Solar Power System -

Important material → silicon

Si_{14} → 2, 8, 4.

4 volance Electron is present in outer most shells.

Sand of silcion oxicle mixed with carbon burn in flurance with 2000°c than we easily extract Si element. It is semiconductor

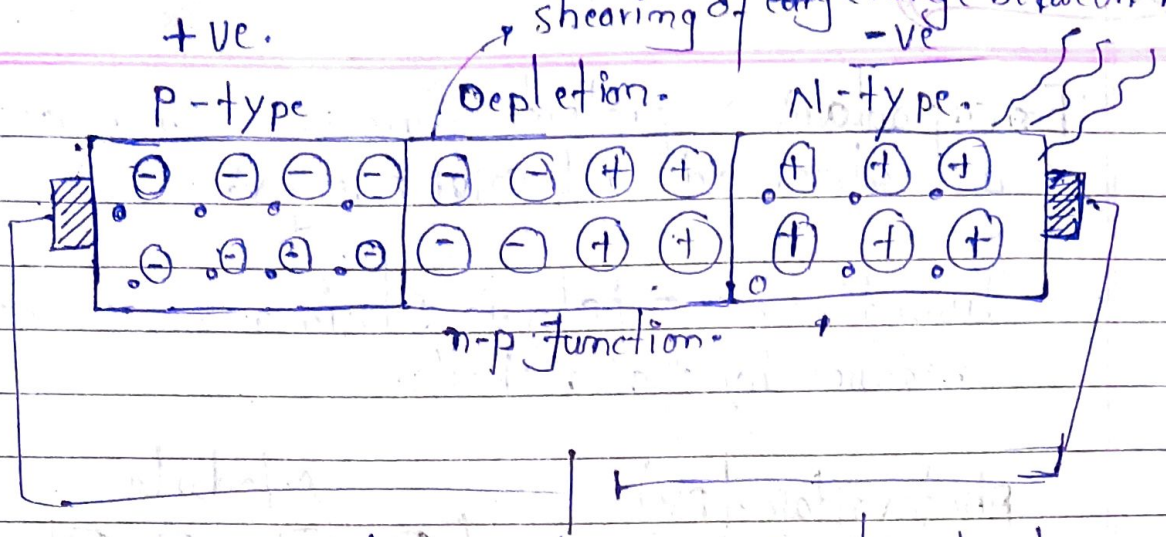
Dopping → when one element is mixed with another Element it's processes is called dopping

Al_{13} → 2, 8, 3

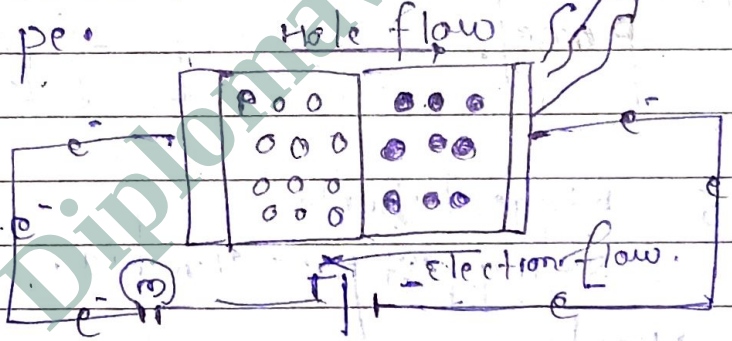
when Alminum is dopping with silicon. Here, Silicon requised 4 Electron to but Aluminium only provide 3 lectron. ie. positive charge is generate and it is called p-type Silicon.

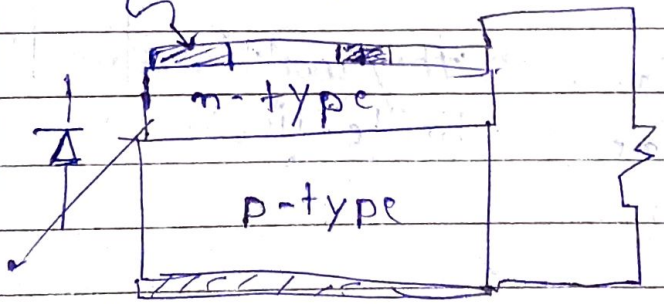
P_{15} → 2, 8, 5.

when phosphorus is dopping with silicon, were Silicon requried 4 Electron but Phosphorus have 5 electron then they have 1 extra Electron. it make its negative charge particle it is called n-type Silicon.



when n-type silicon recived heat energy. due to the n-type lose neutron. then n-type silicon have higher concentration of electron due to which electron want to flow. but it not flow throug depletion zone the we connect wire to n-type to the p-type.





Gives direct current is stored in battery.

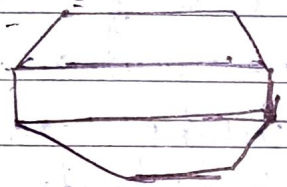
n-type have more doping. They have special type of glass which protect the solar cell and also absorbed sight Energy of sun.

Encapsulant :- protect from mositure and also absorbed all solar energy.

Junction box - help in storing solar energy produce by solar shells.

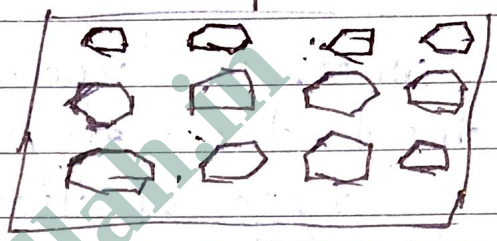
Photovoltaic (PV)

Cell



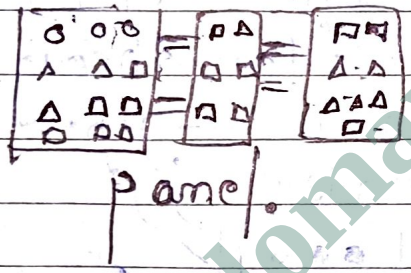
0.5 volt

Module

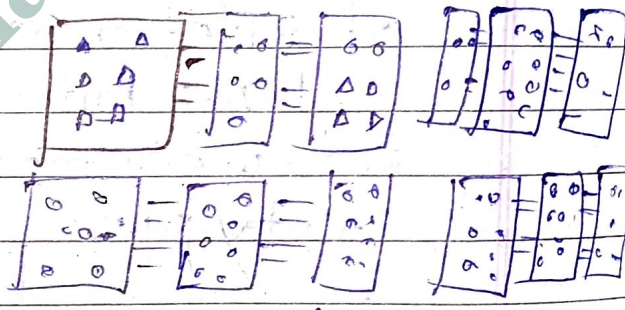


72 cell

36-volt.



Panel.



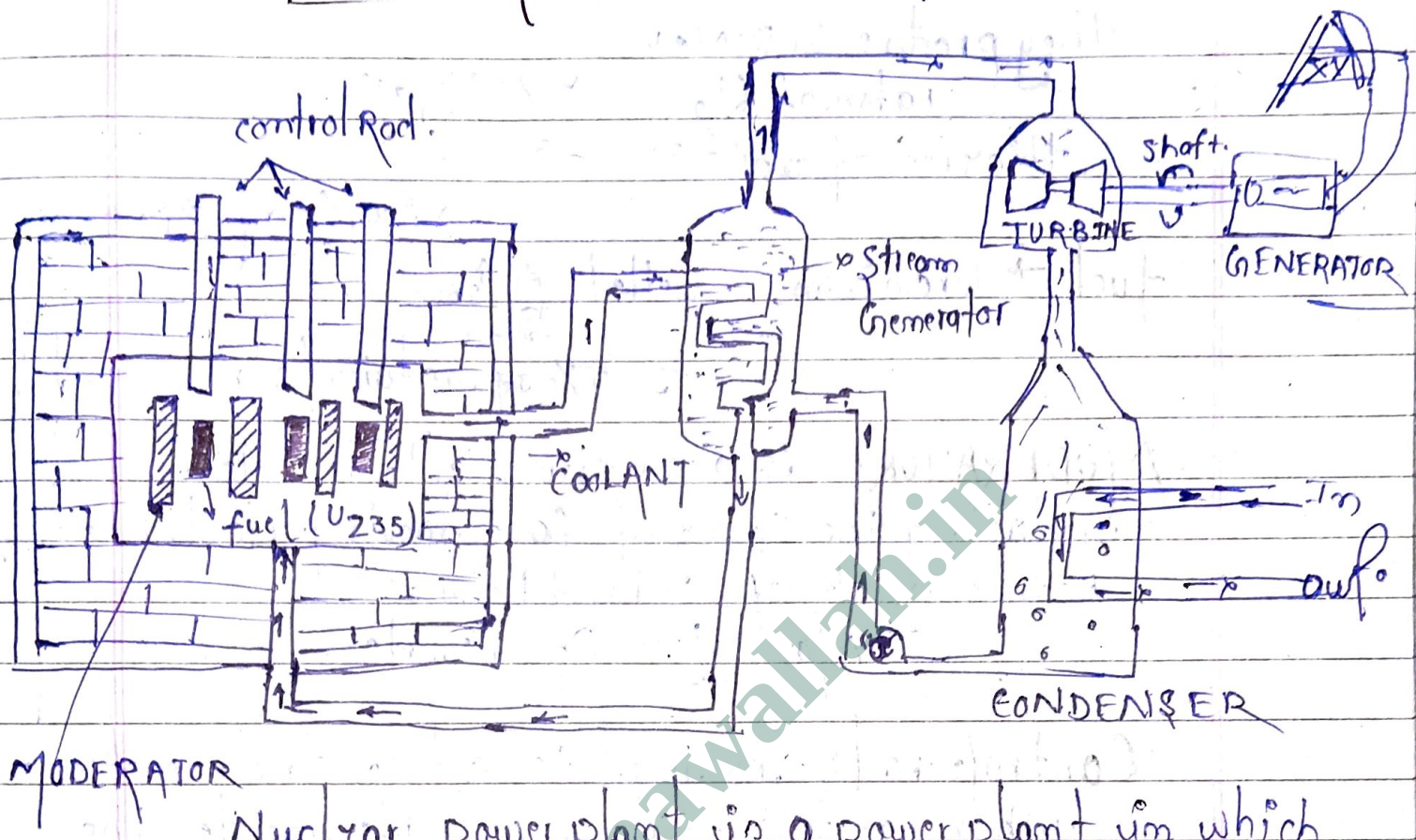
Array

5 - biggest park

8 - biggest park India.

