass. This Biomass Passes through various cycles Producing different forms of energy sources. For example, fodder for animals that in turn produce dung, agricultural waste for cooking etc., The types of biomass used are agricultural waste, Wood, charcoal (or) dried dung.

Advantages:-

i) Always available as a renewable source of energy.

ii) It is Carbon neutral

iii) It is less expensive than fossile fuels.

Dis-advantages :-

i) Can lead to deforestration.

ii) It is not entirely clean.

Hydroelectricity :-

when electrical current is generated from the kinetic energy of flowing water. We call it hydroelectricity. It could be a water turbine driven electric generator is a dam.

Advantages :-

i) It is clean and non-Polluting source of energy.

No fuel is required. water is the source of energy and it does not consume water

Dis - advantages :-

i) Highly expensive.

ii) Large areas of human habbitations and agricultural fields are submerged.

Ocean Energy :-

Ocean covers 70 percent of the earth's surface and represent an enormous amount of energy. Although currently under - utilized, ocean energy is most exploited by just a few technologies. Wave, Tidal, current Energy and Ocean or Thermal energy.

Nuclear Energy :-

Nuclear Power is the use of nuclear reactions to Produce electricity. Nuclear Power can be obtained from nuclear fission, nuclear decay and nuclear fusion reactions. Presently, the vast majority of electricity from nuclear power is produced by nuclear fission of uranium and plutonium in nuclear Power Plants.

Advantages :-

i) Low-cost Energy.

ii) Reliable.

iii) High energy density.

Dis-Advantages :-

i) Expensive to Built.

ii) Produce Radioactive Waste.

5. Energy Crisis.

An energy crisis is any significant bottleneck in the supply of energy resources to an economy.

Causes of Energy Crisis :-

Overconsumption :-

The energy crisis is a result of many different strains on our natural resources, not just one. There is a strain on fossile fuels such as oil, gas, and coal due to over consumption - which then in turn, can put a strain on our water and oxygen resources by causing pollution.

over population :-

Another cause of the crisis has been a steady increase in the world's population and its demands for fuel and products No matter what type of food (or) products you choose to use - from fair trade and products. not one of them is made (or) transported without a significant drain on our energy resources.

Poor Infrastructure :-

Aging Infrastructure of Power generating equipement is yet another reason for energy shortage. It is the responsibility of utilities to keep on upgrading the infrastructure and set a high standard of performance.

unexplored Renewable Energy option:

Renewable energy still remains unused in most of the countries. Most of the energy come from non-renewable source like coal. Renewable energy sources can reduce our dependance on fossil fuels and also helps to reduce greenhouse gas emission.

Waste of Energy:-

In most parts of the World, people do not realize the importance of conserving energy. It is only limited to books, the internet and supply of newspaper Ads and seminars.

Unless we give it a serious thought, things are not going change anytime sooner.

Simple things like switching off fans and lights when not in use, using maximum daylight, walking instead of driving for short distance.

Poor Distribution System:-

Frequent tripping and breakdown are a result of a poor distribution system.

Major Accidents and Natural Calamities:-

Major accident like Pipeline burst and natural calamities like the eruption of volcanoes, floods, earthquakes can also cause interruption,

to energy supplies. The huge gap between supply and demand for energy can raise the price of essential items, which can give rise to inflation.

Wars and Attacks :-

Wars between the Countries can also hamper the supply of energy, especially if it happens in middle East Countries like Saudi Arabia, Iraq, Iran, Kuwait, UAE (or) Qatar.

Miscellaneous Factors :-

Tax hikes, strikes, military coup, Political events, severe hot Summers (or) cold winters can cause a sudden increase in demand for energy and can choke supply.

A strike by trade unions in an oil-producing firm can cause an energy crisis.

Effects of the Global Energy Crisis :-

The growth of human civilization has led to an increase in the consumption of traditional sources of Energy. The very basic source of energy is precious fossile fuels. The usage of all these sources is bound to produce certain effects. Some important effects of the global energy crisis are as follows,

Environmental Effects :-

Energy is produced by burning of non-renewable fossil fuels. This does not only affect the global resources of fossil fuels, but it also affect the environment. The burning of fossile fuels release greenhouse gases like carbon dioxide and others.

Increasing prices of fuel Resources :-

As the use of fossil fuels increases, the cost of these resources increases too. We must remember that the quantity in which these fossil fuels are available, is limited As we keep on using these resources, the amount of

these fossile fuels further decreases.

Political disturbances :-

The fact that the energy crisis creates some socio-economic disturbances, also tells us that this global energy crisis also creates a lot of Political disturbances across the Globe. The quest for fossil fuels is one of the major causes of the same.

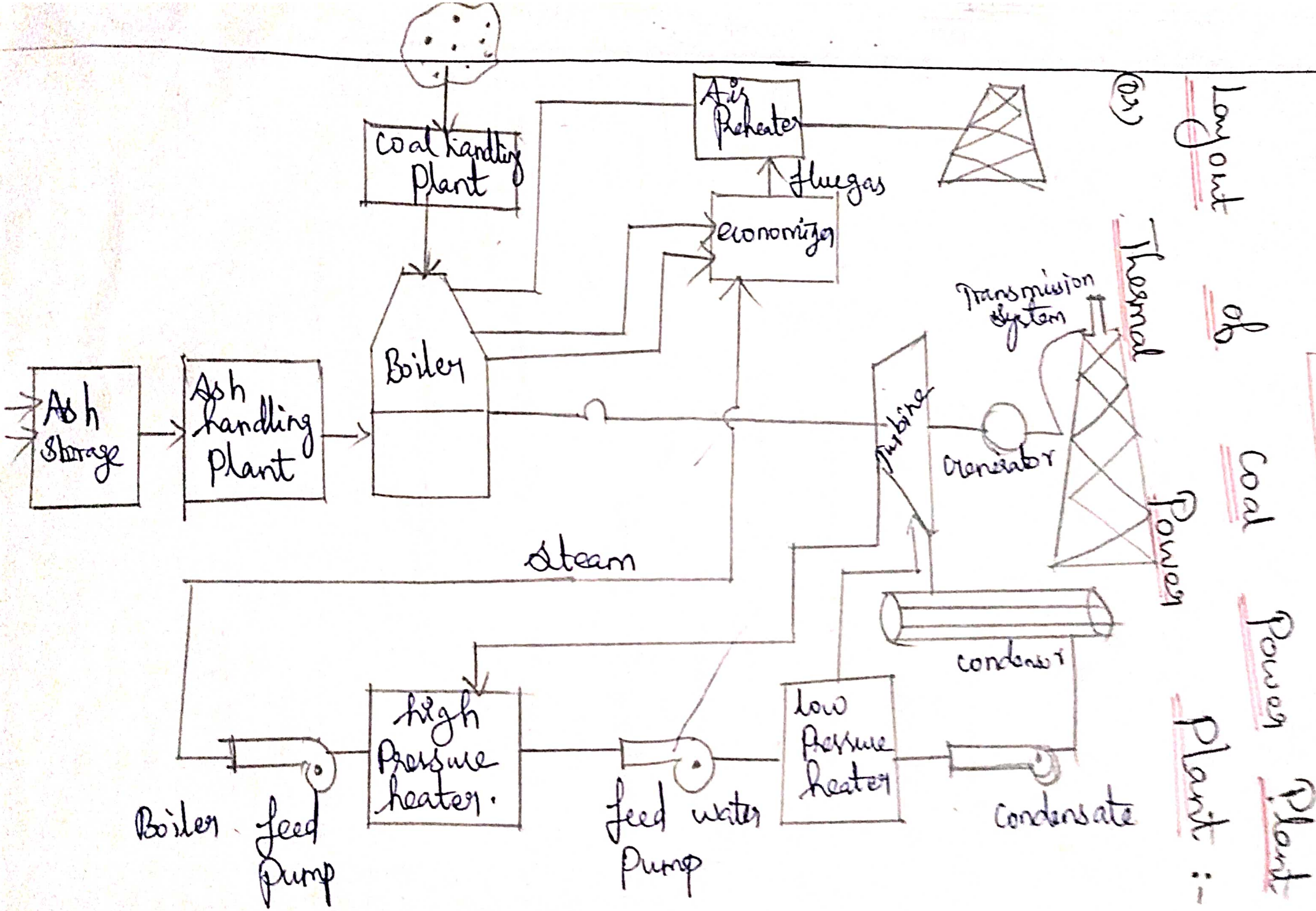
The Effect on the Tourism Industry :-

The tourism Industry is largely dependent on the rise and fall of fuel prices The tremendous rise of the fuel Prices that comes as a result of the energy crisis affects the tourism industry pretty adversely.

UNIT - 2.

Layout of Coal Power Plant :

(or) Thermal Power Plant



Steam is an important medium for Produces mechanical Energy. Steam is used to drive the engines and steam turbines. steam has the following advantages,

i) Steam can be raised quickly from water which available in plenty.

ii) It does not react much with materials of the equipment used in power plants.

iii) It is stable at temperature required in the plant.

iv) The steam power plant must have the following Equipement.

* A furnace for burning the fuel.

* A steam generator (or) steam boiler for steam Generation.

* Engine (or) Turbine to convert heat into mechanical energy.

* A Generator to convert Mechanical energy into Electrical energy.

* Piping system to carry steam and water.

The working of a steam Power Plant can be explained in four circuit.

1) Fuel and ash Circuit
2) Air and flue gas Circuit
3) feed water and steam flow circuit
4) cooling water flow Circuit.

1. Coal and Ash Circuit :-

This includes coal delivery, Preparation coal handling, boiler furnace and fish handling and Ash storage. The coal from the coal mines is delivered by ships rail (or) by trucks. This coal is sized by Crushers, breakers.

The coal is transffered to the boiler and the heat will be generated. The Ash will be stored in the Ash storage

2. Water and steam Circuit :-

It consist of feed Pump, economizer, boiler drum, Super heater, turbine, condenser etc., feed water is pumped to the economizer from the hot well. This water is preheated by the flue gases in the economizer. Heat is transffered to the water by the burning of coal. Due to this, water is converted into steam. This steam is enpanded in a turbine to work. The turbine drives a generator, to produce electric Power.

The exhaust steam is then passed through the condenser. In the condenser, the steam is condensed into water and recirculated.

3. Air and flue gas Circuit :-

It consist of forced draught fans, air pre heater, boiler furnace, Super heater, economizer, dust collector, induced fan chimney etc., Air is taken from the atmosphere by the action of a forced draught fan. It is passed through an air pre-heater. This air is pre-heated by the flue gases in the pre-heater. Due to combustion of fuel, hot gases are formed.

The flue gases from the furnace pass over the tubes and super heated tubes. Then the flue gases pass through the economizer to heat the feed water. After that, it passes through the air pre-heater to

the incoming air. It is then passed through a dust catching device finally, It is exhausted to the atmosphere through chimney.

