GTS
N.S.PUR, CUTTACK

GURUKRUPA TECHNICAL SCHOOL

Narasinghpur, Cuttack

Lecture Notes

On

POWER PLANT ENGINEERING

6th Semester

DEPARTMENT OF

MECHANICAL ENGINEERING

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POWER PLANT ENGINE

Power plant :-

To set of the plant to Produce electricity is known as power plant.

Energy :-

The capacity of during work

Power :-

The rate of during work is known as power.

Sources of energy :-

There are various sources of energy.

(i) fuel.
(ii) energy storred in water.
(iii) Nuclear energy.
(iv) Wind energy
(v) Solar energy.
(vi) Tidal power.
(vii) geo-thermal energy.
(viii) Thermo electric power.

Fuel :-

→ fuels maybe chemical or nuclear.

→ A chemical fuel is a substance which Relises heat energy or Combustion.

→ The major combustible element of each

fuel carbon and hydrogen.

Classification of fuel:-

(i) The occurred in nature called Primary fuels. Or prepare fuels are called secondary fuel.

(ii) There in solid, liquid, Gassious state.

* Solid fuel:-

Cole:-

→ It's the main consituents of carbon, hydrogen, oxygen, Nitrogen. moisture and ash.

Peat:-

→ It's the first stage peat in the formation of cole from wood.

→ It containes huge amount of moisture there fore it's dried one to two month before it's fuse.

→ It's used as a domestic fuel in 'Urop' and the power generation in 'Rusia'. But in India it doesn't come catagories of good fuels.

Lignite and Brown cole:-

→ These are intermidiate state bet peat and cole. It containes high ash, high moisture and low heat containes.

→ The break easily.

→ The burn in a smoki flame. so it's used in local use only.

Bituminous cole:-

→ It Burns with long yellow and smokiflame and has high persentage of volatile matter.

→ The Avg. calorific value about 33,500KJ/kg

* There are 2 types.
    - (i) coking Bituminous cole.
    - (ii) non-coking Bituminous cole.

Semi-Bituminous cole:-

→ It's softer than the anthracite.

→ It burns with very small amount of smoke.

→ It containes 15% to 20% volatile matter.

Semi-Anthracite cole:-

→ It has a less fix carbon and gives out longer and more luminious flame when burn.

Anthrasite:-

→ It has a very hard Cole.

→ It ignite slowly unless the fornes temp. is high.

→ It burns either with is very short blue flame.

→ The calorific value is high. 35,500 KJ/kg

Wood charcol:

→ It's optained by destroptive distilation of wood.

→ During this process the volalite matter and water are a speled.

→ It depens open the rate of heating and temp.

Coke:

→ It consist of carbon, mineral with about ~~1~~ 2 % sulphur and small quantities of Hydrogen, Nytrogen & Phusphorous.

→ It's smoke less and clear fuel and can be produced by several process.

→ It's mainly used blast furnes to produced heat & same time ~~it~~ to reduce the iron ~~ore~~. ~~Coke~~ Cole.

Briquettes :-

→ These are Prepaired from high coke or coke by compressing the material under high Pressure.

Analysis of Coke :

→ There are 2 types of analysis is done in the coke.

(i) Proximate Annaylis

(ii) Ulti-mated Annaligsis.

(i) Proximate Annalysis :

→ In Proximate annalysis individual elements are not determind only determine Percentage of Moisture, volatile matter, fixed Carbon & ash.

→ These annalysis used only commercial.

(ii) Ulti-mated Annyalisis :

→ In U.M Annyalisis the Percentage of various element are determine.

→ These type of Annyalisis used for combution used only.

* Properties of coke :-
   (i) Energy contained and heating value.
   (ii) Sulphure contained.
   (iii) Burning charateristic.
   (iv) Going ability.
   (v) Whether ability.
   (vi) Air sustaining temperature.

→ A good coke should have low air containe and high chalorific value.
   → Small percentage of sulphur less than 1 %.
→ Good burning charateristic so that the combution is completed.
→ High going ability.
→ High wheather ability.

Liquid fuels :-
→ Liquid fuels is Paetroolium. Which is optained from wells under the earth cust.

Comparision bet solid fuel & Advantage.

- Require less space for storage.
- High calorific value.
- easy control of consumption.
- Staff economic.
- No Ash Problem.
- easyli handling & transporting.
- Absence of danger from spontanious condition.

Petrolium:-

→ It consist of a mixture of gases, liquids and solid hydro carbon with small amounts of Nydrogen and sulphur compounds. (Assam, Gujurat) sources of India.

→ Petrol can be made by polimorision & refinaisation gases.