- Monocrystallion. (best.) → they work in dim light.
- Polycrystalline → brite light.
- Thin filion.

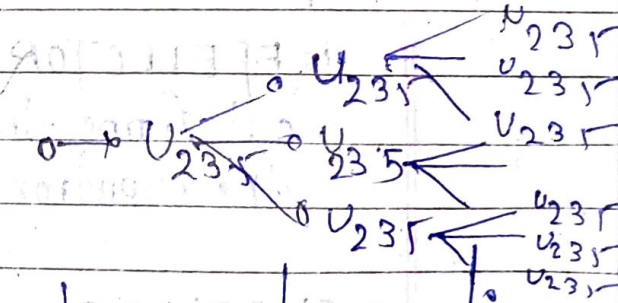
NUCLEAR POWER PLANT



Nuclear power plant is a power plant in which nuclear fuel is used to generate Electricity

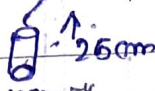
Important Component of Nuclear power plant:-

- Nuclear Reactor.
- Stream Generator (Boiler)
- TURBINE.
- Generator.
- Condensor.



Nucler Reactor → is a place where nuclear reaction take place. Here, Neutron is bombed in Uranium (U_{235}) atom then Uranium Spilt and generate large atom of heat Energy by the prosess of fission chain reaction

they produce 200 MeV
1 atom of U_{235} → 200 MeV
thickness of wall - 20cm - 30cm.

fuel → Uranium pellet  coating of Zirconium

3-5% of contain (enrichement).

MODERATOR → is a medium which help reducing the speed of fast moving Electron.
Reduce risk of Exhust boom.
Material → D_2O, water.

Control rod → is used to control the reaction. when control rod is inserde inside the reactor control rode absorbed the neutron and control the reaction.
Material of control rode → Boron, cadium, Indium

REFELECTOR → Due to some essue some neutron out frome the core then reflector reflect the neutron to the core.

SHIELDING → In case the exident was occur in reactor then heavy shielding not allow flow out the radiation from the reactor.

COOLANT :- main function of coll coolant absorbed the heat energy from reactor and flow to stream generater. where water absorbed the coolent heat and converte into steam then steam goes to turbine and again cool coblant goes to the reactor.

TURBINE - manalmeta (Cut ni) ~~tur~~ when superheated steam passes through turbine then turbine rotate with very high speed. shaft of turbine coppal with Generator.

→ It generate clean energy.

CONDENSER - Help to convert steam into the water (liquid.) → then they again sent to the steam Generator.

Site selection
→ Nearby load center
→ Alway away form populated are because of radiation.
→ Availibility of water
→ Transportation facility
→ Radioactive waste disposal arrangement have to present.

Multipication factor

K = Nuteron produced in one generation / Nuteron produced in preceding generation.

$K < 1$: chain reaction stop (Subcritical)

$K > 1$: chain reaction grows (Super-critical)

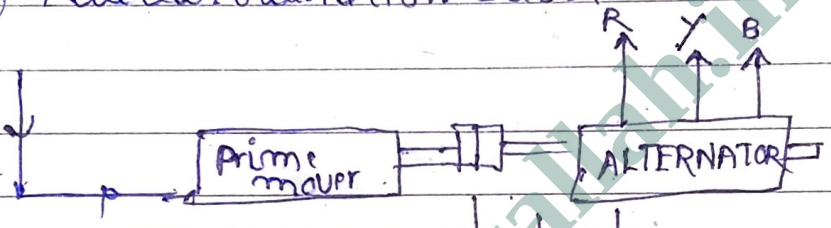
$K = 1$: chain reaction steady. (critical). ← ideal

GENERATION of ELECTRICAL ENERGY

The conversion of Energy available in different forms in nature into Electrical Energy is known as Generation of Electrical Energy.

Energy available in nature different from -

(i) Pressure of water.
(ii) chemical Energy of fuels.
(iii) Nuclear radiation substance.



→RUBINE convert heat Energy into mechanical Energy.
which is futher converted into Electrical Energy by Alternator.

↓

Work on the principal of Electro magntic induction.
State that change in magnetic flux time is directly proportion to the flow of charge.

A generating ~~sat~~ station essentially employs a prime ~~motor~~ mover coupled to an alternator for the production of Electric power.

prime mover (e.g., steam turbine, water turbine, etc.)

Steam Power station: (Thermal station).

A generating station which converts heat energy of coal combustion into Electrical energy.

A steam power station work on Rankie cycle. Steam is produced in the boiler by utilising the heat of coal combustion. The steam is then expanded the prime move (ie, steam turbine) and is condensed in a condenser tube bed into boiler again. The steam turbine drives the alternator which converts mechanical energy of the turbine into Electrical energy.

ADVANTAGE :-

(i) The fuel (ie coal) used is quite cheap.
(ii) Less initial cost as compared to other generating stations.
(iii) It can be installed at any place irrespective of the existence of coal. The coal can be transported by rail.
(iv) It requires less space as compared to the hydroelectric power station.
(v) The cost of generation is lesser than that of the diesel power plant.

Disadvantages:-

(i) It pollutes the atmosphere due to the production of large atomount of smoke and fumes.
(ii) It is costlier in running cost as compared to hydroelectric plant.

Efficiency of steam power station :-

Efficeny is quite low (29%) due to mainly to two reason -

(i) Huge amount of heat is lost in the condenser.
(ii) Heat Losses occur at various stages of the plant.

The heat lost in condenser cannot be avoided. It is because heat energy cannot be converted into mechanical energy without temperature difference. The greater the temperature difference, greater is the amount of heat ~~lost~~ energy converted into mechanical energy.

Thermal efficiency = $\frac{\text{Heat equivalent of mech. eng. transmitted to turbine shaft}}{\text{Heat of coal combution.}}$

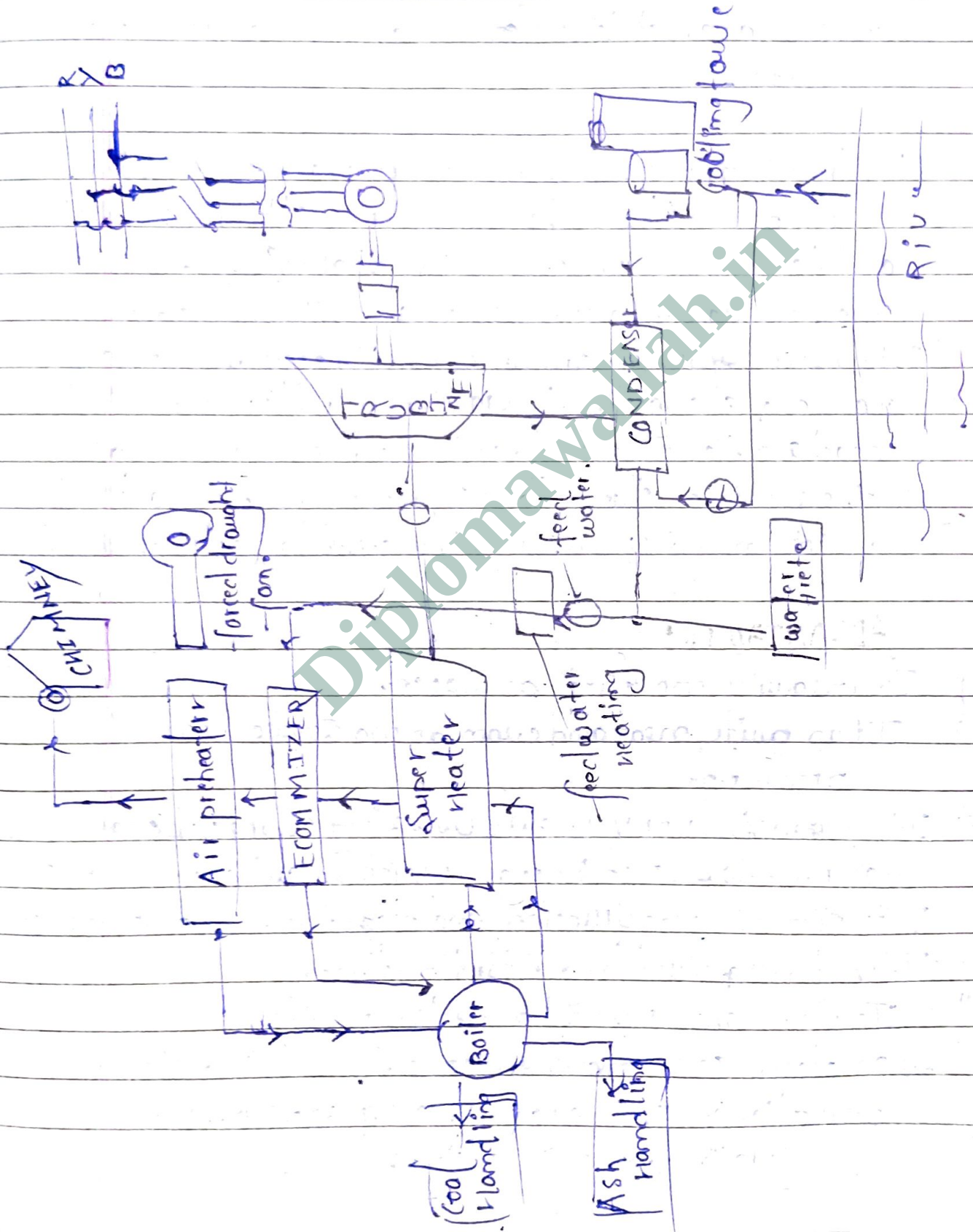
30% Efficiency

it mean that 100 calories of heat is supplied by them mechanical energy of 30 calaries will be auiliable at ~~the~~ turbine shaft and rest is lost.