Cooling Water Circuit:-

The circuit includes a Pump, condenser, cooling tower etc. The exhaust steam from the turbine is condensed in condenser. In the condenser cold water is circulated to condense the steam into water. The steam is condensed by losing its latent heat to the circulating cold water. is heated. This hot water is

Advantages :-

* Thermal Power station has less initial cost as compared to hydro-electric generating station.
* It requires less space.
* The fuel gas is less as compared to gas.
* The cost of generation is less as compared to diesel Power station

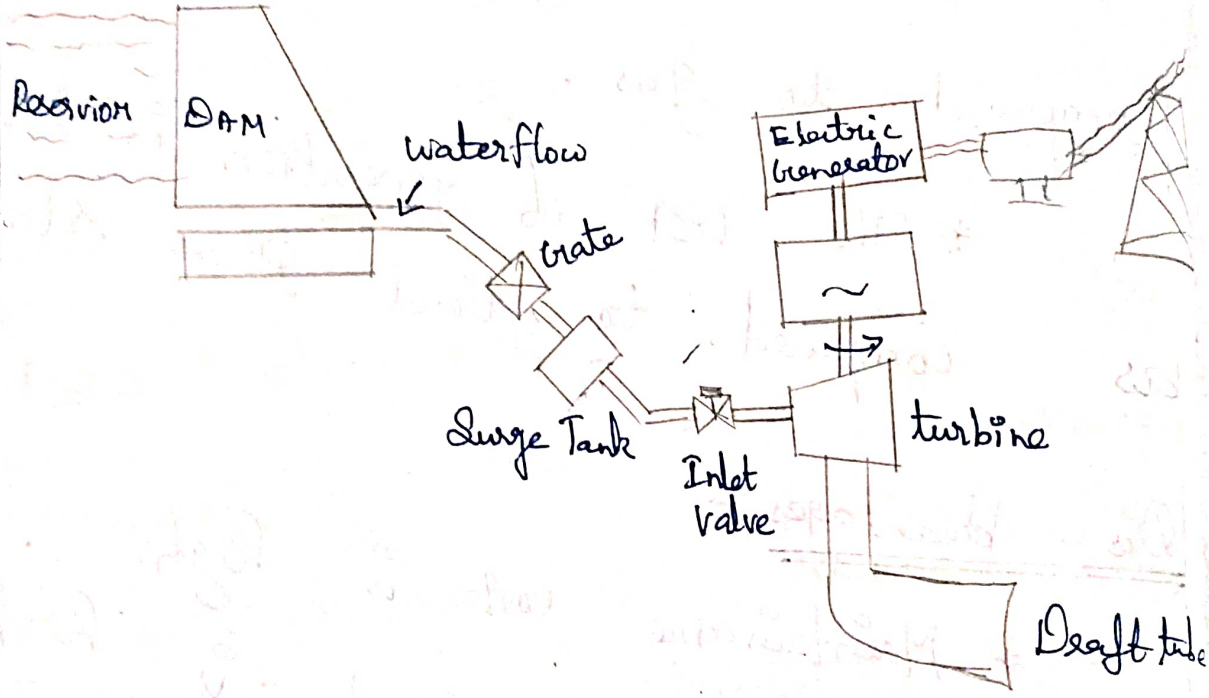
Dis - Advantages :-

* Maintainance cost is high.
* The running cost is high compared to other stations.
* Land requirement is high

Hydroelectric Power Plant.

In Hydroelectric electric Power Plant, the electricity will be produced from the flow of water.

Construction:-



DAM & RESERVOIR:-

The dam is constructed on a large river in hilly areas to ensure sufficient water storage, at height, the dam forms a large reservior behind it.

CONTROL GATE :-

Water from the reservior is allowed to flow through the Penstock to the turbine. The amount of water which is to be released in the penstock can be controlled by a control gate. when the control gate is fully opened, maximum amount of water is released through the penstock.

Surge Tank :-

Surge tanks are provided in high/medium head power plants when long penstock is required. A storage is (surge tank) a small reservior. The water level is the surge tank rises (or) falls to reduce the Pressure swings in the penstock.

Water turbine:-

Water from the penstock is taken into the water turbine. The turbine is mechanically coupled to an electric generator. Kinetic energy of the water drives the turbine and consequently the generator gets driven. There are 2 main types of water turbine

i) Impulse turbine
ii) Reaction turbine.

Generator:-

A generator is mounted on the power house and it is mechanically coupled to the turbine shaft. When the turbine blades are rotated, it drives the generator and mechanically electricity is generated, which is then stepped up with the help of a transformer for the transmission purpose.

Draft Tube :-

Draft tube is a diverging tube fitted at the exist of runner of turbine and used to utilize the kinetic energy available with water at the exit of runner. The draft tube at the end of the turbine increases the Pressure of the exiting fluid at the expense of its velocity.

Working Principle :-

* Hydro electric energy is renewable source.
* Hydroelectricity is very reliable energy.
* As previously, mentioned adjusting water flow and output of electricity is easy.

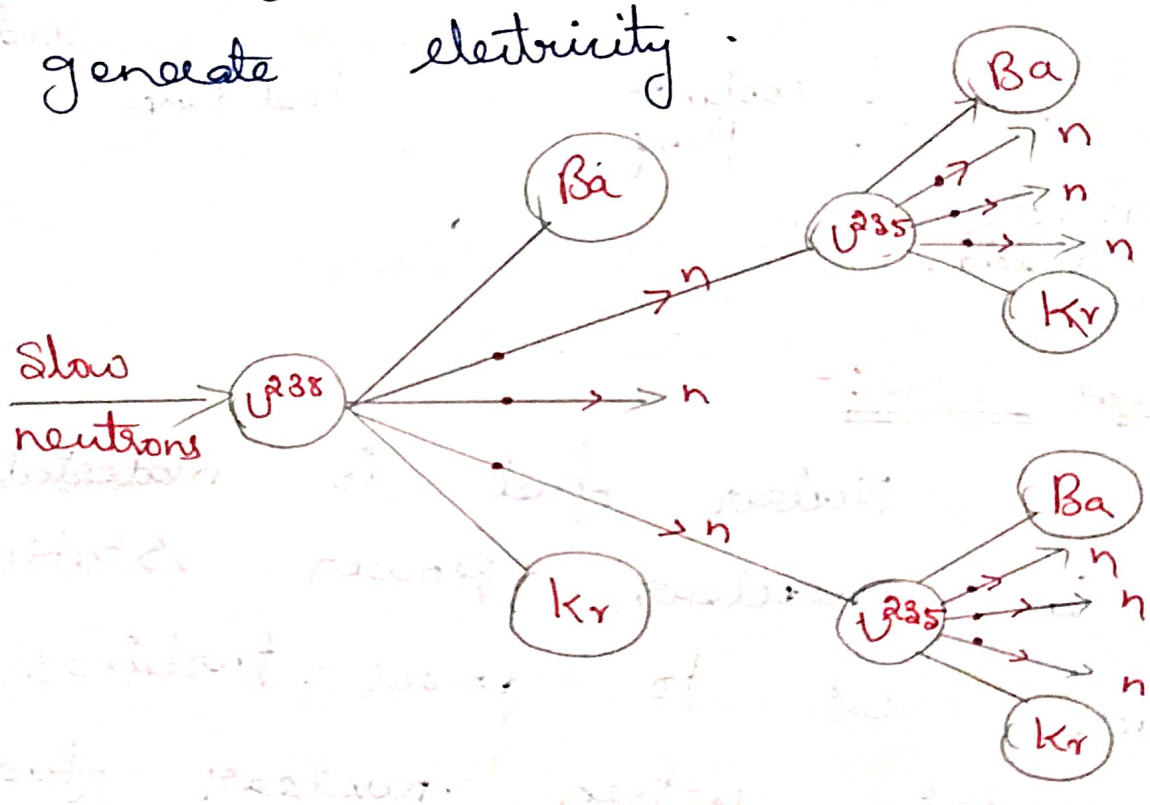
When the water is flow from the dam is passed to the penstock. it is then flow to the turbine. The turbine get start to rotate. Then the electricity will be Produced. This power will then send to the transmission lines to the consumers.

Dis-Advantages:-

* It's Expansive.
* There are limited Reservoirs
* It's not always Safe.
* Large areas of human habitation and agricultural fields are submerged.

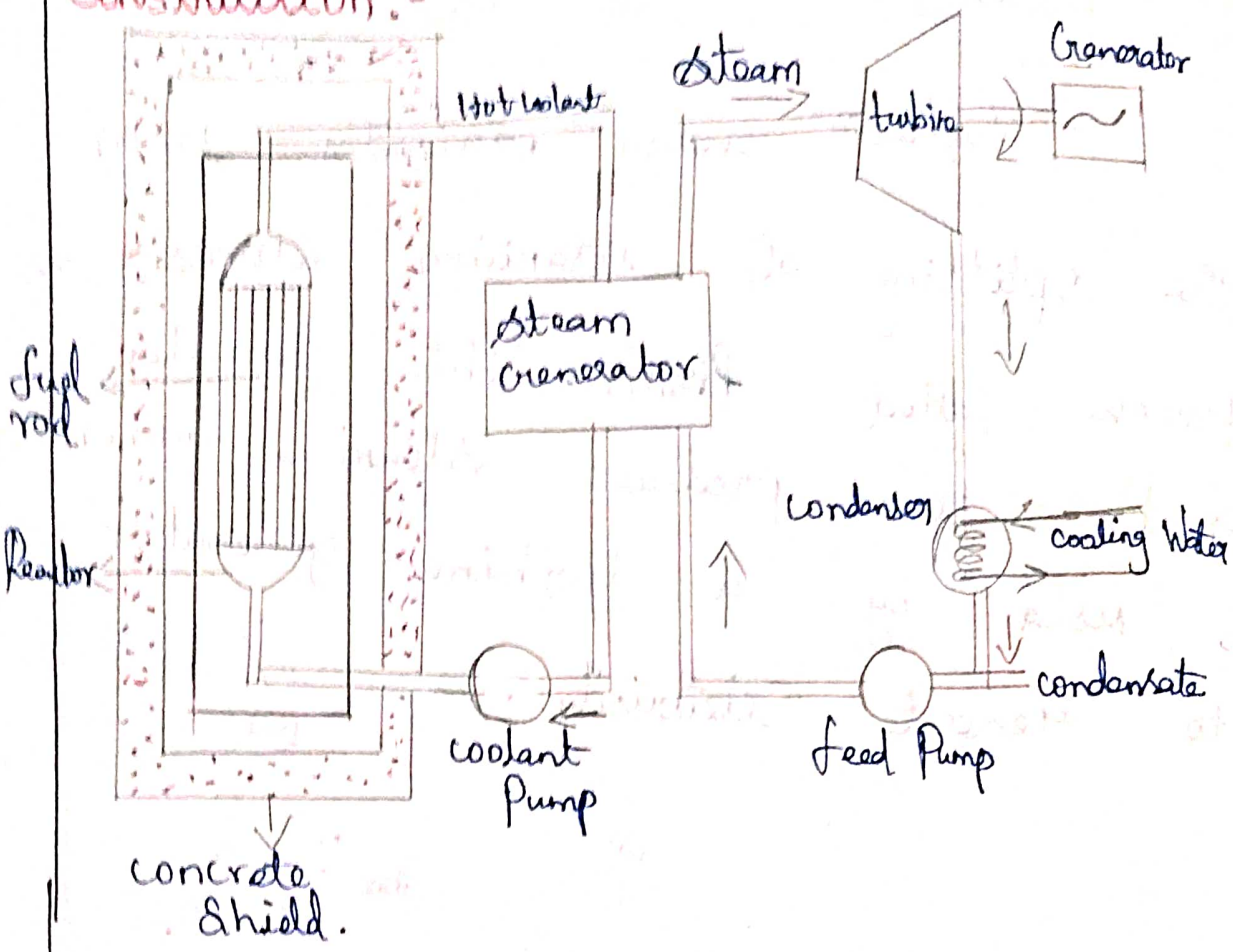
Nuclear Power Plant.

Nuclear energy originates from the splitting of uranium atoms - a process called fission. This generates heat to produce steam. which is used by a turbine generator to generate electricity.



In nuclear Power plant, the splitting of atoms will generate huge amount of electricity.

Construction:-



Nuclear Fuel:-

Nuclear fuel is material used in nuclear power stations to Produce heat to power turbines. Heat is created when nuclear fuel undergoes nuclear fission.

Control rods:-

A rod, plate (or) tube containing a material such as hafnium, boron, etc., used to

control the power of a nuclear reactor. By absorbing neutrons, a control rod prevents the neutrons from leading further fusions.

Properties of control rods :-

* To start the nuclear reaction
* To maintain the chain reaction at steady state.
* To shut down the reactor.

Ex :- boron, cadmium, silver, hafnium (or) Indium.

Coolants :-

A substance circulated through a nuclear reactor to remove (or) transfer heat. The most commonly used coolant in the United States is water. Other coolants include heavy water, air, Carbon dioxide helium, liquid Sodium and Sodium

Potassium alloy.

Coolants :-

A substance circulated through a nuclear reactor to remove (or) transfer heat. The most commonly used coolant in the United States is water. Other coolants include heavy water, air, Carbon dioxide, helium, liquid Sodium and a Sodium-Potassium alloy.

Reflector :-

Reflector is a region of unfueled material surrounding the core. It's function is to scatter neutrons that leak from the core, thereby returning some of them back into the core. This design features allows

for a smaller core size.
Common reflector materials are graphite, beryllium, water and uranium.

Moderator :-

The moderator of a nuclear reactors, the moderator is the same thing as the coolant: It's water, when fast neutrons in H_2O, strike hydrogen atoms they slow down a lot.

Moderators do not absorb the neutrons but slow down the speed of neutrons.

Properties :-

* Must be light
* Should slow down neutrons
* Must have high melting point.