* Composition of some common liquid fuels:

fuel	carbon	Hydrogen	Sulphur	Ash
(1) Petrol.	85.5%	14.4%	0.1%	0
(2) Benzene	91.7%	8%	0.3%	0
(3) Kirosine	86.3%	13.6%	0.1%	0
(4) Disel oil	86.3%	12.8%	0.9%	0
(5) Light fuel oil	86.2%	12.4%	1.4%	0
(6) Heavy fuel oil	88.3%	9.5%	1.2%	1

* Important Properties of liquid fuel :-

(i) Specific gravity.
(ii) flash point.
(iii) fire point.
(iv) Sulphur contained.
(v) Volatility.
(vi) Viscosity.
(vii) Ash containe
(viii) Heating value.
(ix) optained Number.
(x) cetend Number.

* Gasious fuel:-

Natural gas:-

→ Main constituent of Natural gas (Methane - CH_4) (Ethane C_2H_6)

→ It's calorific value 21,000 KJ/m^3.

→ It's used for internal combustion engine

Cole gas:-

→ Main consituent of Hydrogen, carbon-monoxide, & hydro carbon.

→ It's Preparied by carbonition of coke.

→ It's used in boilers & commercial ~~Propores~~ Purposes.

Producer gas:-

→ It's the Partial oxidation of cole, coke or peat. when there burnt insefficent quantity of Air.

→ It's low heatting value.

→ It's used in steel industries for firing open hearth furnes.

* Advantages of Gases fuel:-

→ Better control of combustion cleanlines.

→ No problem of stores of the supply available from public supplier.

→ Economic in fuel and more efficiency.

→ Easy mentanance of oxydising or reducing Atomsphere.

* Important Properties of gasious fuel:-

(i) Heating value or calorific value

(ii) viscosity & density

(iii) Specific gravity.

* Central power plant and captive power plant.

C.P.P:- In captive power plant run by manufacturing company. and It's out put is not available for general call.

→ It's used for own ~~per propose~~ Purpose.

→ Captive power plant is also know as Industrial power plant.

Ex: "NALCO".

Central power plant:-

→ In central power plant the electricity available is meant for general sell to the customer or electricity boards who which to purches it.

Ex: power plant runs by "NTPC".

* Principle types of power plant:-

(i) Steam plants using coal oil or nuclear fision

(ii) Internal combustion plant.

(iii) Gas turbine plant.

(iv) Hydro electric plant.

Steam Power Plant:-

→ In steam power plant chemical fuel of fussifuel (coke, oil, gas) convert in to Mechanical or electrical energy.

→ It's main Purpose to Produce electricity.

→ To Produce Stream for industrial Propose beside Producing electric power.

* Classification of Stream power plant.

The steam Power plant may be classified

(i) Central Stations.

(ii) Industrial power stations.

(captive power Stations)

(i) Central Stations:-

→ The electrical energy available for there Station is Meet for general sell to the Customers which to Purches It.

(ii) Industrial Power Station:-

→ These type of power Station is run by a manufacturing company for it's own use and it's out put is not available for general sell.

* Normally these plant are non-condensing, because a large quantity of steam is required for different manufacturing process.

* Layout of Steam power plant.