50% of total heat combustion is lost in Condenser. The other heat loses occur in flume gases, radiation, ash etc

Overall effi. = $\frac{\text{Heat equivalent to Electrical output}}{\text{Heat of combustion of}}$

Overall efficiency = Thermal efficiency × Electrical efficiency



Hydro Electric Power Stations —

A generating station which utilises the potential energy of water at a high level for the generation of Electrical Energy.

Hydro-Electric power station is generaly located in hill areas where dams can be built conveniently and large water reservoirs can be obtained.
From the dam, water is led to a water turbine.
The water turbine captures the Energy in the falling water and change the hydraulic energy (ie, product of head and flow of water) into mechanical energy at the turbine shaft. The turbine drives the alternator which convert mechanical Energy into Electrical Energy.

ADVANTAGES —

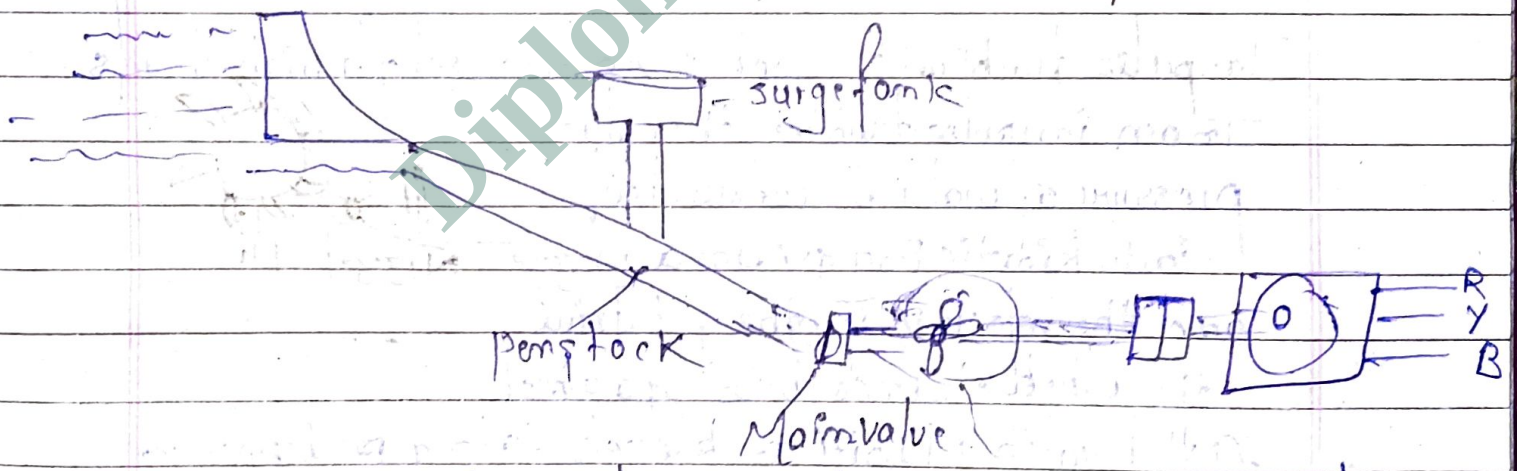
(i) It requires no fuel as water.
(ii) It is quite neat and clean as no smoke or ash is produced.
(iii) It requires very low running charge because water is source of Energy which is available free of cost.
(iv) It simple construction and requires less maintance.
(v) It not required long starting time.
(vi) It is robust and has a longer life.
(vii) Such plant serve many purpose. In addition to the generation of Elec. Eng. they also help in irrigation and controlling floods.

(viii) for operation, a few experienced person may do the job well.

DISADVANTAGES:-

(i) It involves high capital cost due to construction of dam.
(ii) There is uncertainty about the avilibility of huge amout of water due to dependeness on weather conditions.
(iii) Skilled and Experienced hands are requried to build the plant.
(iv) It requires high cost of transmission lines as the plant is located in hilly area which is quite away from the consumers.

Schematic Aragument of Hydro-Electric power station—



A dam is constructed across a river or lake and from the catchment are collects at the back of the dam to form reservoir.

from the value house water is taken to water turbine through a huge steel pipe known as penstock.

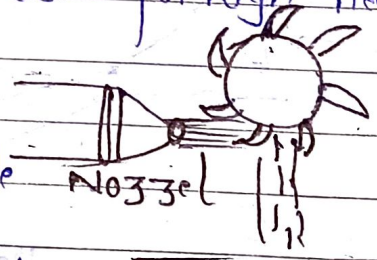
The water turbines converts hydraulic energy into mechanical energy. The turbine drives the alternator which convert to mechanical energy into electrical energy.

A Surge tank — (open from the top). is built just before the valve of house and protects the penstocks from bursting in case the turbine gate suddenly close. The surge tank absorbs this pressure swing by increasing in its level of water.

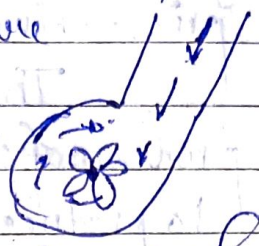
Water turbine — water turbines are used to convert the energy of falling water into mechanical energy.

(i) Impulse turbine (ii) Reaction turbine.

Impules turbines — such turbine used for high heads. In an impulse turbine, the entire pressure of water is converted into kinetic energy in a nozzle and the velocity of the jet drive the wheel. It consists of a wheel fitted with Elipitical buckets along periphery. The force of water jet strike the bucket on the wheels drives the turbine.



(ii) Reaction Turbine:- Reaction turbines are used for low and medium heads. In a reaction turbine, water enters the runner partly with pressure energy partly with velocity head.



(b) Kaplan turbine.

Francis turbine.

Diesel power station —

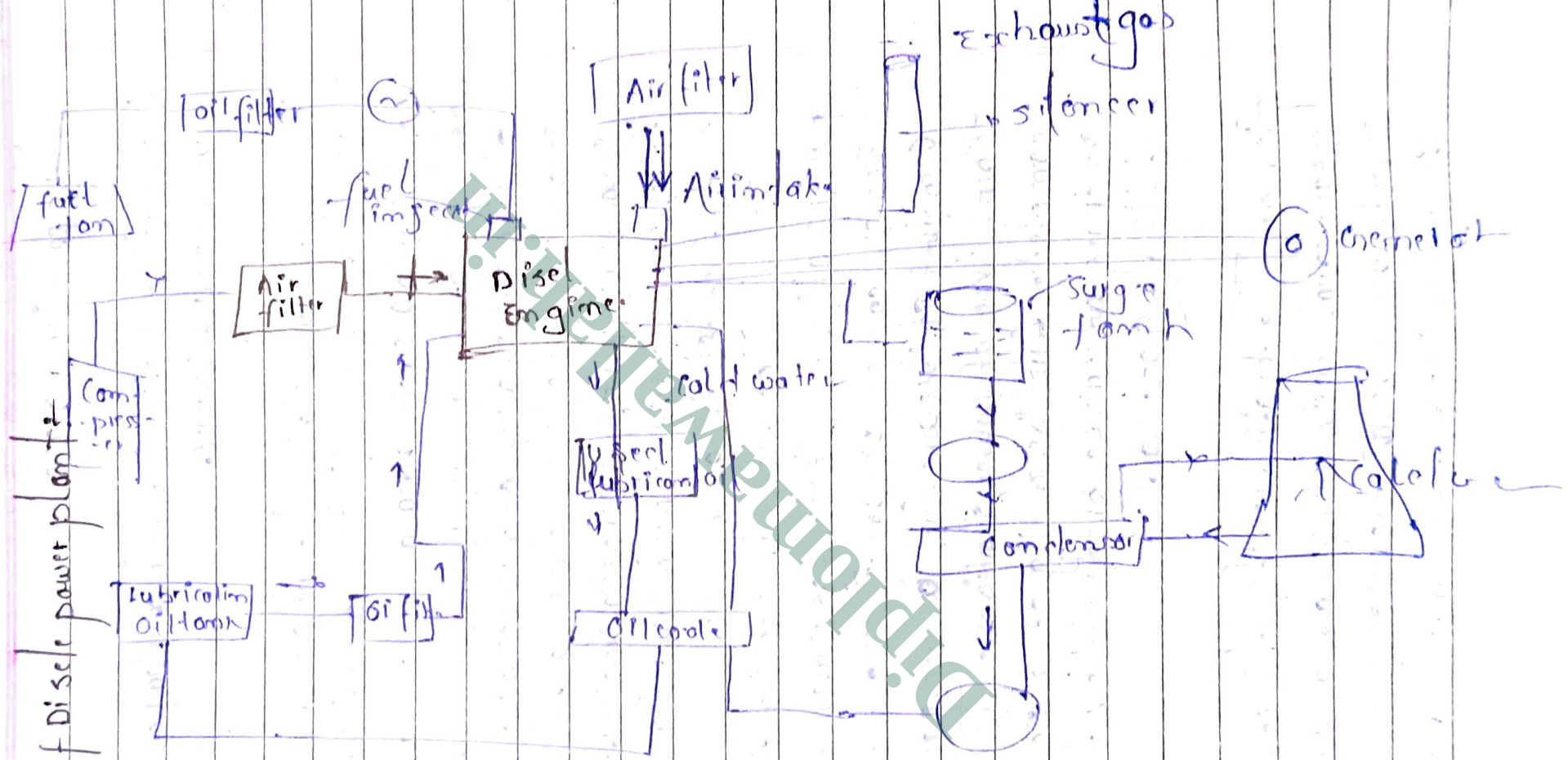
A generating station in which diesel engine is used as the prime mover for the generation of electrical energy.