Shielding :-

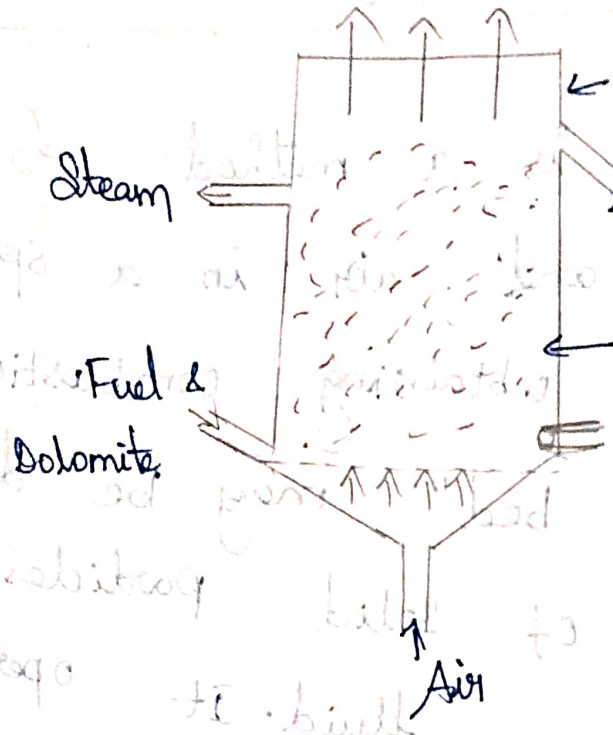
The function of shielding in a nuclear reactor is to Prevent the harmful radiations which are emitted from radioactive materials like Uranium and plutonium, so to prevent this the reactors are shields with lead/concrete etc.

Working Principle :-

The water in the core is heated by nuclear fission and then pumped into tubes inside a heat exchanger. Those tubes heat a seperate water source to create steam. The steam then turns an eletric generator to produce electricity.

Fluidized Bed Combustion:

Fluidization is a method of mixing fuel and air in a specific proportion, for obtaining combustion. A "fluidized bed" may be defined as the bed of solid particles behaving as a fluid. It operates on the principal that when an evenly distributed air is passed upward through a finely divided bed of solid particles at low velocity, the particles remain undistributed, but if the velocity of air flow is steadily increased, a stage is reached when the invidual particles are suspended in the air stream.



If the air velocity is further increased, the bed becomes highly turbulent and rapid mixing of particles occur which appear like formation of bubbles in a boiling liquid and the process of combustion as a result is known as "Fluidized bed Combustion".

Hence, these parameters are given due consideration, while

manipulating with air flow velocity for desired rate of combustion.

In "Fluidized bed combution", rapid mixing ensures uniformity of temperature.

Hence, these paramators are given due to consideration, while manipulating with air flow velocity for desired rate of combustion.

Parts of Fluidized Bed Combustion :-

Bed :-

The coal, limestone, ash and sand are mixed on this bed. After mixing, the mixture formed is burnt on this bed.

combustion chamber :-

The fuel which is coal and the mixture of sand

Water tubes:-

It is present above the bed. The water tubes get heat from the burning fuel.

Blower:-

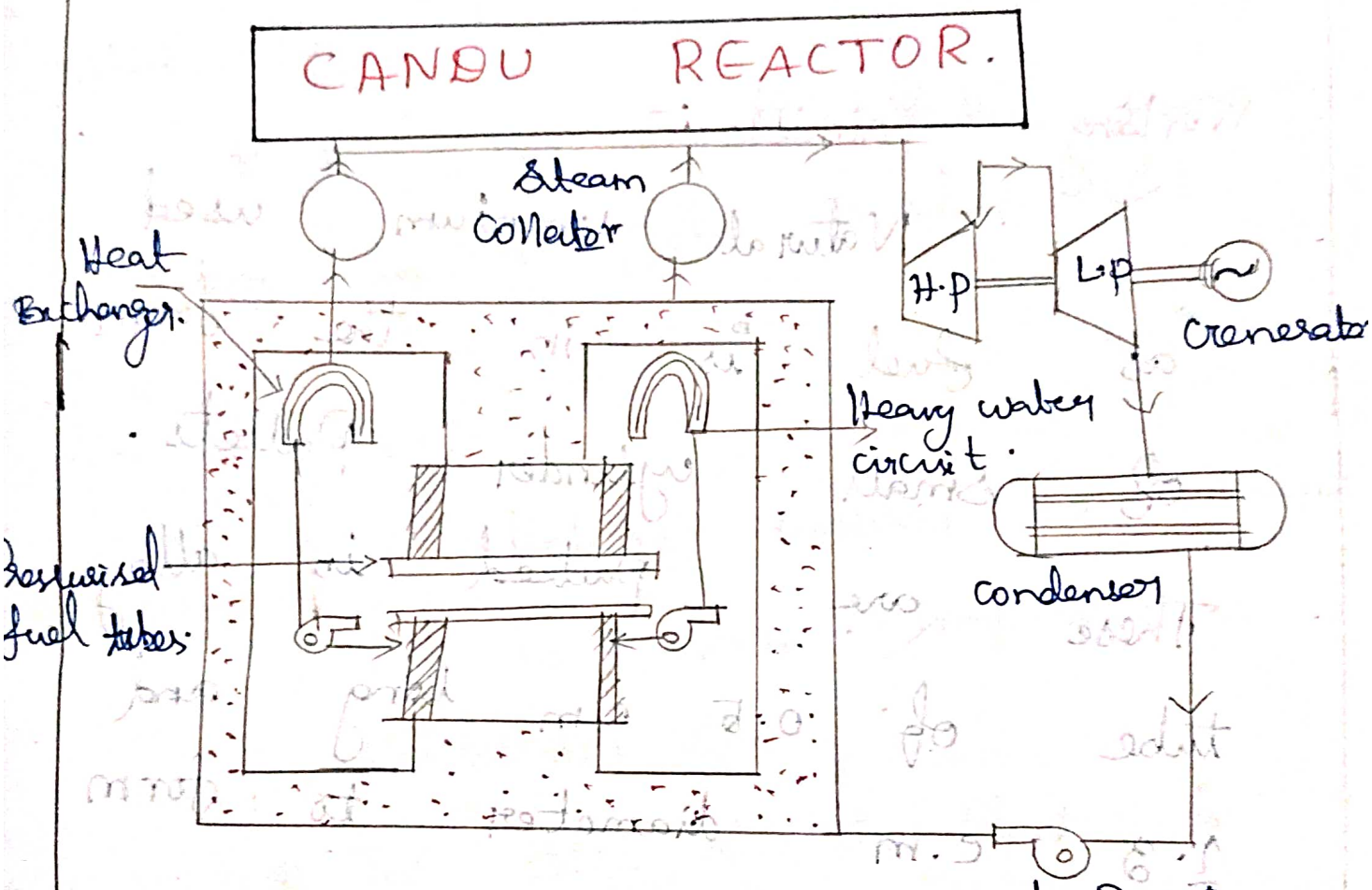
The blower is used to blow high-pressure air to the fluidized bed combustion system and this air is used to fluidize the mixture of coal, limestone, sand, and ash.

Advantages:-

* High Combustion efficiency.
* Reduction in Boiler size.
* Fuel flexibility
* Pollution control.
* Easier Ash Removal.

Dis-Advantages :-

* In this combustion system, the fan speed has to be maintained at a high value.



A reactor developed and designed by Canadian is called "CANDU". It uses pressurized heavy water. Natural Uranium is used as

fuel for this reactor. A Canadian Deutarium Uranium Pressurized Heavy water power Plant.

Working Principle :-

Natural Uranium used as fuel is in the form of small cylinder Pallets. These are packed in alloy tube of 0.5 c.m long and 1.3 c.m diameter to form a fuel rod.

In the primary ciscuit the deuterium coolant enters

Advantages :-

* Enriched fuel is not required.
* The cost and time of construction are less.
* Heavy water is used as moderator which has low fuel consumption.
* It has good neutron economy resulting in a good breading ratio.

Dis-Advantages :-

* A leakage problem may occu
* It has critical temperature limitations.
* The size of the Plant is large.

UNIT-III :- NON- CONVE

Solar energy :-

Solar energy is the type of energy generated by the Sun. Solar energy can be harnessed directly (or) indirectly for human Use. These Solar Plants (Panels) mounted on a rooftop in the Buildings and harvest solar energy and convert it to electricity.

Solar thermal System :-

"Solar Thermal Power Plants" are electricity generation plants that utilize energy from the Sun to heat a fluid to a high temparature. This fluid then transfer

its "heat" to "water", which then becomes "superheated steam". This steam is then used to turn turbines in a power plant, and this mechanical energy is converted into electricity by a generator. This type of generation is essentially the same as electricity generation that uses fossil fuels, but instead heats steam using "sunlight" instead of "combustion" of fossil fuels. These system use "solar collectors" to concentrate the sun's rays on one point to achieve appropriately high temperatures

There are 2 types of system to collect "solar radiation" and store it. Passive systems and active systems. solar thermal Power Plants are considered active

systems. These Plants are designed to operate using only Solar energy, but most plants can use fossil fuel combustion to supplement output when needed.

Solar Collectors :-

A "Solar Collector" is a device that collects and concentrates "Solar Radiation" from the Sun. These devices are Primary used for active solar heating.

Flate Plate Kollectors :-

Flate Plate Collectors are one of the most commonly used one in large buildings.

Swimming pools etc. Flate plate collectors are the metal bar which consists of glass (or) Plastic cover which is present at the top and this is dark colored absorbed plates on the bottom. In Flate plate collectors the which are at side and bottom are usually insulated, this done due to prevent the heat losses when the sunlight passes through glass and strikes the absorbed plates. By this, the heat is Produced which from solar energy to heat energy.

Working of Flate Plate Collectors:-

When the sunlight falls on the metal box which contains with glass this used. to strikes the plates which are placed to absorb the heat from the sun, this get heated and this is used to transfer the heat into the water which is passing in th tubes by this water gets heated in this observers are coated with some useful coating to collect more heat.

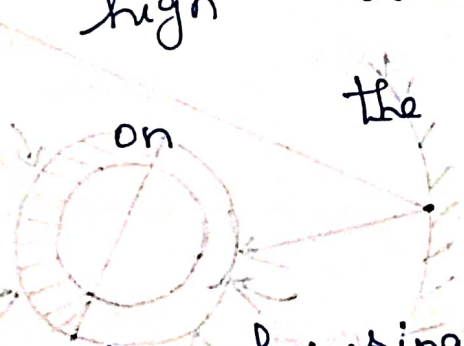
Advantages:-

* This is a non-pollution syst
* This can collect direct and diffuse radiation.

* The Power we use for this is renewable energy (sun).
* Construction is easy.
* more energy can be observed at low temperature.

Focusing Collectors :-

* Focusing collector is a device to collect solar energy with high density of solar radiation on the energy absorbing surface.

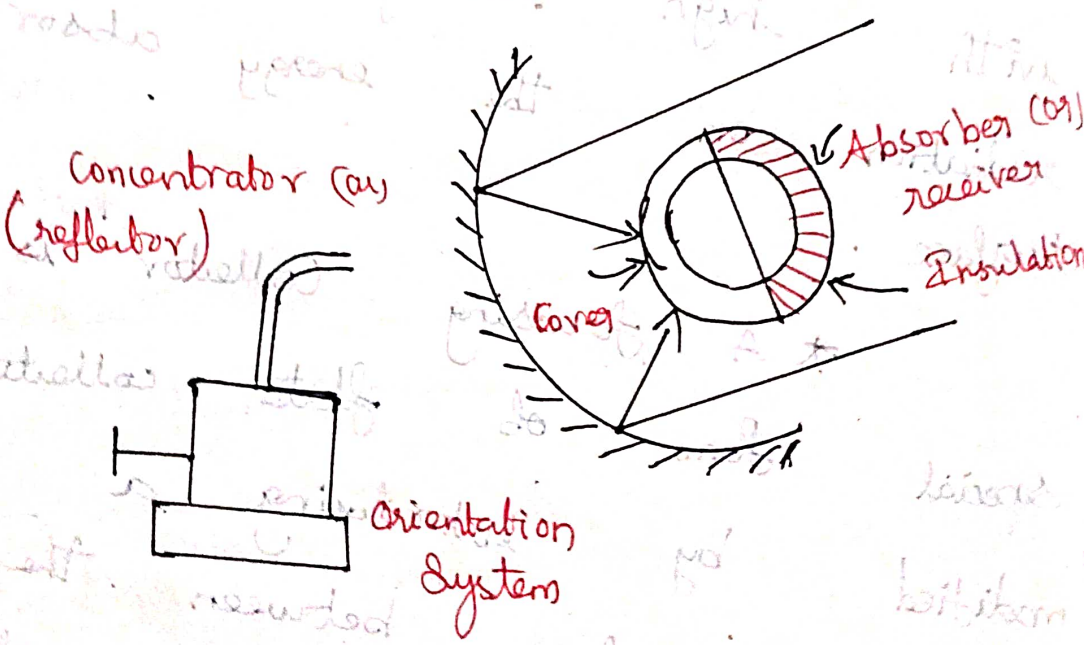


* A focusing collector is a special form of flate collector modified by introducing a reflecting surface between the solar radiations and the absorber

Focusing collectors can have radiation increases from low value of 1.5 to ∞; high values of the order of 10,000.