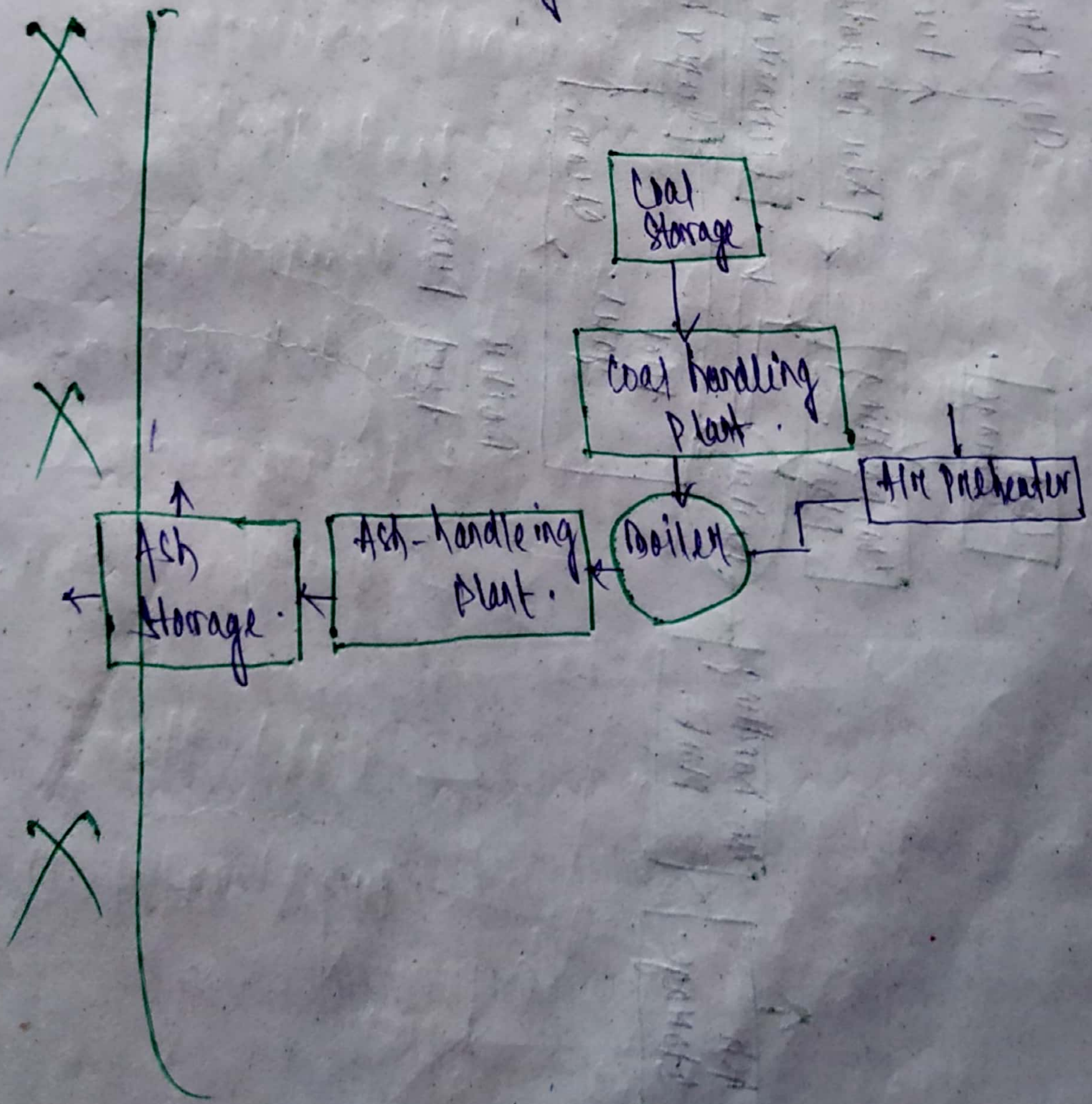
The steam power plant comprises four ckt.

(i) Coal and ash ckt.

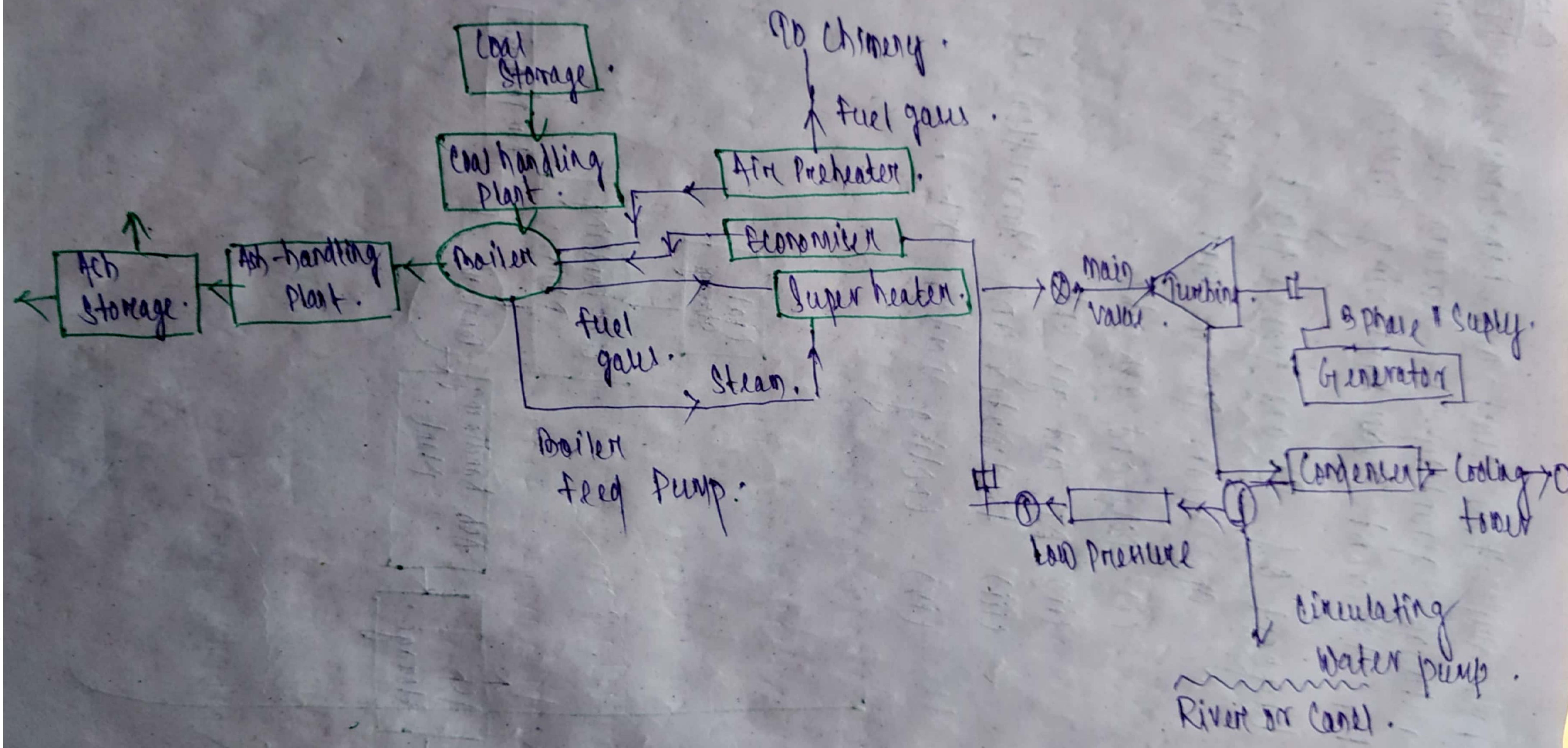
(ii) Air and gas ckt.