The diesel burns inside the engine and the products of this combustion act as the working fluid". to produce mechanical the engine and the products of this combustion acts as the working fluid to produce mechanical energy. This diesel engine drives the alternator which converts mechanical energy into Electrical Energy.

Yet diesel power station are finding favour at places where power is less, sufficient quantity of coal and water is not available, and transportation facilities are inadequate.

Advantage:-

(i) The design and layout of the plant is quite simple.
(ii) It occupies less space.
(iii) It can be located to any place.
(iv) It can started quickly and can pick up load in a short time.
(v) There is no standby loses.
(vi) It requires less quantity of water for cooling.
(vii) It requires less operating staff.
(viii) The overall cost is much less than that of steam power station of the same capicity.


Layout of Diesel power plant
oil filter
fuel tank
fuel injector
Air filter
Air intake
exhaust gas
silencer
Diesel Engine
Air filter
Compressor
cal water
Diesel lubricant oil
lubrication oil tank
oil filter
Oil cooler
Surge tank
Condenser
Cooling tower

Nuclear Power Station—

A generating station in which nuclear energy is converted into Electrical Energy.

In nuclear power station heavy elements such as Uranium (U^{235}) or Thorium (Th^{232}) are subjected to nuclear fission in a special apparatus known reactor. The heat energy released is utilised in raising steam at high temperature and pressure. The steam steam runs to steam turbine which converts steam energy into mechanical energy. The turbine drives the alternator which convert mechanical energy into Electrical energy.

The most important feature of a nuclear powerstation is that huge amount of Electrical Energy can be produce from a relatively small amount of Nuclear fuel as compared to other conventional type of power stations. It has been found that complete fussion of 1kg of Ur can produce as much energy as can be produced by burning of 4,500 tons of high grade coal.

Fission— The breaking up of nuclei of heavy atom into two nearly equal parts with release a huge amount of energy is known as nuclear fission. The release of huge amount of energy during fussion is due to mass

defect, ie the mass of final product comes out to be less than initial product. This mass defect is converted into heat energy according to Einstein's reaction $E = mc^2$

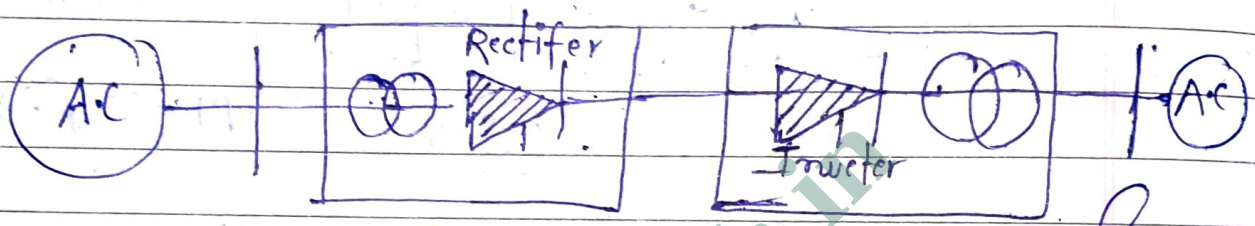
Advantage:-

(i) The am

HVDC

HVDC

AC power get as input to converter station that converted in to DC power by using rectifier in converter station and that d.c power transmites through overload line



The conversion from A.C to DC and D.C to A.C is done in HVDC converter.

Smoothing reactor - It avoid commutation failures in inverter and reduces the harmonics and avoid the discontinuous current.
Smooting reactor is oil field oil cooled reactor having a large inductance it is connected in series with converted before the DC filter.

- Smoothing reactor smooth the ripple in the direct current.
- It decrease the harmonics in dc lines
- They limit the fault current in dc lines.

Electrode -
Electrode is the conductor used to connect the system to earth.

DC Lines-
We transmite the power through over head line or cable to vrecieving end.

Reactive power Supply-

Reactive power is vrequried for the operation of converters More than 50% of total power of factive power capacitor is used for this.

The additional supply may also be obtain from shunt capacitor modifier and var compensator, the choice depends upon speed of control desired.

AC Filter - AC filter is the RLC circuit is connected between phase and earth they offered low impedance path to the harmonic frequency.

D.C Filter - is connected between the pole bus and neutral bus it diverts the harmonics to the Earth.

High frequency filter - hvdc converter may be produce the Electrical noise in the carrier frequency band from 20 khz to 490 khr.
it is use to minimized noise and interference in carriet Line communication
it con. to converter tansformer and station AC bus.

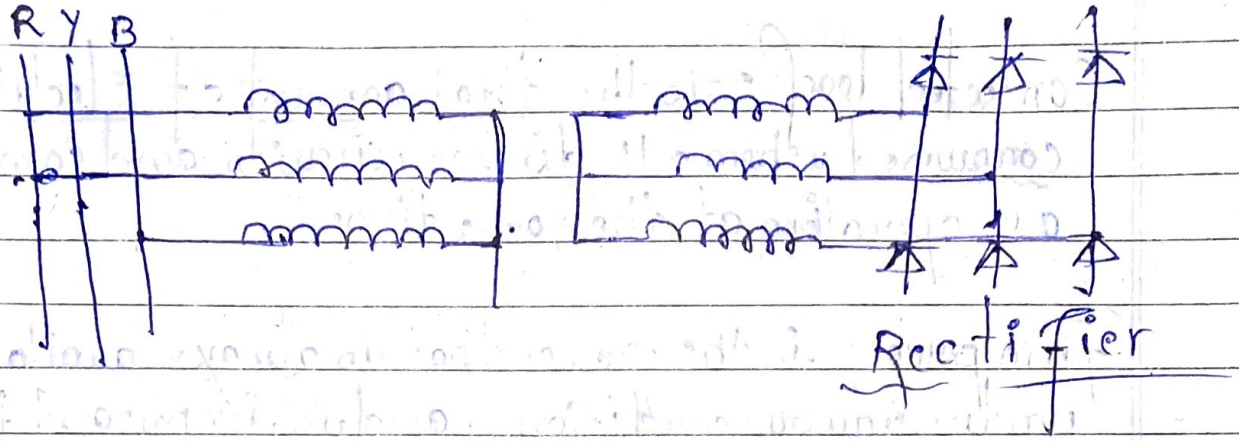
HVDC System pole—
hvdc system pole is the part of consisting all the equipment in hvdc sub station.

Type of HVDC System:

(1) Back to back HVDC :- System which transfers energy between AC buses and the the same location. in this system rectifier and inverter placed at same substation.

(2) Two termial HVDC :- The terminal with two converter station and one hvdc line ~~is called~~

(3) Multi Terminal ~~HD~~ HVDC :- This system has more than two converter station and dc terminal lines some of the converter station operates as rectifer while some of the converter station operates as inverter.



ECONOMIC of POWER GENERATION.

Connected load - is the total amount of Electricty consumed when all divices, circuits and component are operating at the same time.

Firm power - is the power that is always available, even under adverse conditions, and is important for the reliability of power generation.

Variable load on power system -
The load on a power station varies from time to time due to uncertain demands of the consumers.

(i) Need of additional equipment:
(ii) Increase in production cost.

Load curves - The curve showing the variation of load on the power ~~sat~~ station with respect to time.

Average load = Area (in kwh) under daily load curve / 24 hour

Load factor = Average load / Max. demand

→ The load curve help in selecting * The size and number of generating units.

→ The load curve helps in preparing the operation schedule of the station.

Important terms and factors —

Demand factor — It is the ratio of maximum demand on the power station to its connected load.

$$\text{Demand factor} = \frac{\text{Maximum demand}}{\text{Connected load}}$$

Average load — The average of load occurring on the power station in a given period.

$$\text{Daily average load} = \frac{\text{No. of units generated in a day}}{24 \text{ hours}}$$

$$\text{Yearly average load} = \frac{\text{No. of units generated in year}}{8760 \text{ hours}}$$

Load factor — The ratio of average load to the maximum demand during a given period.

$$\text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}}$$

$$= \frac{\text{Units generated in T hours}}{\text{Max. demand} \times T \text{ hour}}$$

Diversity factor — The ratio of the sum of individual maximum demands to the maximum demand on power station.

$$\text{Diversity factor} = \frac{\text{Sum of individual max. demands}}{\text{Max. demand on power station}}$$

(viii) Plant capacity factor —

$$= \frac{\text{Actual Energy produced}}{\text{Max. Energy that could have been produced.}}$$

$$= \frac{\text{Average demand}}{\text{plant capacity.}}$$

Reserve capacity = Plant capacity − Max. demand.