* Reach temperature upto 450-500°

* Receiver can be convex, flat, cylindrical (or) concave and can be covered with glazing (or) uncovered



There is wide variety of means for increasing the flux of radiation on receivers.

They can be classified on basis of.

→ lenses (or) reflectors.

→ By the types of mounting and orientation system.

→ By the concentration of the radiation they are able to accomplish.

→ By materials used of construction or by orientation.

Concentrator is a component used to increase the intensity of energy flux on a receiver.

Concentration Ratio [CR] :-

It is the ratio of the area of the concentrator aperture to the energy absorbing area of the receiver

$$CR = A_a / A_r.$$

It is determines the effectiveness of a concentrator.

Advantages :-

* Surface: Required less material to provide high collection of radiation.

* Heat loss rate is less than flat-plate collection low maintain

* Can be used for power generation.

* We can get high concentration (or) radiation.

Dis-Advantages :-

* Only beam radiation collected because diffuse component cannot be reflected.

Solar Water Heating.

One of the popular devices that utilizes the solar energy is solar water Heating System.

"Heating System" is not a new concept in india now. The techology is easily available in our country and use in most mega cities.

Features of SWH's :-

* "Fuel Saving" → A 100 litres capacity SWH can replace an elatric geyser for residential use and saves 1500 units of electricity annually.

* "Benifitial for Enrironment" → A SWH of 100 litres Capacity can Prevent emission of 1.5 tones of Carbon di-oxide per year.

* Total life → 15 to 20 years approximately.

Major Components :-

* Solar collector → It's purpose is to collect solar energy.

* Insulated Tank → It's purpose is to store hot water.

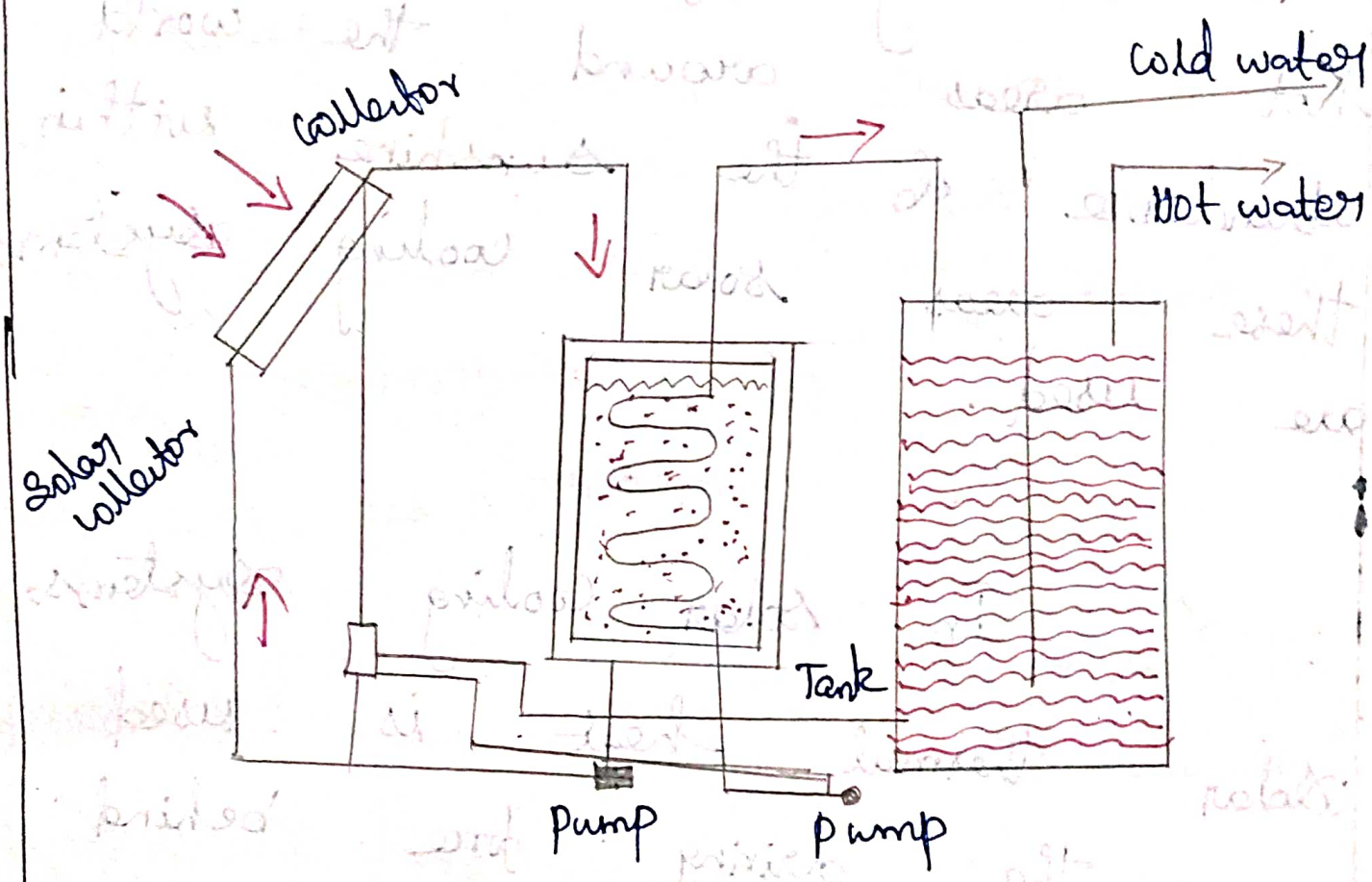
* Supporting Stand.

* Connecting pipes and instrumental

Working Principle :-

The Sun rays fall on the solar collector. A black absorbing surface inside the collector, which absorbs solar radiation and transfers the heat energy to water flowing it. heated

water is collected in a tank which is insulated to prevent heat loss. Then circulation of water from the tank through the collector and back to the tank continuous automatically



A solar water Heater consist of the major component collector panel to collect solar energy and an insulated storage Tank to store hot water.

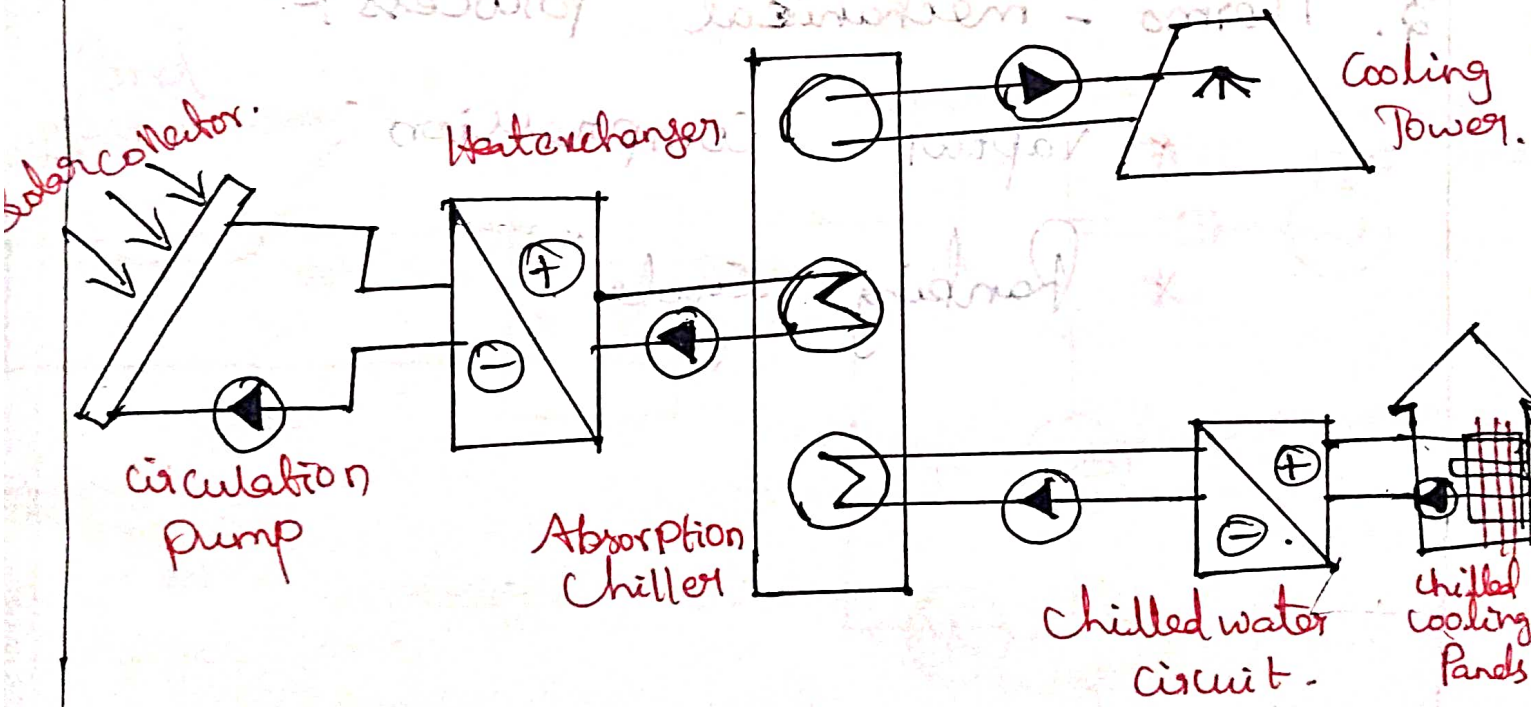
Solar cooling :-

Solar cooling is another efficient use of renewable energy technology. The necessity for air-conditioning for our homes in hot areas around the world within abundance of the sunshine these areas solar cooling systems are used.

In solar cooling systems, solar thermal heat is used as the driving force behind the cooling process. Thermally driven cooling machines, such as absorption chillers have been used for many decades. Compared to designing a domestic "solar hot water" or heating system,

the Planning and designing of a solar cooling system can be a little more complicated.

Solar cooling and air-conditioning can be accomplished by three types of systems: open desiccant, closed absorption (WET), closed absorption (DRY) and mechanical processes as outline below.