Plant use factor — It is the ratio

$$= \frac{\text{station output in kwh}}{\text{plant capacity} \times \text{Hour of use.}}$$

Unit generated per annum.

$$= \text{Max. demand} \times \text{L.F.}$$ (L.F. : load factor.)

Based load — The unvarying load which occur almost the whole day on the station is known as base load.

Peak load — The various peaks demands of load over and above the base load of the station.

Units Generated per Annum —

Load factor = $\frac{\text{Average load}}{\text{Max demand}}$

Average load = Load factor × Max. demand

Units generated/annum = Average load × Hour in year

= L.F × max. × Hour in year.

daily load curve — Operation

Monthly load curve — billing.

Yearly load curve — planning.

Daily Average load = $\frac{\text{Gen. Units (KWh) per day}}{24 \text{ hour}}$

$\frac{\text{Area under load curve}}{\text{curation.}}$

8760 hour

PUF = $\frac{\text{Max. demand}}{\text{plant capicity.}}$ capacity > max. demand

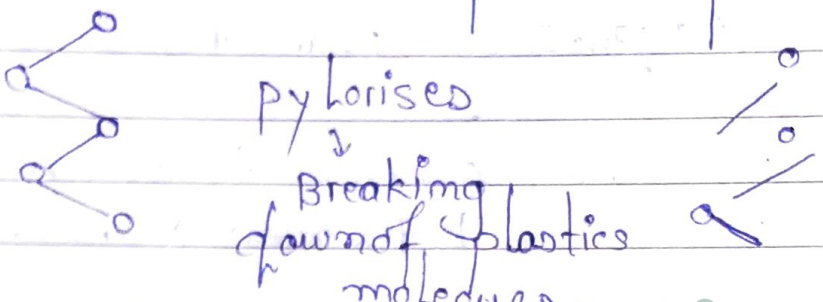
DF = $\frac{\text{Sum of individual max. demand}}{\text{Max. concurrent Demand}}$

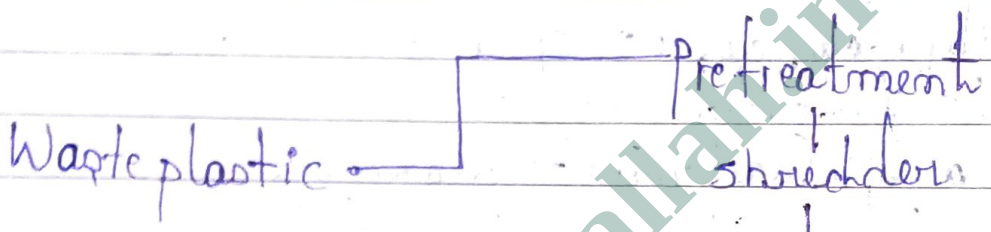
D.F > 1, as high as possible.

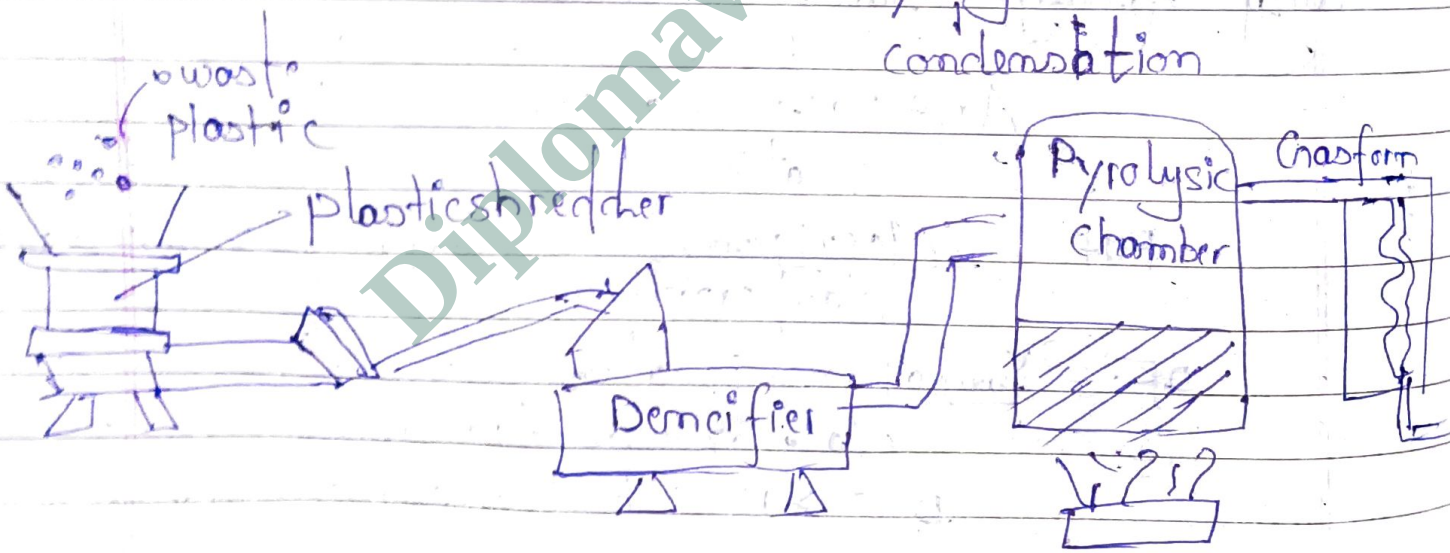
Reserve cap. = plant capacity − max. demand.

How plastic is turn into fuel.

The frequency at which molecules vibrates is Directly proportional to the temperature of molecules.







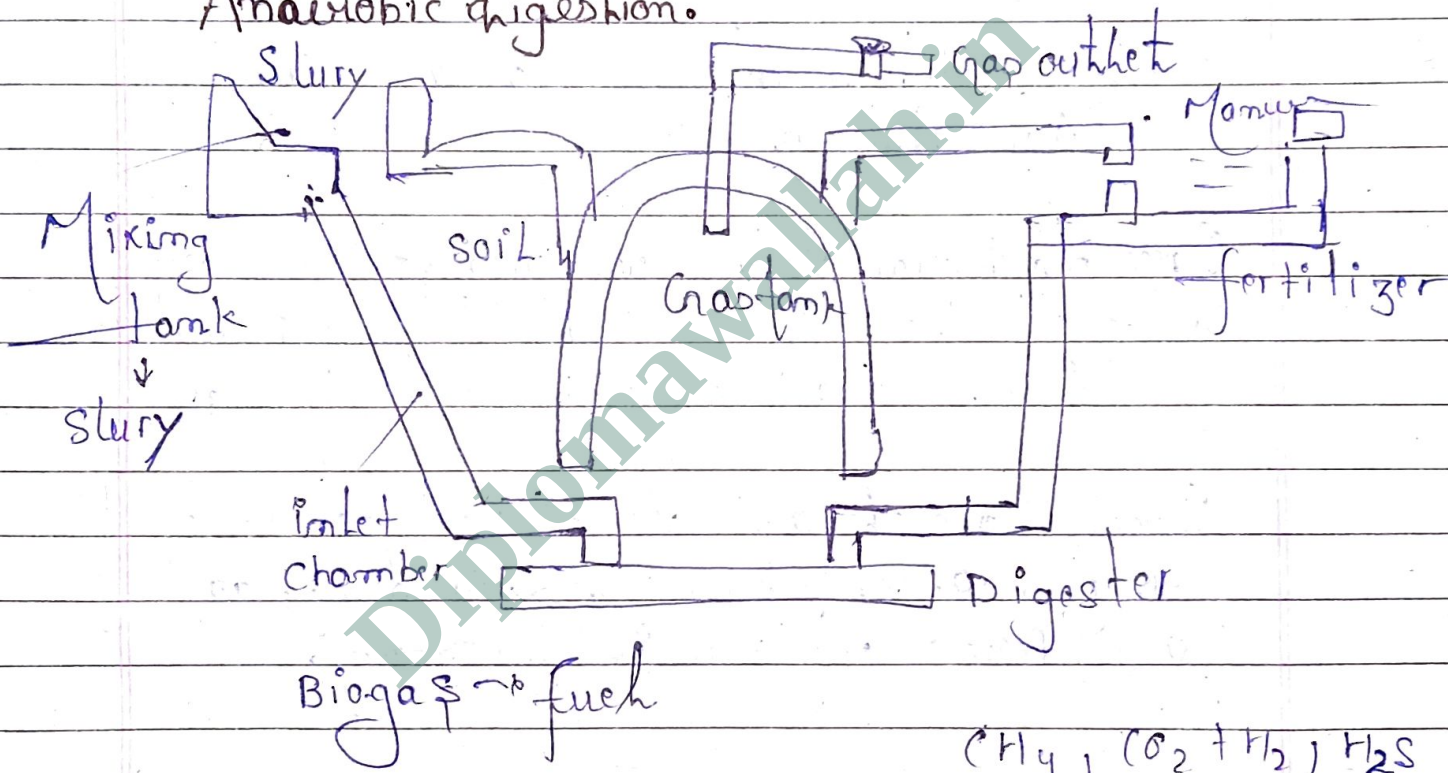
Pyrolysis is an energy consuming process more Energy has to be put into treat the waste than can actually be recovered.