1. Open cycle Heat Transformation Thermal Process:-

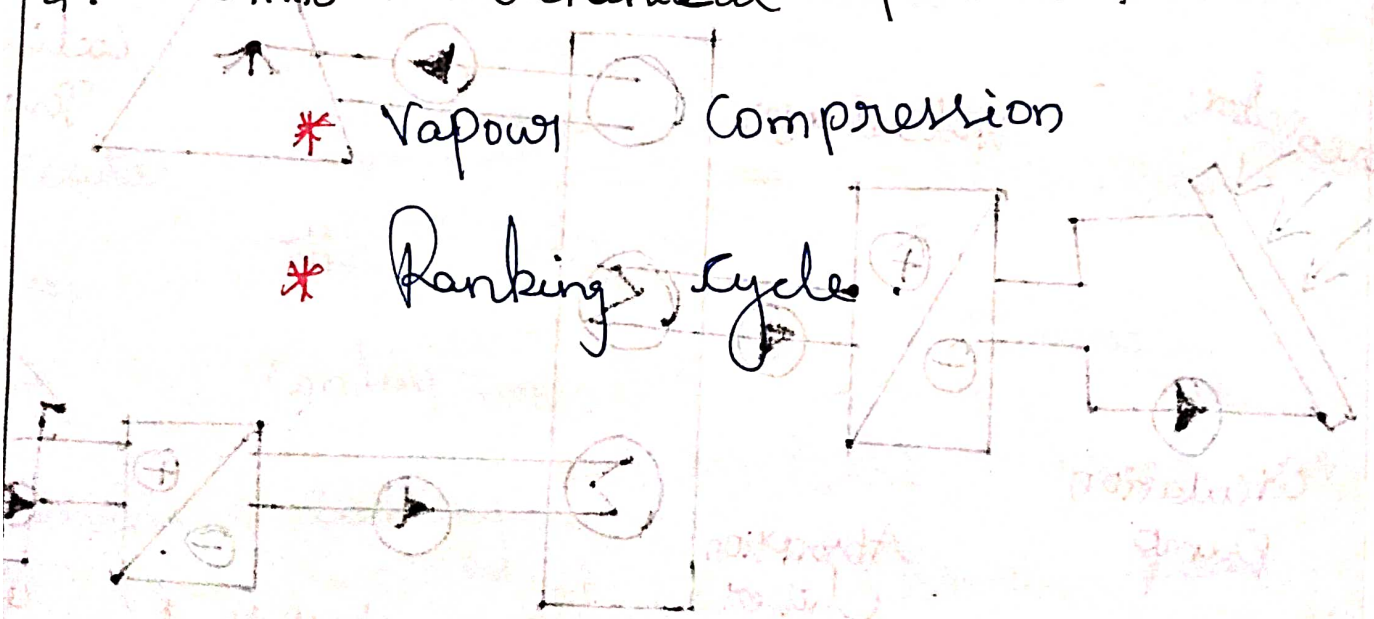
* Liquid Aborber usually Water
* Solid Absorber usually Silica gel.

2. Closed cycle Heat Transformation Thermal process :-

* Liquid Absorbtion process using water / lithium - bromide (or) water / ammonia solution
* Solid Absorbtion using Silica gels, salts (or) ammonia activated Carbon.

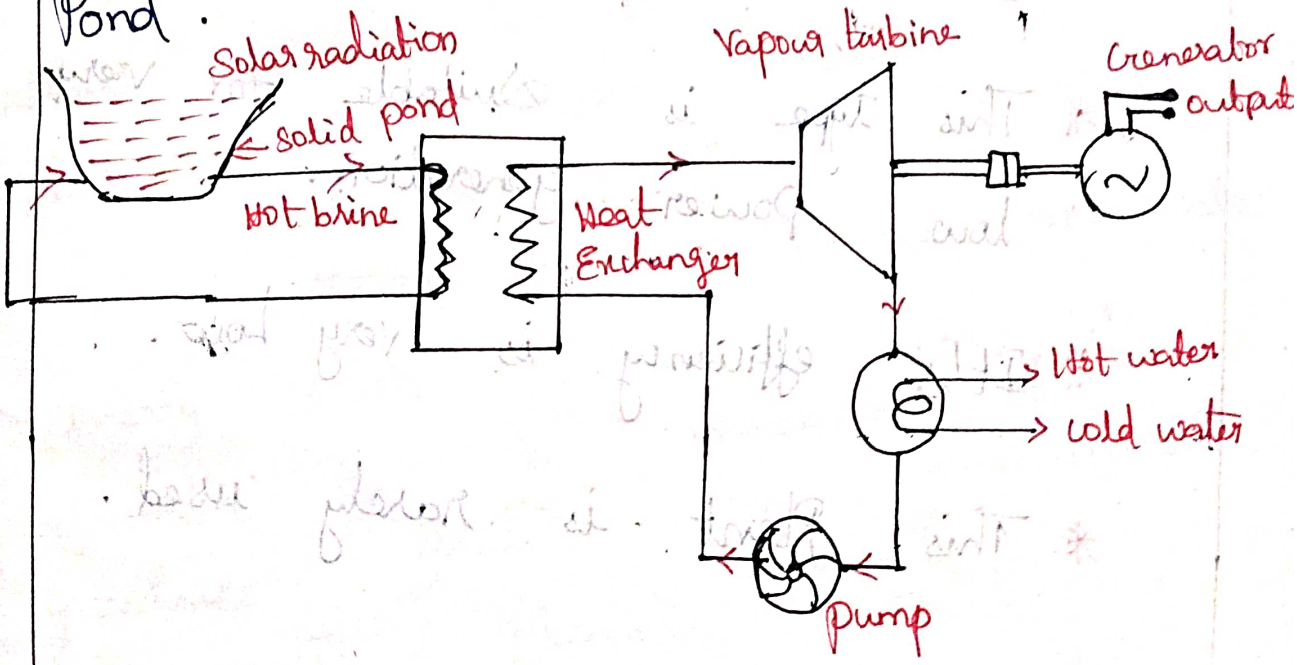
3. Thermo - mechanical process :-

* Vapour Compression
* Ranking cycle.



Solar Pond:

A "solar pond" is a solar energy collector, generally fairly large in size, that looks like a pond. This type of solar energy collector uses a large, salty lake as a kind of a flat plate collector that absorbs and stores energy from the sun in the warm, lower layers of the pond.



Electric Power generation steps :-

* Solar Pond filled with brine.
* Receives solar radiations. Temperature of brine increases - goes to Boiler.

* Working substance evaporates - Vapour goes to turbine - Converted mechanical power into electrical Power. Then Liquid goes back to heat exchanger (Boiler). Condenser receives cooling water from cooling water.

Advantages:-

* This is a low temperature Solar Plant.
* This type is suitable for very low power generation.
* It's efficiency is very low.
* This Plant is rarely used.

Solar Thermal Power Conversion:-

A Solar thermal Power plant (or) solar thermal energy is an Industry installation based on concentrating solar radiation to transform it into electrical energy.

These types of power plants have the same operating principles as Conventional thermal power plants but with the difference that the heat source is not fossil fuels but rather Solar energy.

Solar energy is a renewable energy source. Therefore it is an alternative to the emission of greenhouse gases from conventional thermal Power Plants.

"Solar Thermal Power Plants" are electricity generation plants that utilize energy from the Sun to heat a fluid to a high temperature. This fluid then transfers its heat to water, which then becomes superheated steam. This steam is then used to turn turbines in a Power Plant, and this "mechanical energy" is converted into "electrical energy" by a generator.

This type of generation is essentially the same as electricity generation that uses "fossil fuel", but instead heats steam using "Sunlight" instead of combustion of fossil fuels. These systems use "Solar Collectors" to concentrate the Sun's rays on one point to achieve

appropriately high temperatures.

There are 2 types of systems to collect "Solar radiation" and store it. passive systems and active systems. Solar thermal Power plants are considered active system. These plants are designed to operate using only solar energy, but most plants can use fossil fuel combustion to supplement output when needed.

Wind Power Generation :

Wind results from air in motion arives from pressure gradient. The wind is bari cally caused by solar energy radiating the earth.

The useful work done for the Conversion of kinetic energy can be utilized to generate the electricity.

Wind energy conversion devices are known as wind turbines, they convert wind stream into energy of rotation.

Basic principle of wind energy Conversion

Any energy conversion device can entract the motion and convert it into useful work depending on,

i) The wind speed.

ii) The cross section of wind swept by the rotors.

iii) The overall efficiency of the rotor and generator efficiency.

The power in the entrated wind can be found out by kinetic concepts.

The amount of air passing in unit time through an Area A with velocity V is $A \times V$.

Mass is Given By,

$$M = \rho A V$$

$\rho \rightarrow$ density of the air.

Kinetic energy of the particle is given by,

$$E = \frac{1}{2} M V^2$$

$$E = \frac{1}{2} \rho A V^3$$

($\rho = 1.225$ kg/m^3 at sea level).

It shows the maximum wind energy available and is proportional to the cube of the wind speed.

Since power available is proportional to the cube of the wind speed, since power available is proportional to density, it may vary 10-15 %.

As power available is directly proportional to the cross sectional area, it decides the diameter of the vanes for the required power.

Tip speed ratio :-

Faster rotating windmills have tipspeed ratio of more than 1, Slower rotating windmills have tip speed less than 1.

The power of wind :-

wind is made up of moving air molecules which have mass. Any moving objects with mass carries kinetic energy in an amount given by;

$$\text{kinetic energy} = \frac{1}{2} m v^2 \ (J)$$

$$\text{mass/sec} \ (kg/sec) = \text{Velocity} \ (m/s) \times \text{Area} \ (m^2) \times \text{Density} \ (kg/m^3)$$

$$\text{Power} = \frac{1}{2} \times \text{Swept area} \times \text{Air Density} \times \text{velocity}^3 .$$

watts = (½ × m^2 × kg/m^3 × ... m/s)

P → mechanical Power

ρ → Air density

A → Area swept by the rotor blades m^3.

r → velocity of the air m/s.

volumetric flow rate = A.V

mass flow rate = ρ. A. V

Power in the wind $P = ½(\rho AV).v^2$

$$P = ½ \rho A V^2 \text{ watts}.$$

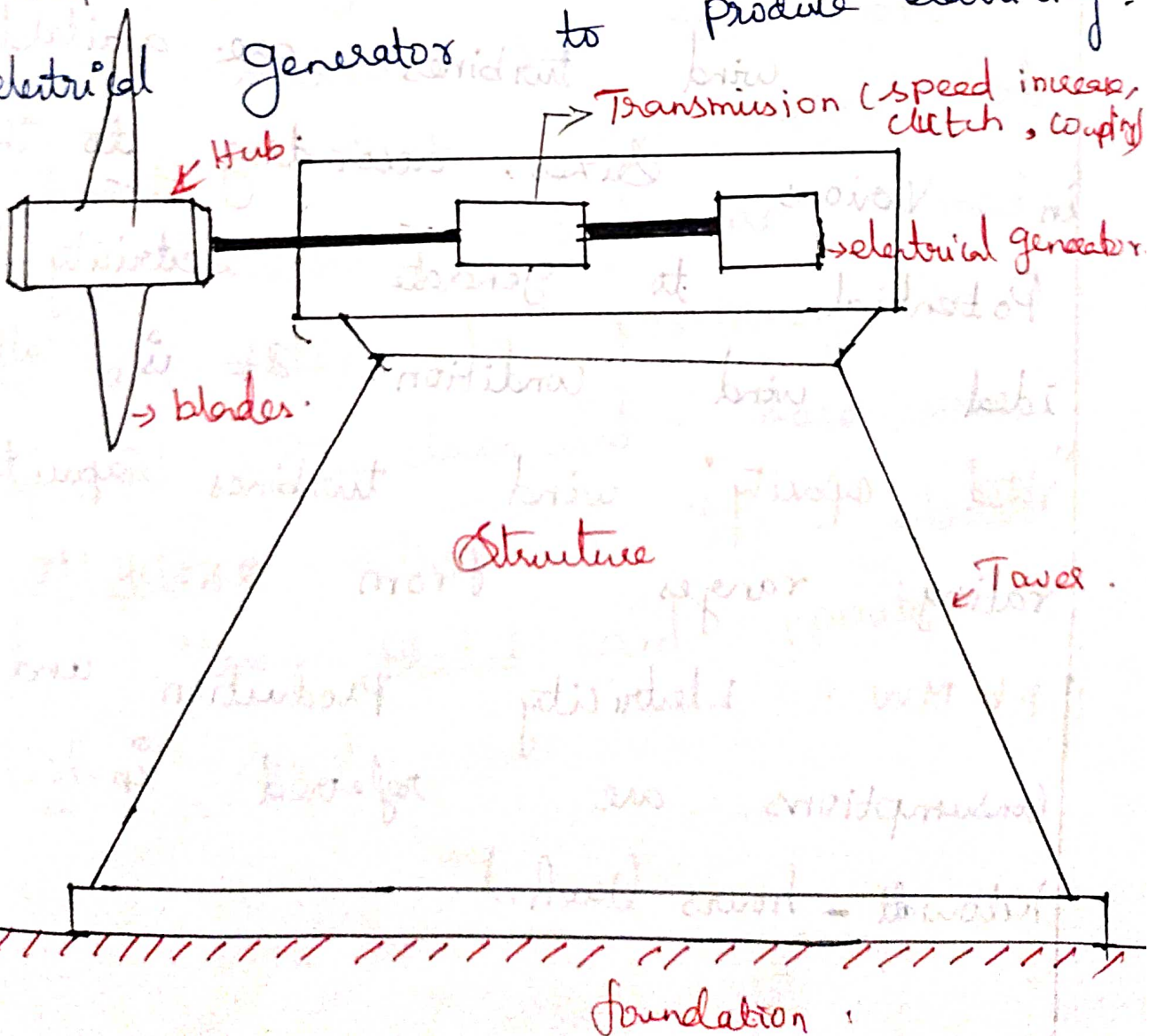
$$A = \pi/4 \, D^2.$$

$$P = ⅛ \rho (\pi/4 D^2) V^3$$

$$P = ⅛ \rho \pi D^2 V^3 \text{ watts}$$

The Construction and working Principle of wind Power generation :-

A wind mill converts wind energy into rotational energy by means of its blades. The basic Principle of every wind mill is to convert kinetic energy of wind into mechanical energy which is used to rotate the turbine of electrical generator to produce electricity.



Wind mill :-

The main components of a wind energy conversion is the wind mill alone. A system of blade fixed on a tower is rotated by the wind to either produce mechanical works (or) electrical work.

Wind turbines :-

wind turbines are available in various sizes, according to the Potential to generate electricity in ideal wind condition. It is called "rated capacity". wind turbines capacity rating ranges from 250 W to 1.6 MW. Electricity production and consumptions are referred in kilowatt - hours (kwh.).

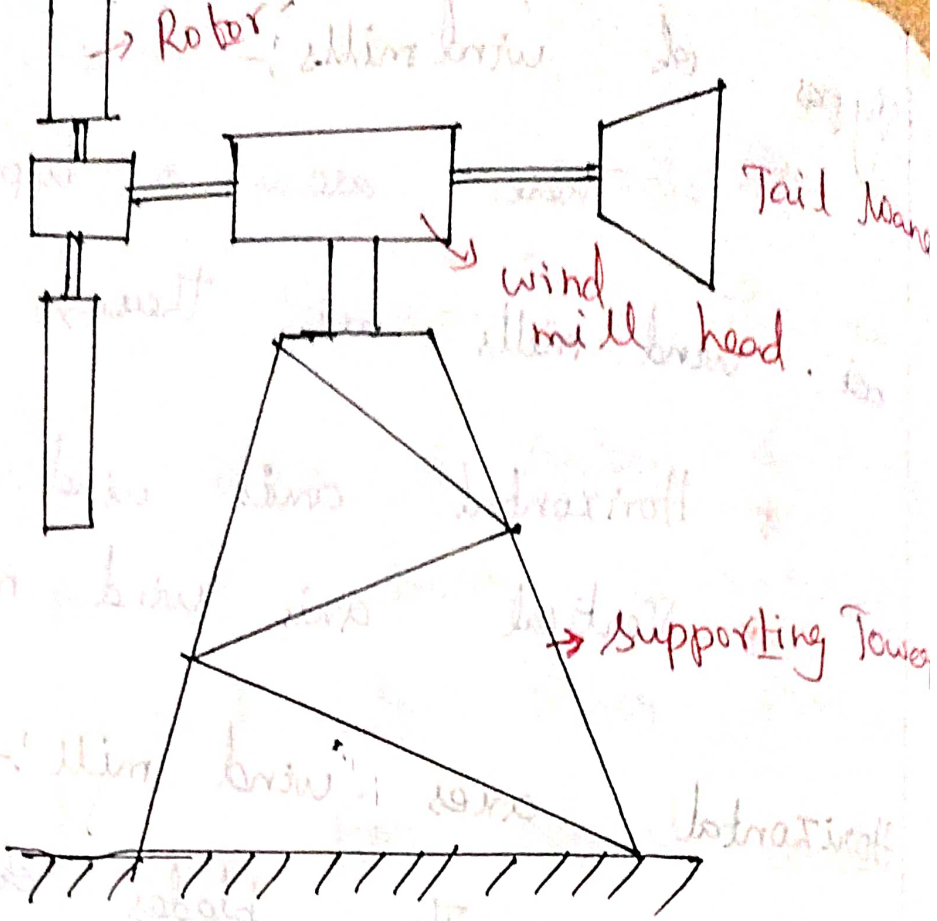
Types of wind mills :-

There are 2 types of wind mills are there;

* Horizontal axis wind mill
* Vertical axis wind mill.

Horizontal axes wind mill :-

The blades of wind mill may have the thin cross section (or) the more efficient thick cross section of an airofoil. which are connected to a rotor by positioning in up wind (or) down wind. These are available either in two - bladed (or) three Bladed and operate at high speed.



Advantages:-

* Simple blade Controls
* lower blade weight and cost
* lower Gear box cost.

Dis - Advantages:-

* Vibrational Produced.
* unconventional appearance.

Vertical Axis Wind turbine :-

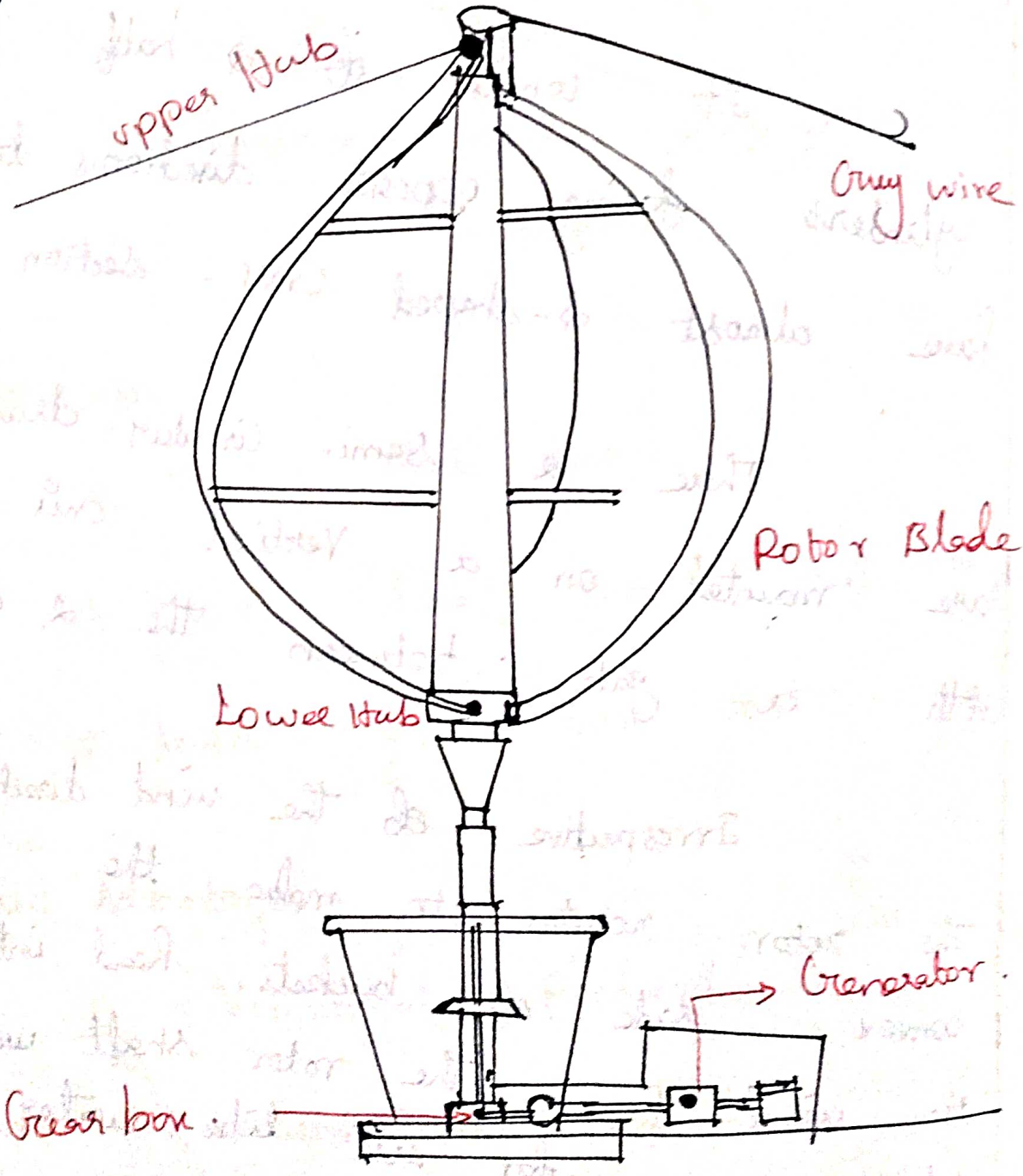
Vertical axis machines are drag forces to turn rotors of different shapes. It use cups, blades (or) turbines as the drag device.

It consist of 2-half cylinders facing opposite directions to have almost S-shaped cross-section.

There 2 semi-circular drums are mounted on a vertical axis with a gap between the 2 drums.

Irrespective of the wind direction, the rotor rotates to make the convex side of buckets head into the wind; from the rotor shaft we take power for use like water-Pumping, battery charging.

Two edges are overlap to leave a wide space between the two edges. Each edge is near the central axis of the oppsite cylinder.



Types of wind Rotors:-

The most preffeable wind rotors are,

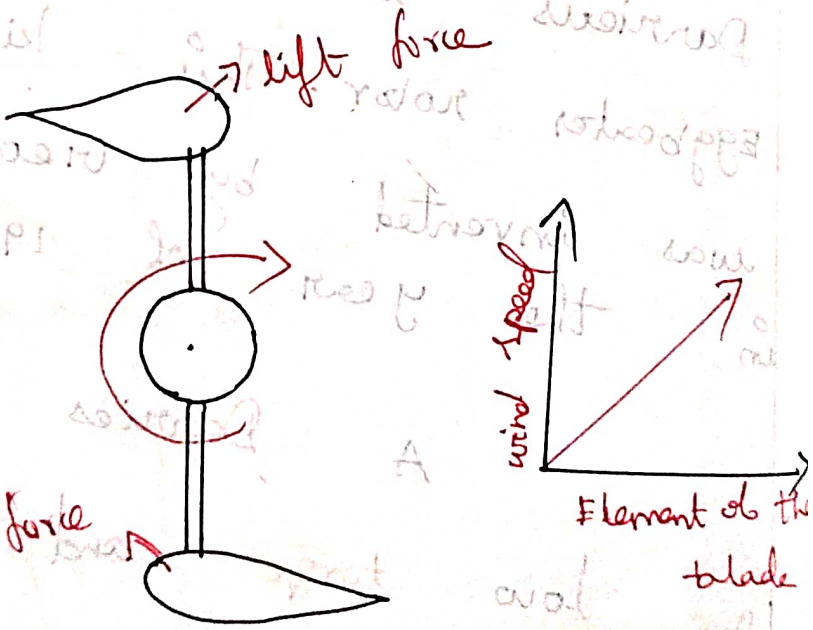
i) Savonius
ii) Darrieus
iii) H- Rotor.

Darrieus wind Rotor :-

An alternative name of Darrieus wind rotor is an Eggbeater rotor. This kind of rotor was invented by Georges Darrieus in the year of 1931.

A Darrieus machine is a low torque and High-speed device used to generate AC. Generally, Darrieous requires Physical push to some exterior power source is used to start rotating

The machine consists of 2 blades that are vertically oriented and rotating around a perpendicular shaft. The Darrieous type wind rotor is a lift-type VAWT. Instead of gathering Airstream within cups, the rotors will drag around. Darrieous utilizes its forces which are produced through the air-stream hitting aerofosil to make revolutions.



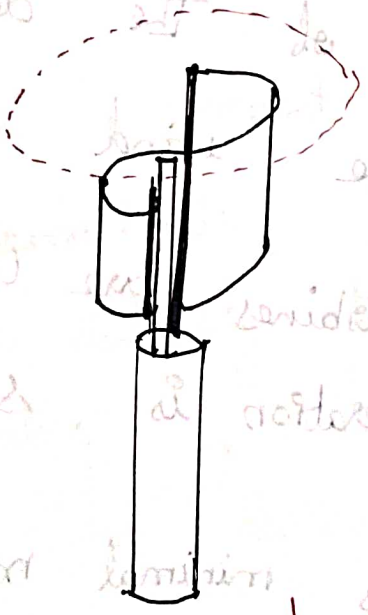
Application:-

i) Water Pumping

ii) water Cooling and water heating

Gravion Rotor :-

The Gravion wind rotor definition is that it is employed for the conversion of "wind force" into "torque" based on the rotational shift. The rotor is included with multiple aerofoils, but these are not every time placed on the rotational shaft, but also ground positioned (or) even these are airborne systems.