Biomass -

is defined as living matter or it's residues are is a renewable source of Energy.

Example
- Agricultural and forest residues.
- Carbonaceous waste.

Anaerobic digestion.



Advt.
- No destruction take place for construction
- No harmful gas is evolved in large amount.
- It's initial cost is very low.
- It's not require high skilled labour for maintances.

When human waste and organic waste are fragmentation in tank without presence oxygen it produce large amount fuel gas like (Methane, Ethanol). CO_2, H_2 + H_2S

Biogas → 75% CH_4 (Excellent fuel).

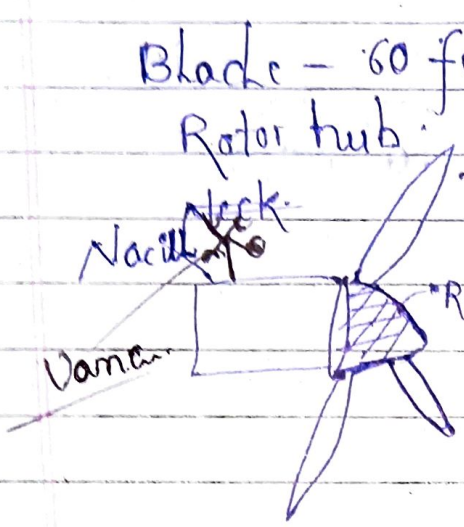
Spent slurry is also used as a manure in Agriculture activities.

Green plants trap solar energy through the process of photosynthesis & convert it into organic matter. This organic matter is known as biomass.

Wood, charcoal, agricultural waste produce the bio-energy after burning & cowdung, garbage are decomposed to obtain the energy.

Wind Trubine

Blade – 60 feet

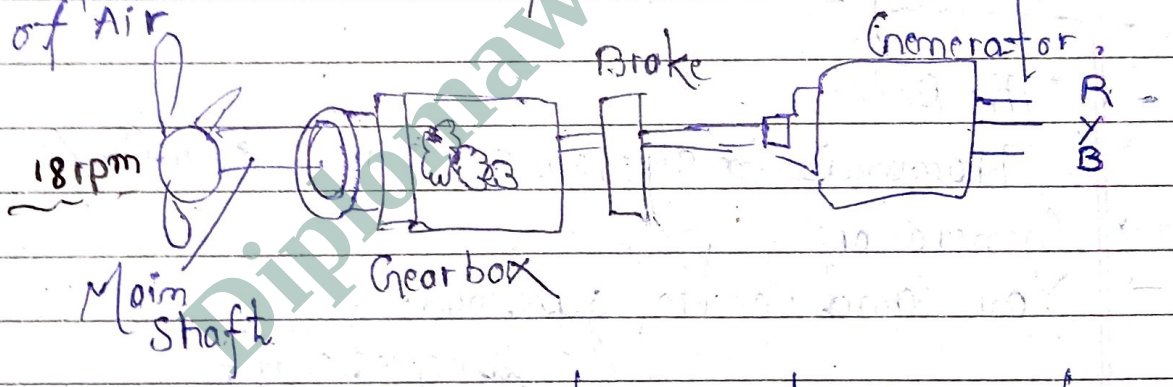


Blade of wind trubine is connected with rotor hub.

Gear box – funtion of Gear box convert low into high RPM.
RPM

RPM → 1 : 90

Speed → 11 → 90km/hr.



Yawing

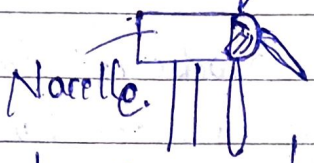
The wind power plant is used for generation of Electric power with the help of wind trubines. Wind trubine is a device that converts kinetic Energy from the wind into Electric power.

Wind Energy is created when the atmosphere is heated unevenly by the sun in day and night, some patches of air become warmer than other.

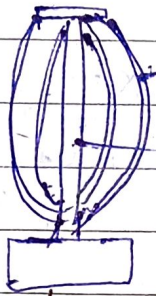
These warm patches of air rise, other air rushes in to replace them – thus, wind blows.

Types of wind trubine.

(1) Horizontal axis wind trubine

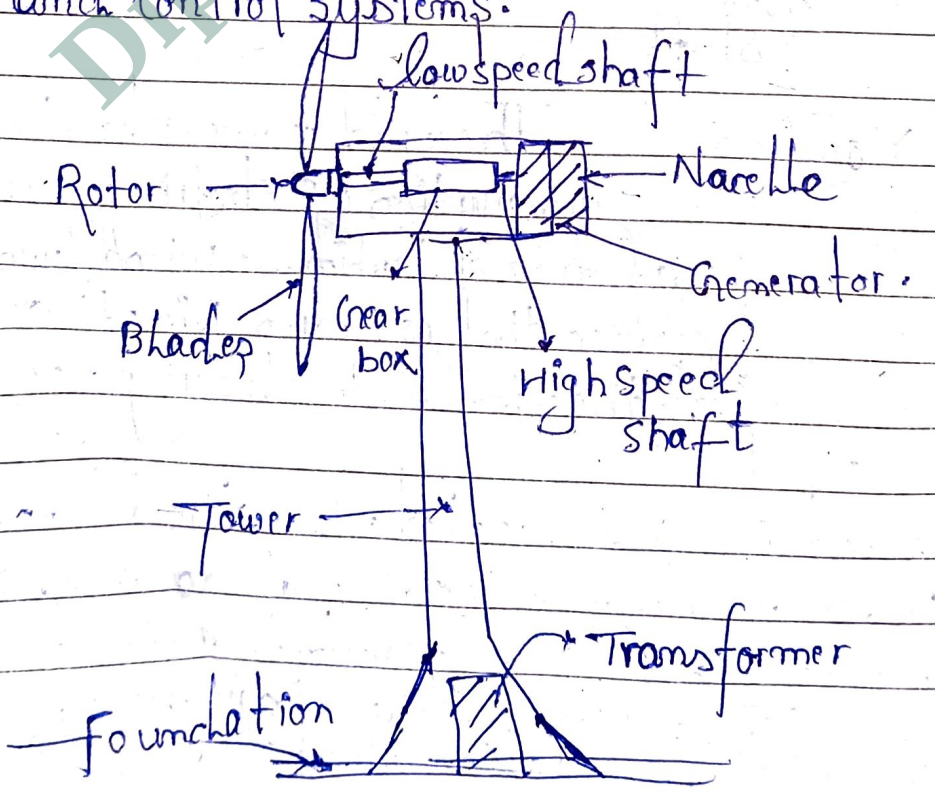


(2) Vertical axis wind turbines



Parts of wind trubine -

- The Rotor.
- Transmission system = Shaft, Gear box, high speed shaft
- Generator
- Yaw and control systems.

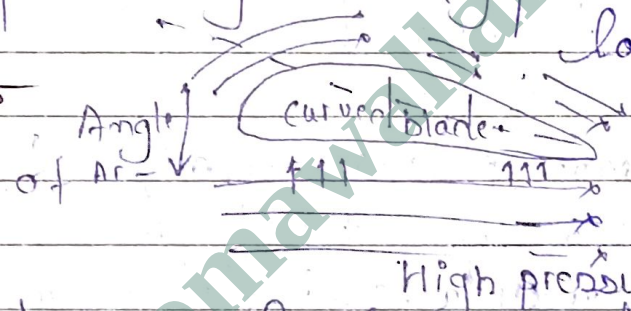


Tower – Made from tubular steel, concrete, or steel lattice. Supports the structure of the turbine.

Nacelle – It is placed the top of tower and contains the gear box, low- and high speed shafts, generator, controller and brake.

Rotor – The rotor consists of the hub three blades and a pitch regulation system.

Blades –



The blades are made of air foils design, which depends on aerodynamic lift to move the blades and cause rotation.

Gearbox – Connects the low-speed shaft to the high-speed shaft and increase the rotational speeds from about 30 - 60 rpm to about 1,000 - 1,800 rpm.

High-speed shaft – the mechanical power generated by the rotor blades is transmitted to the generator by the high-speed shaft.

Yaw and control systems:- The yaw system turns the nacelle into the actual wind direction using a rotary actuator and a gear mechanism at the top of the tower.

Anemometer:- Measures the wind speed and transmits wind speed data to the controller.

Wind vane:- Measures wind direction and communicates with the yaw drive to orient the turbine properly with respects to the wind.

Pitch System:- pitch system adjust the ~~pi~~ blade angle by rotating them so that they use the right amount of the available wind energy to get the most power output.

Brake:- They are used for holding the turbine for maintenance or repair or in case of extreme wind speed conditions.

Advantages:-

- Energy for free of cost.
- Produces electricity throughout the day
- Pollution free and clean.
- Vast wind energy is available
- Wind energy is a renewable source of energy.

Disadvantage-

- → The wind is inconsistent
- → Wind turbines involve high capital investments
- → May reduce the local bird population.
- → Installation can take up a large portion of land.
- → Wind turbines are only suited to particular region.