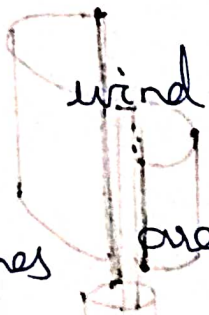
[Gravion wind rotor]

The device is a similar way to a cup anemometer. The Gravion rotor working principle can be easily Explained because this is

considered as the most streamlined turbine when compared with other turbines. This is a dragging kind of instrument where it consists of some 2-3 cups. From the above portion, the rotor appears in the shape of "S" in the form of cross-section.

Advantages:-

i) Operation of the device is regardless of the wind direction.



ii) The turbines are cost-effective and the operation is so streamlined

iii) Provides minimal noise.

Dis-Advantages:-

i) The equipment used for the installation is not desirable.

Wind Power in India:-

As India's economic growth accelerates, its energy consumption and greenhouse gas emissions accelerate analog with it. India's electricity consumption has increased 459% since 1990, and its emissions have increased by 335%. 74% do this electricity still comes from coal powa plants.

The Goverment of India has made remarkable progress in providing axes to electricity to rural populations, also integrating a high share of renewable energy sources into the grid".

Wind power plants in india are,

* "Pratapgarh" - Wind farm
  → Rajasthan
  → 126 MW.

* "Nimbagallu" - Wind farm.
  → Andhra Pradesh
  → 100 MW.

* "Poolavadi" - Wind farm.
  → Tamil Nadu
  → 99 MW.

* "Khnadke" - Wind farm
  → Maharasthra
  → 50.4 MW.

* "Samana" - Wind farm
  → Gujarat
  → 50.4 MW.

OCEAN THERMAL ENERGY CONVERSION

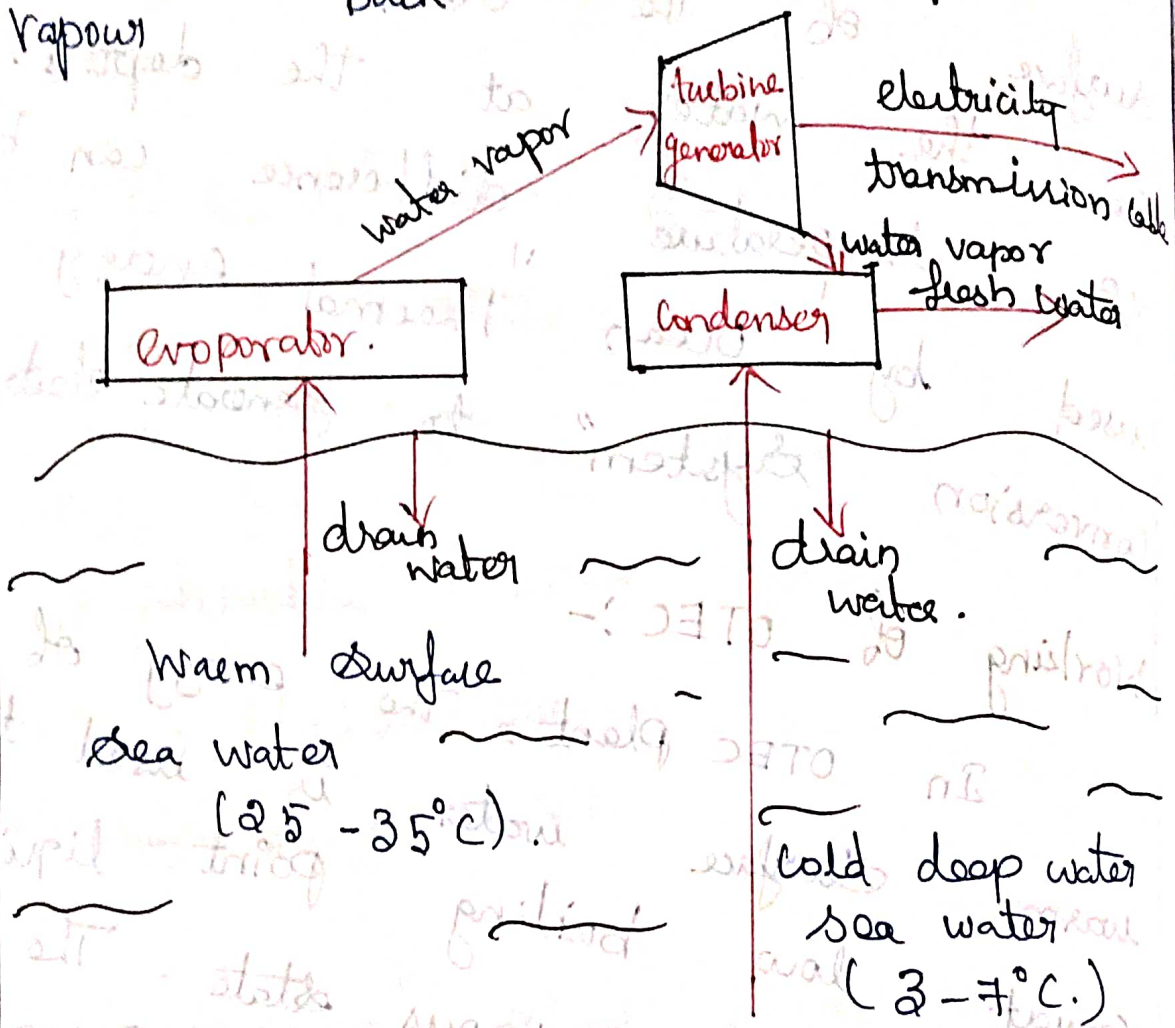
The water at the surface of the ocean is warmer than the water at the depths. This temperature difference can be used by ocean "Thermal energy conversion system" to generate electricity

Working of OTEC :-

In OTEC plant, the energy of warm surface water is used to convert low boiling point liquid ammonia into gaseous state. The vapour of ammonia into gaseous high pressure is used to spin the turbines of generators converting the ocean thermal energy to the electricity.

The used vapour pass through the condenser where cold

water, pumped from the deeper parts of Ocean condenses ammonia vapour back into a liquid.



This process is repeated again and again to get Continuous Production of electricity. Essential condition for it to operate properly. The temperature difference between

The warmer water at the surface and colder water at depths upto "2 km" should be 293 K 293 K (20°C) (or) more.

Advantages:-

* Renewable and Pollution-free
* Drawing of warm and cold-water are returning.
* Minimal Environmental impact.
* Unlike other forms of solar energy, the output of OTEC shows very little daily (or) Seasonal variation.

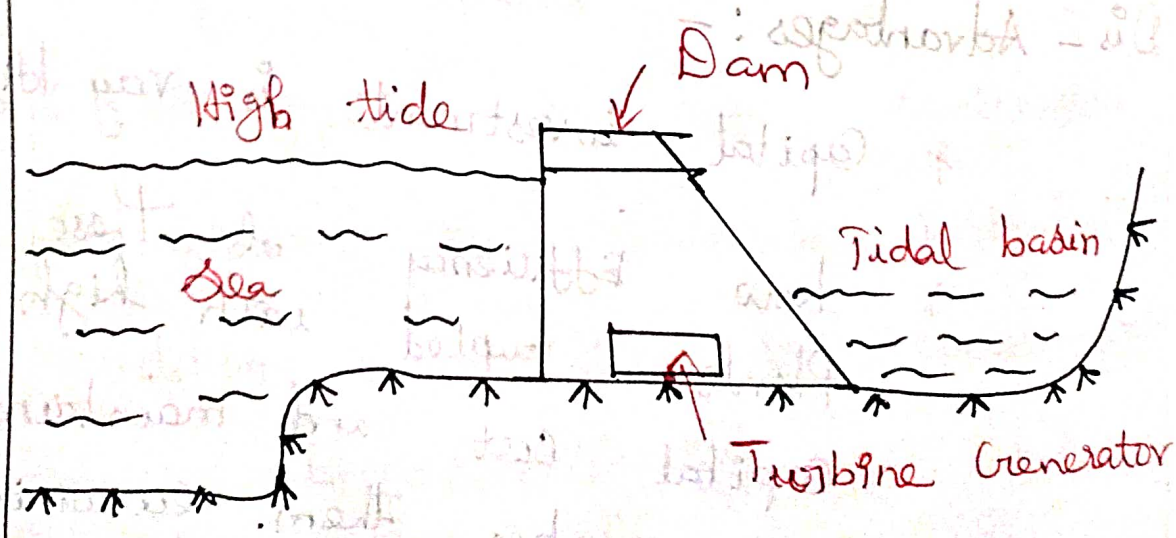
Dis-Advantages:-

* Capital investment is very High.
* Low Efficiency of these Plants coupled with high Capital Cost and maintainance cost makes them economical for small plants.

Tidal Energy Conversion

Tide (or) wave is periodic rise and fall of water level of the sea. Tides occur due to the attraction of sea water by the moon. Tides contain large amount of potential energy which is used for power generation. When the water is above the mean sea level, It is called "flood tide". When the water is below the mean level it is called "ebb tide".

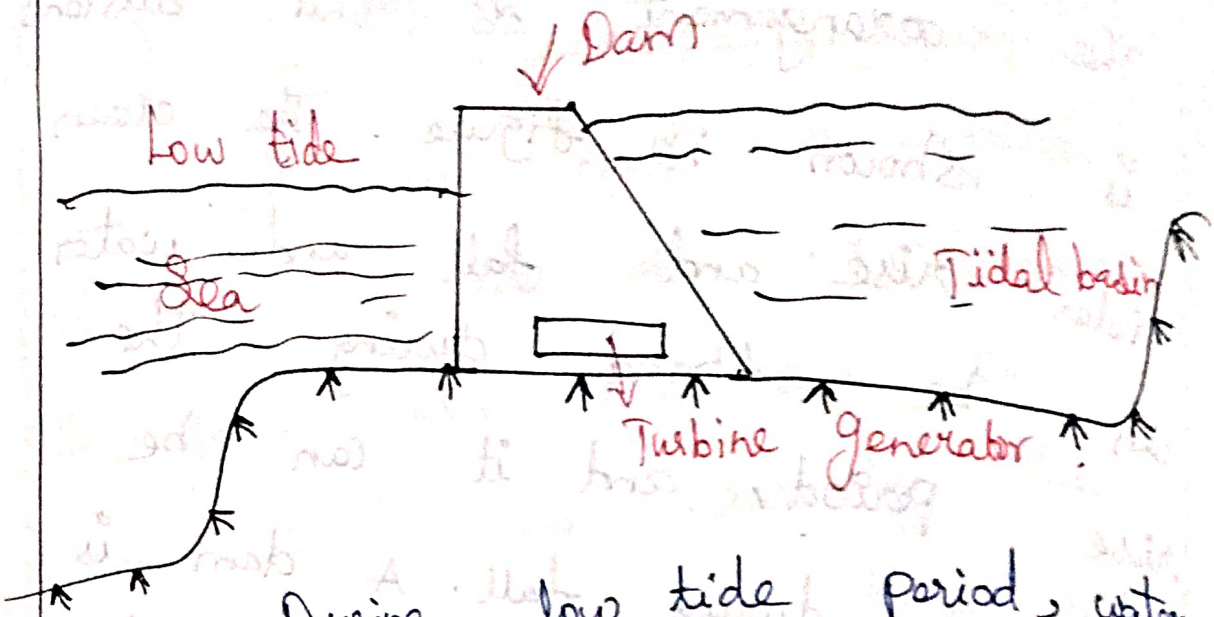
Construction and Working :-



[fig → High to Low Tide]

The arrangement of this system is shown in figure. The ocean tides rise and fall and water can be stored during the rise period, and it can be discharged during fall. A dam is constructed separating the tidal basin from the sea and a difference in water level is obtained between the basin and sea.

During High tide period, water flows from the sea into the tidal basin through the water turbine. The heigh of tide is above that of tidal basin. Hence the turbine unit operates and generates power, as it is directly coupled to a generator.



During low tide period, water flows from tidal basin to sea, as the water level in the basin is more than that of the tide in the sea. During this period also, the flowing water rotates the turbine and generator Pair

The generation of power stop only when the sea level and the tidal basin level are equal. For the generation of power economically using this source of energy requires some minimum tide hight and suitable site.