	HORIZONTAL Axis Wind Turbine	Vertical Axis Wind turbine.
1.	In this turbine, the shaft is mounted horizontally parallel to the ground.	In this turbine, the shaft is mounted on a vertical axis perpendicular to the ground.
2.	They use tower for support	They use guy wire for support.
3.	Gear box and generator mounted above the ground on a tower	Gear box and generator are mounted at ground level.
4.	Installation and maintenance are difficult as the equipments are at height.	Easy installation and maintance as all the equipments are at ground level.
5.	Yaw machine is required to align the blades to face the wind.	Yaw mechanism is not needed as the rotor rotates for any wind direction.
	Energy output is more	Energy output is less.

Transmission and Distribution

AC Transmission :- The conveyance of Electric power from a power ~~sat~~ station to consumer's.

Three principal components of power supply :-

(i) The power station
(ii) transmission line
(iii) Distribution.

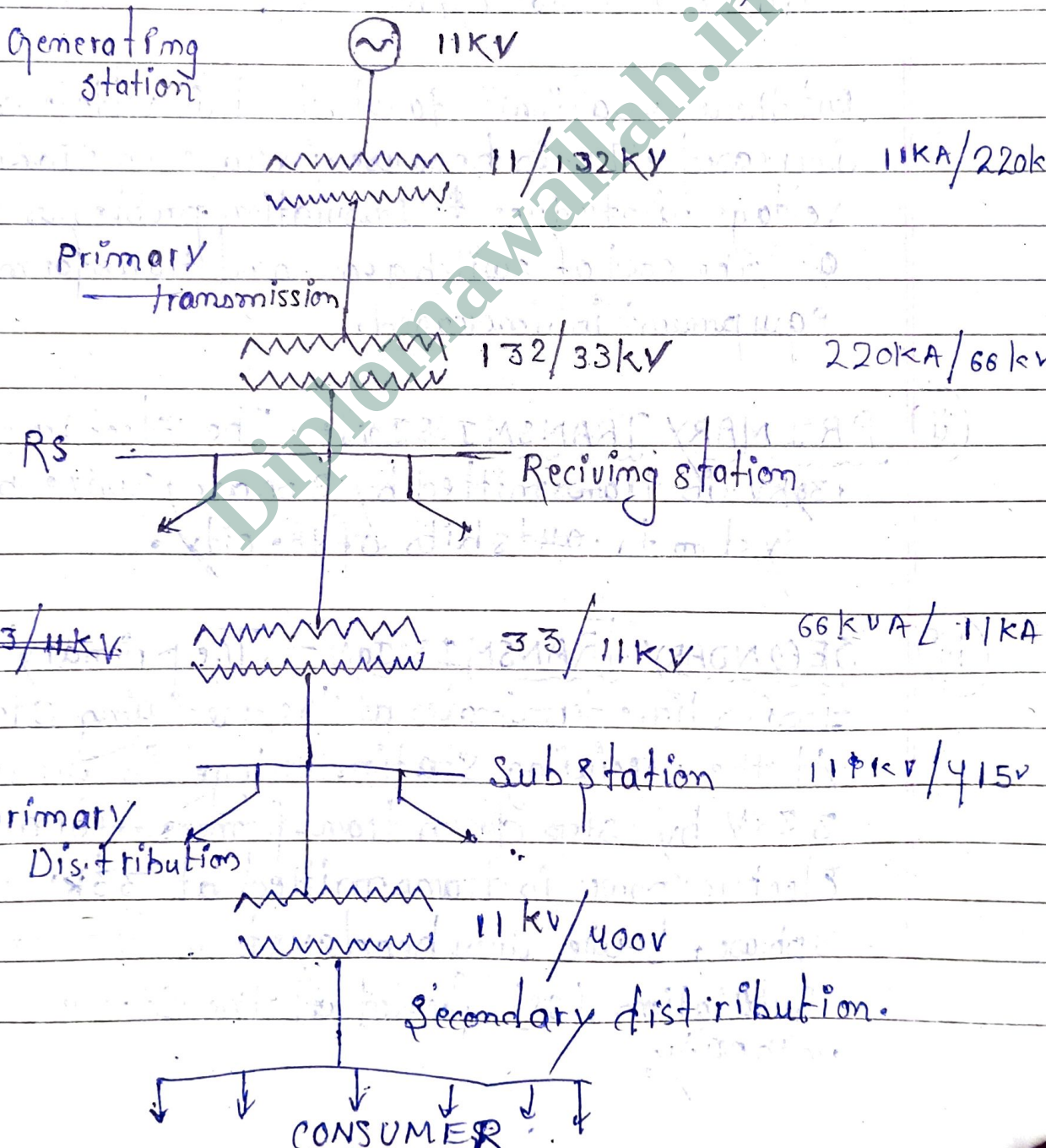
Electric power is produced at the power station, which are located at favourable places, generally quite away from the consumers. That why it requires to transmission of Electric current to the consumers.

The underground system is more expensive than the overhead system. Therefore in our country it is mostly adopted for transmission and distribution of Electric power.

A.C TRANSMISSION

The large network of conductor between the power station and the consumers can be broadly divided into two parts viz, transmission system and distribution system.

- Primary transmission
- Secondary transmission.



(i) Generating station :- Where Electric power is produced by 3-phase alternator operating in parallel. The usual generation voltage is * 11KV. For economy in transmission of Electric power, the generation voltage (ie, 11KV) is step with help of transformer upto 132 KV. The transmission of Electric power at high voltages has several advantages including the saving of conductor material and high transmission Efficiency.

But there is a limit to which this voltage can be increased. It is because increase in transmission voltage introduce Insulation problems as well as the cost of switchgear and transformer equipment is increased.

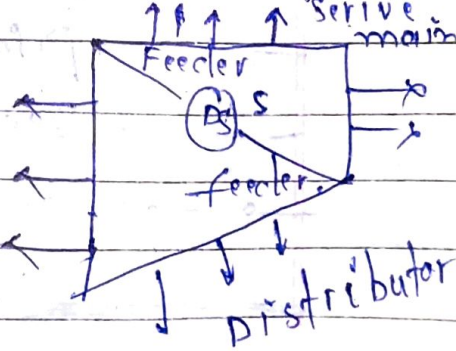
(ii) PRIMARY TRANSMISSION :- The Electric power at 132KV is transmitted by 3 phase, 3 wire overhead system to outskits of the city.

(iii) SECONDARY TRANSMISSION :- The primary transmission line terminates at the reciving station. At the reciving station voltage is reduced to 33 kV by step down transformers. form this Electric power is transmitted at 33kV by 3 phase, 3-wire overhead system to various substation (SS) located at the strategic point in the city.

v) PRIMARY DISTRIBUTION :- The secondary transmission line terminates at the substation (SS) where voltage is reduced from 33KV to 11KV, 3phase, 3wire. The 11KV lines run along the important road sides of the city. This forms the primary distribution distribution.

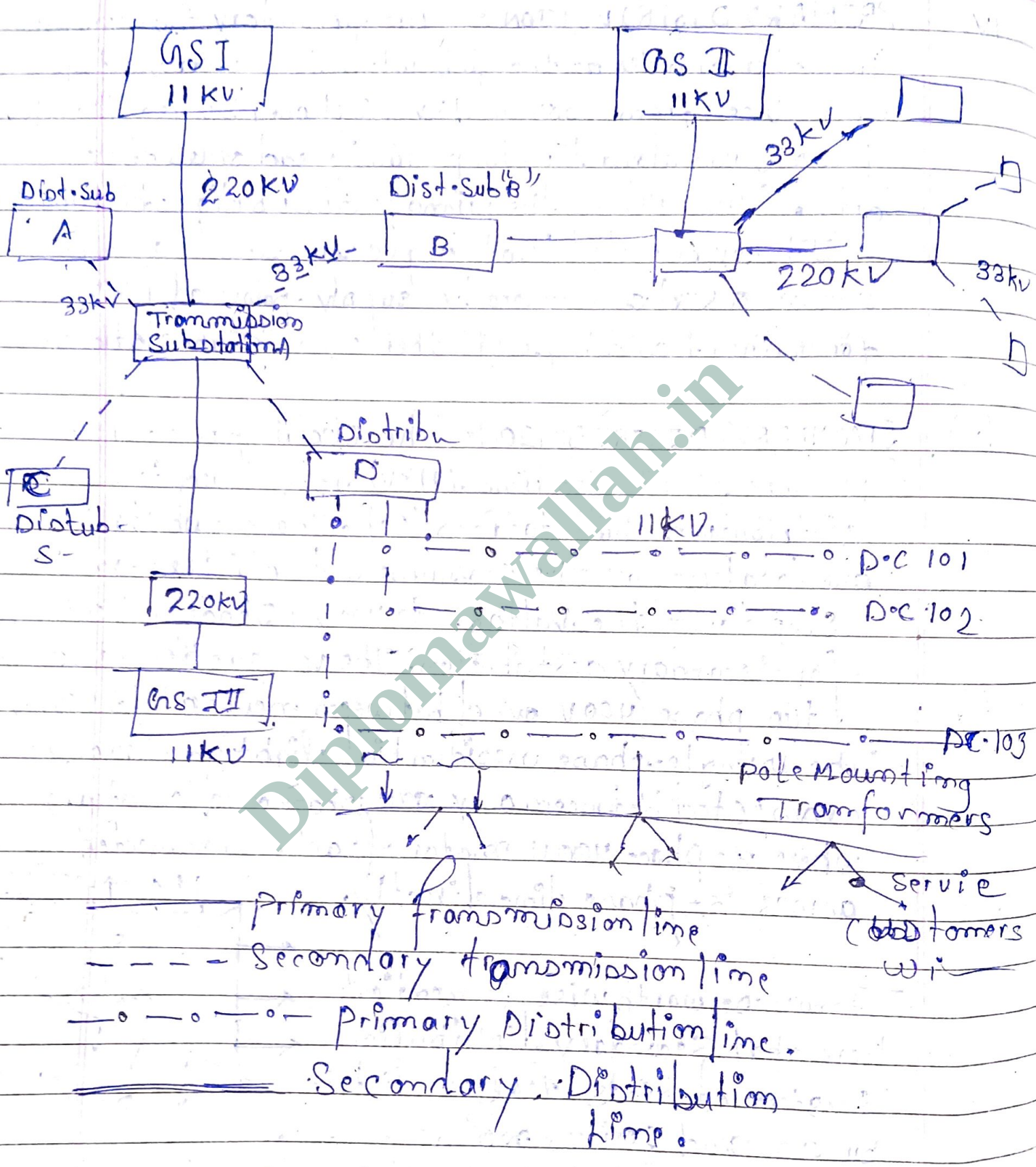
It may be noted that big consumers (having demon 50KW) are generally supply power at 11KV for further handing with their own sub-stations.

v) SECONDARY DISTRIBUTION- The electric power from primary distribution line (11KV) is delivered to distribution Sub-stations (DS). These substation are located near the consumers localities and step down the voltage to 400V, 3phase, 4 wire for secondary distribution. The voltage between any two phase 400V and between neutral is 230V. The single-phase residential lighting load is connected between any one phase and Neutral, where 3-phase 400V motor load is connected across 3-phase line directly.



It may be worthwise to mention here that secondary distribution system consists feeder, distributors and serives mains.

Show the elements of low distribution System.



Comparision of DC and AC Transmission —

DC transmission — for some year past, the transmission of Electric power by DC has been receiving the actives consideration

Advantage of high voltage DC transmission.

(i) It required only two conductors as compared to three ~~from~~ for a.c transmission.

(ii) There is no inductance, capacitance, phase displacement and surge problem.

(iii) Due to the absence of inductance, the voltage drop in a D.C transmission line is less.

(iv) There is no skin Effect in dc system. Therefore Entire cross-section of the line conductor is utilised.

(v) The potential stress on the insulation is less in case of D.C system than that in A.C system.

(vi) A, DC line has less corona loss and reduced interference with communication circuit.

(vii) free from the dielectric losses particulary in case of cable.

Disadvantage:—

(i) Electrical power cannot be generated at high dc voltage; due to communication problems.

(ii) DC voltage cannot be stepped up for transmission

(iii) DC switches and circuit breaker have its own limitation.

A.C transmission – Nowa day, Electrical Energy is almost exclusively generated transmitted and distributed in form of A.C.

Advantages:-

(i) The power can be generated at high voltage.
(ii) The maintenance of A.C substations is easy and cheaper.
(iii) The A.C voltage can be stepped up or stepped Down by transformer with ease and Efficency.

Disadvantages.

(i) An A.C line requires more copper than D.C line.
(ii) The construction of A.C transmission line is more complicated than D.C transmission line.
(iii) Due to skin Effect in AC system, the Effective resistance of line is increased.
(iv) An A.C line has capacitance. Therefore there is a continuous loss of power due to charing current Even when line is Open.

$V = IR$

Advantage of High transmission line.

(i) Reduced volume of conductor material. It can be proved that the greater the transmission voltage, the lesser is the conductor material required.

(ii) Increase transmission efficiency.
(iii) Decrease percentage line drop.

Limitions of High voltage transmission.

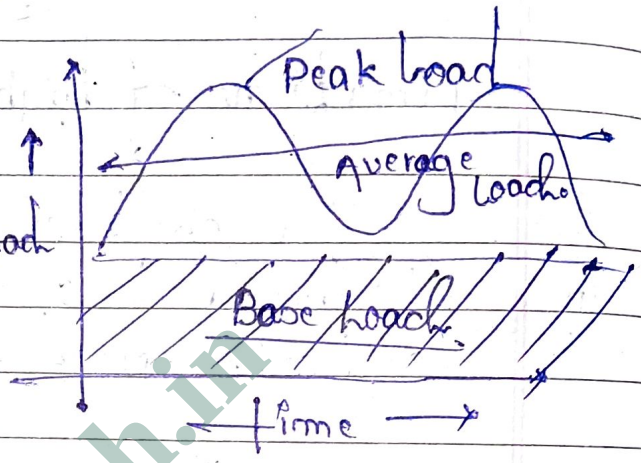
(i) the increased cost of insulating the conductor.
(ii) the increased cost of transformers, switchgear and other terminals.

Economics of power Generation-

Types of power plants-

→ Base load plants.
- Nuclear power plant.
- Coal power plant
- Wind and Solar power.

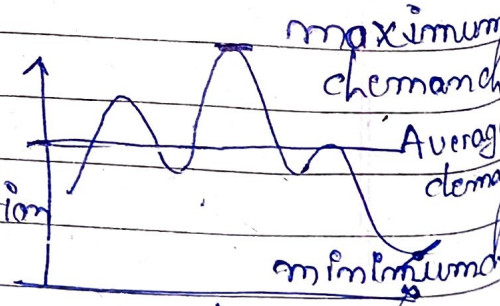
→ Peak load plants.
- Gas power
- ~~Solar power plants.~~
- ~~Wind turbines~~ / Pump storage.
- ~~Disc~~ Diesel generators
  - → they must be quickly starting power on demand.
  - → More Expensive.



Load characteristics.

→ Connected load — It sum of continuous power rating of all loads connected in power system.
  - → load can be OFF or ON.

Maximum demand
It is the peak of load curve over the entire duration



Minimum Demand — lowest point on load curve represents minimum demand.

Demand factor = $\frac{\text{Maximum demand}}{\text{Total connected load}}$

* Since all loads cannot be operate at same time so maximum demand is less than connected load.

→ * Demand factor < 1

Average load.

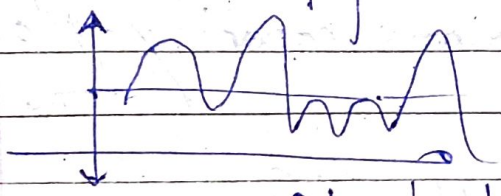
Daily Avg. load = $\frac{\text{Gen. units (kwh.) per day}}{24 \text{ hours.}}$

→ for month → 30×24 hours.

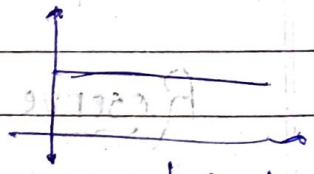
→ for year = 365×24 hours.

Load factor = $\frac{\text{Average load}}{\text{Maximum demand}}$

Load factor < 1



Load factor = 1



→ Fluctuating curve : max↑ capicity↑ capt↑

Plant utilization factor = $\frac{\text{Maximum demand}}{\text{plant capacity.}}$

* it tells how well the capacity of a plant gets utilized.

Diversity factor = Actual load / Maximum Demand

Eg. 6am - 12pm
P_{max} = 100 MW

8pm - 6am
P_{max} = 80 MW

12pm - 8pm
P_{max} = 200 MW

Diversity power = $\frac{100 + 200 + 80}{200}$

Diversity factor = 1.9 > 1

it shows how divide the demand is throughout the day.

Power use factor = Power Generated / max power that could be generated

Station output / plant capacity × hours of use

Reserve capacity = plant capacity - Max. demand.

Capacity factor = Average demand / plant capacity.

= avg. / max × max / capacity

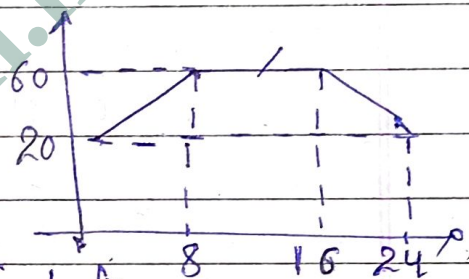
= load f.c. × utilization factor.

- Utilization factor = $\frac{\text{maximum (kW)}}{\text{capacity (kW)}}$

- Capacity factor = $\frac{\text{average (kW)}}{\text{capacity (kW)}}$

- Use factor = $\frac{\text{Energy gen (kWh)}}{\text{capacity} \times \text{Servies hours}}$

plant use factor = 0.6.



Fixed cost — independent of max demand and unit Generated.

Energy Generated per year.
= Average load × 8760 (24×365)

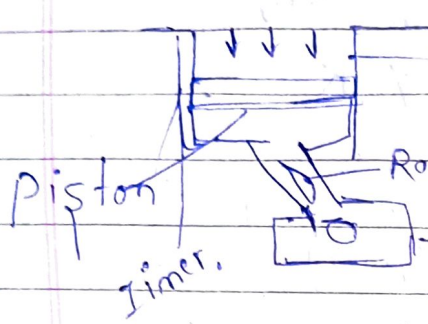
Total annual cost
= Interest × Energy Generated + other cost.

Overall Efficency = $\frac{\text{Electricity Generated}}{\text{Heat is consumb.}}$

Heat produce = a fomount of substance × calorific value.

$\eta_{Thermal} = \eta_{boiler} \times \eta_{trubine}$.

Disel Engine



Distance travel by piston is called stock.

(1) Intake / Admission Stock
(2) Compression stock
(3) power / combustion Stock
(4) Exhust Stock.

CC = Volume between TDC and BDC

320 cc bullet
1600 cc car = 1.6 Liter.
1400 cc.
CC Volume