Advantages :-

* It is free from pollution.
* It is superior to hydro-Power plant as it is totally independent of rain.
* It improves the possibility of fish farming in the tidal basin and it can provide recreation to visitors and holiday makers.

Dis - Advantages :-

* As the sites are available on the bays which are always far from load centres.

UNIT- V

Energy Conservation - Ac ; Energy management importance, duties and responsibilities ; Energy audit - Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management.

Energy Conservation :-

Energy Conservation is the decision and practice of using less energy. Energy conservation is a part of the concept of Eco - Sufficiency. Turning off the the light when you leave the

room, unplugging appliances when they are not in use and walking instead of driving are all examples of energy conservations.

Energy Conservation Act:-

Energy Conservation Act, 2001, accomodates productive utilization of energy and its preservation for matters, associated therewith (or) incidental thereto. It was instituted by the parliment in the fifty-second year of the Republic of India and was enacted on 29th September 2001, but came into Force from 1st march 2002. This act resulted in the formation of "Bureau energy efficiency" which came into to effect.

Need For Energy Audit :-

In an any Industry, the three top operating expenses are often found to be energy (both electrical & thermal), Labour and material.

If one were to relate to the manageability of the cost (or) Potential cost saving in each of the above components, energy would invariably emerge as a top maker, and thus energy management function constitute a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used ~~are~~ in any industry.

and help in identifying the areas where waste occurs and where scope for improvement exists. The energy Audit would give a positive orientation to the maintainance cost reduction, Preventive Programmes and quality control Production and utility activities. Such an audit Programme will help to keep focus on variations which occur in the energy costs, availability and reliability of Supply of energy, decide on appropriate energy mix, identify energy conservation technologies. for retrofit energy conservation equipment etc.,

In general, Energy audit is the translation of conservation ideas into realities, by landing technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output (or) to lower operating costs.

Energy Audit provides "bench-mark" for managing energy in the organization and also Provides the basis for planning a more effective use of energy throughout the organizations

Energy Audit Types and Methodology

Energy Audit is the key to systemic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management Programme.

As per the energy Conservation Act, 2001, Energy Audit is defined as " the verification and analysis of use of energy including submission of technical report containing,

recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption."

Types of Energy Audit :-

The types of energy Audit to be performed depends on :-

Function and type of industry -
Depth to which final audit is needed, and - Potential and magnitude of cost reduction desired.

Thus energy Audit can be classified into the following 2 types,

* Preliminary Audit.
* Detailed Audit.

1. Preliminary Audit :-

Preliminary energy audit is relatively quick exercise to :

a

* Establish energy consumption in the organization.
* Identify the most likely (and the easiest area for attention.)
* Identify immediate (especially no/ low-cost) improvements/savings.
* Set a reference point.
* Identify areas for more detailed study/measurement.
* Preliminary energy audit uses existing, (or) easily obtained data.

II. Detailed Energy Audit :-

A comprehensive audit provides a detailed energy Project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy Savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major components, and includes detailed energy Cost Saving Calculations and Project cost. In a comprehensive audit, one of the key elements in the energy balance. This is based on an inventory of energy using systems, assumptions of current;

operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges.

Instrument for Energy Audit :-

An energy Audit is a systematic analysis of energy use and consumption. It is important to map all major energy in an energy Audit and identify the energy loss area and saving potential. For accurate and quantified identification of energy loss (or) estimation of saving potential, it is important to have some of the important instruments during an energy audit.

1. Temperature Indicator device:-

Temperature indicators are the most important instrument to measure process temperature and heat Losses. Various temperature measurements devices are available to do this activity.

2. Flue gas Analyzer:-

Flue gas analyzer is another important instrument to measu the combustion efficiency of a boile (or) furnace. Carbon - monoxide, carbon dioxide and oxygen monitoring is important to identify loss du to incomplete combustion (or) excess air supply.

Steam Trap Tester / Monitor :-

Steam is one of the major forms of energy being consumed in the process industry for various applications. The Generation, distribution and consumption of Steam must be in an efficient manner, for proper distribution and consumption of steam condensate must be removed as soon as it form in the Steam network. for removal of condensate, steam traps are used.

Conductivity, TDS, PH Meter :-

Conductivity (or) TDS meters are required for measuring the salt concentration of the boiler drum (or) cooling tower. with this meter, we can easily identify

the operational gap in the boiler (or) cooling tower operation pH meter helps to identify the acidity (or) alkalinity of water.

Thermo Hygrometer :-

It is used to measure humidity and temperature of the desired area. Thermo hydrometer is important for the study of HVAC system operation. This meter can also be used to Calculate the dew point of the air.

Ultrasonic Flowmeter :-

Flow measurement is required to measure flow for Calculating pumping efficiency.

with an ultrasonic flowmeter, the velocity of fluid can be measured without actual fluid contact by measuring the ultrasonic sound from the pipe surface of the moving fluid.

Pressure indicator:-

Digital pressure indicator is required to measure fluid pressure. It is important to measure the efficiency of the pump, air compressor, blower, fans, vacum system etc.,

Pitot Tube:-

It is a flow measurement device used to measure fluid flow velocity, the most important use of pitot tube is for the

measurement of duct air velocity.

Anemometer :-

An anemometer is a device used for measuring wind speed and direction. It is commonly used to measure the velocity of the fan calculate air flowrates. Anemometers are essentially fluid flow measuring instruments. As energy audit tools, they are most commonly used to measure air flow heating, ventilation and air conditioning (HVAC) systems.

Tachometer :

Tachometer is used to measure speed of rotating equipment's without contact.

Power Analyzer:

Power Analyzer is a multi-function power analyzing device which is used to measure precisely direct current, alternating current, Ac-voltage, Dc-voltage the intensity of Dc (or) Ac, Phase rotation, apparent and effective power.

Digital multimeter:-

A digital multimeter is a test tool used to measure two (or) more electrical values - Principally voltage (volts), current (amps) and resistance (ohms).

Harmonic Analyzer:-

It is used to measure frequencies, amplitudes, different phases and various components of a non-sinusoidal waveform.

Energy Benchmarking :

Energy benchmarking means assessing and analyzing the energy of building, organization, machineries, equipments, devices and then comparing them with that of established standard reference system

Steps involved (or) designing a energy benchmarking action plan:-

→ Step 1:- Calibrate performance / Da collection & recording

Step 2 :- Create a visual Repor

Step 3 :- Select your competitors/ Establish base line.

Step 4 :- Gather information / Analyze / Assess.

Step 5 :- set clear objectives.

Step 6 :- Reveal findings & Entice Customers.

Step 7 :- Track progress.

Step 8 :- Keep the process going.

The Benefits of Benchmarking :-

* Energy Benchmarking Provides objective, reliable information on energy use and the benefits of improvements.

* Energy benchmarking increases general awarness of energy efficiency among building occupants.

* Energy benchmarking identifies best Pratices that can be replicated, either within a build (or) across a portfolio of buildings.

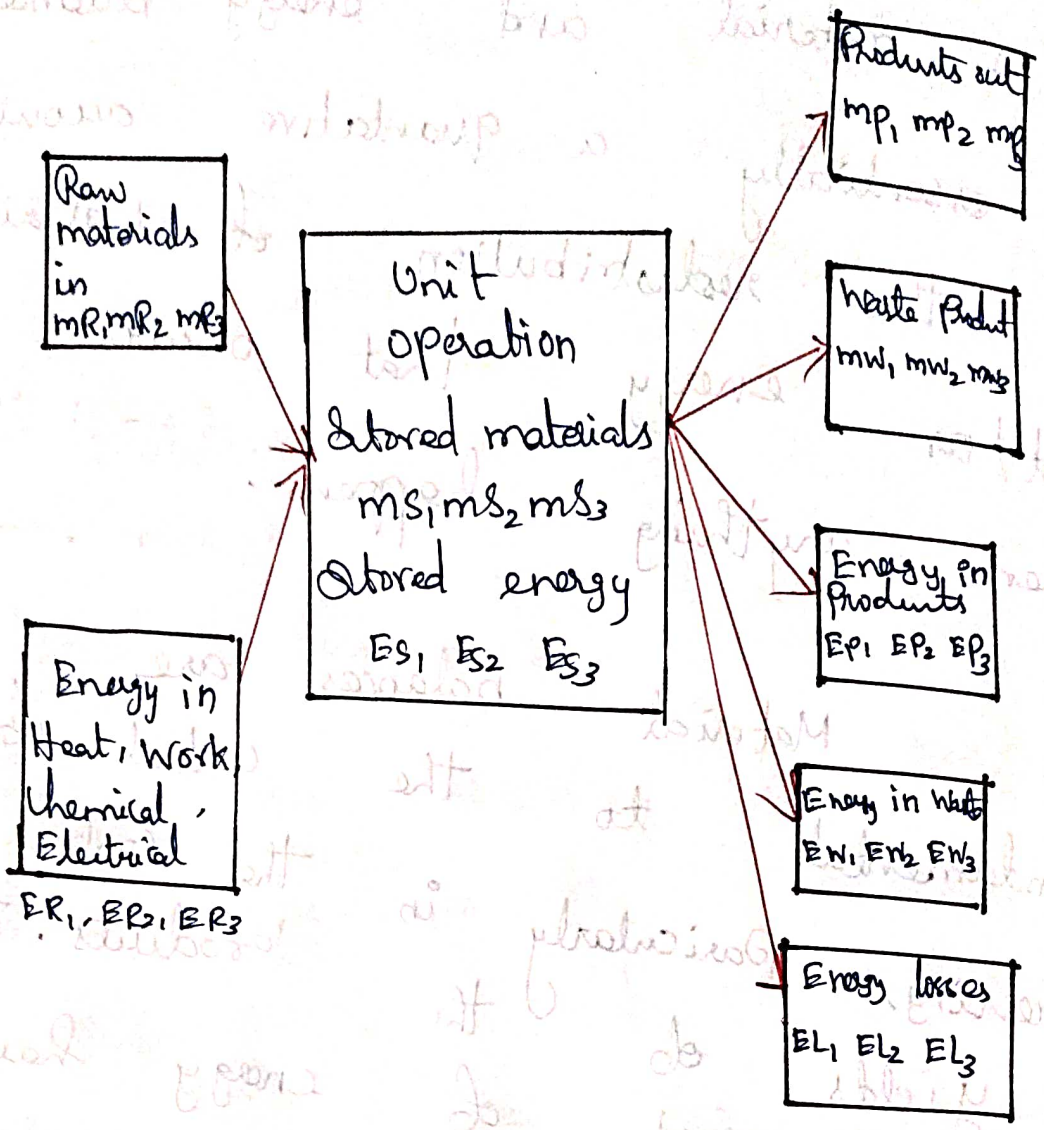
Through Benchmarking, the key metrices for assessing the performa of a building (or) portfolio of buildings can be identified along with the facility's key drives of energy use.

Material and Energy Balance :-

A material and energy Balance is essentially a quantative account of the redistribution of material and/or energy that occurs when anything happens.

Material balances are fundamental to the control of processing, particularly in the control of yields of products. The increasing cost of energy has caused the industries to examine means of reducing energy consumption in processing, Energy balances are used in the examination of the various stages of a process, over the whole process and even extending over the total Production system from the raw materi-al.

to the finished product.



The mass and energy going into the box must balance with the mass and energy coming out.

The law of conservation of mass leads to what is called a mass (or) a material balance.

Mass In = Mass Out + Mass Stored

Raw material = Products + Wastes + Stored materials.

$$\sum m_R = \sum m_p + \sum m_w + \sum m_s$$

$$\sum m_R = \sum m_{R_1} + \sum m_{R_2} + \sum m_{R_3} = \text{Total Raw materials}$$

$$\sum m_p = \sum m_{p_1} + \sum m_{p_2} + \sum m_{p_3} = \text{Total Products}$$

$$\sum m_w = \sum m_{w_1} + \sum m_{w_2} + \sum m_{w_3} = \text{Total waste Products.}$$

$$\sum m_s = \sum m_{s_1} + \sum m_{s_2} + \sum m_{s_3} = \text{Total Stored products.}$$

Energy In = Energy Out + Energy Stored.

$$\sum E_R = \sum E_p + \sum E_w + \sum E_L + \sum E_s$$