(iii) Feed water and steam flow ckt.

(iv) Cooling water ckt.



Lay out of Steam power plant



Feed water and Stream Flow Ckt:-

→ In the water and stream ckt condenset living the condenser is first heated in a flows feed water heater through extrated stream from the lowest pressure extration point of the turbine.

Cooling water ckt:-

→ The cooling water supply to the condenser helps in maintaing a low pressure.

→ The water may be taken from a natural source such as river, lake or sea.

* Componets of a Modern Stream Power Plant

(i) Boiler. (Super heater, economiser)

(ii) Steam turbine. (~~Deaerator~~

(iii) Generator.

(iv) Condenser.

(v) cooling Tower.

(vi) circulating water pump.

(vii) Boiler feed pump.

(viii) Wargonor trippler.

(ix) Crusher house.

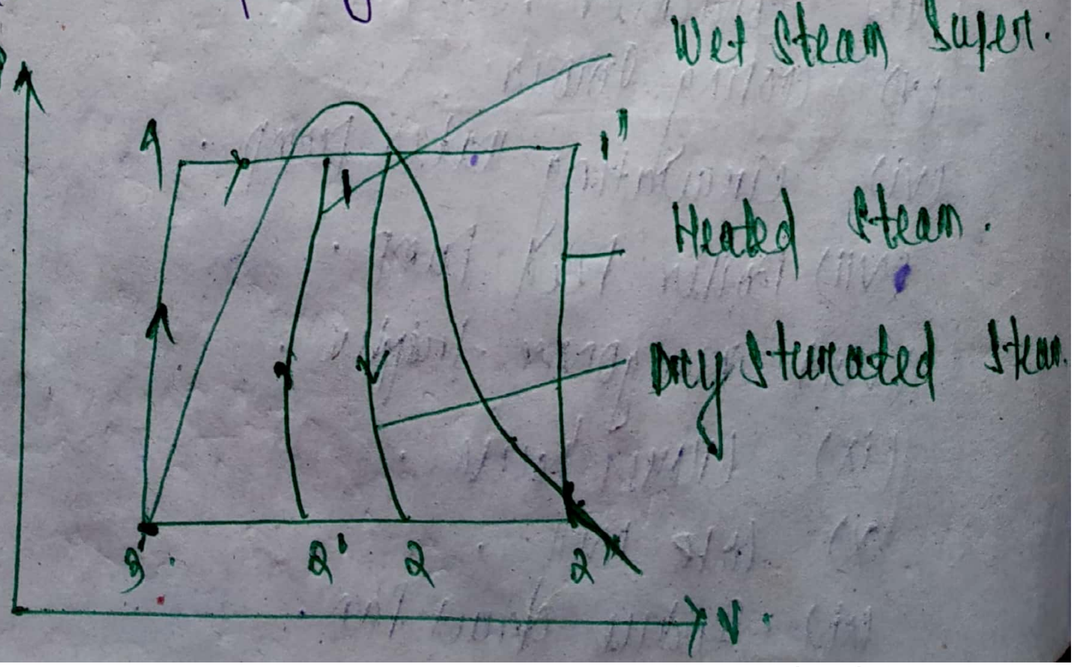
(x) Cole mill.

(xi) Induce draut fan.

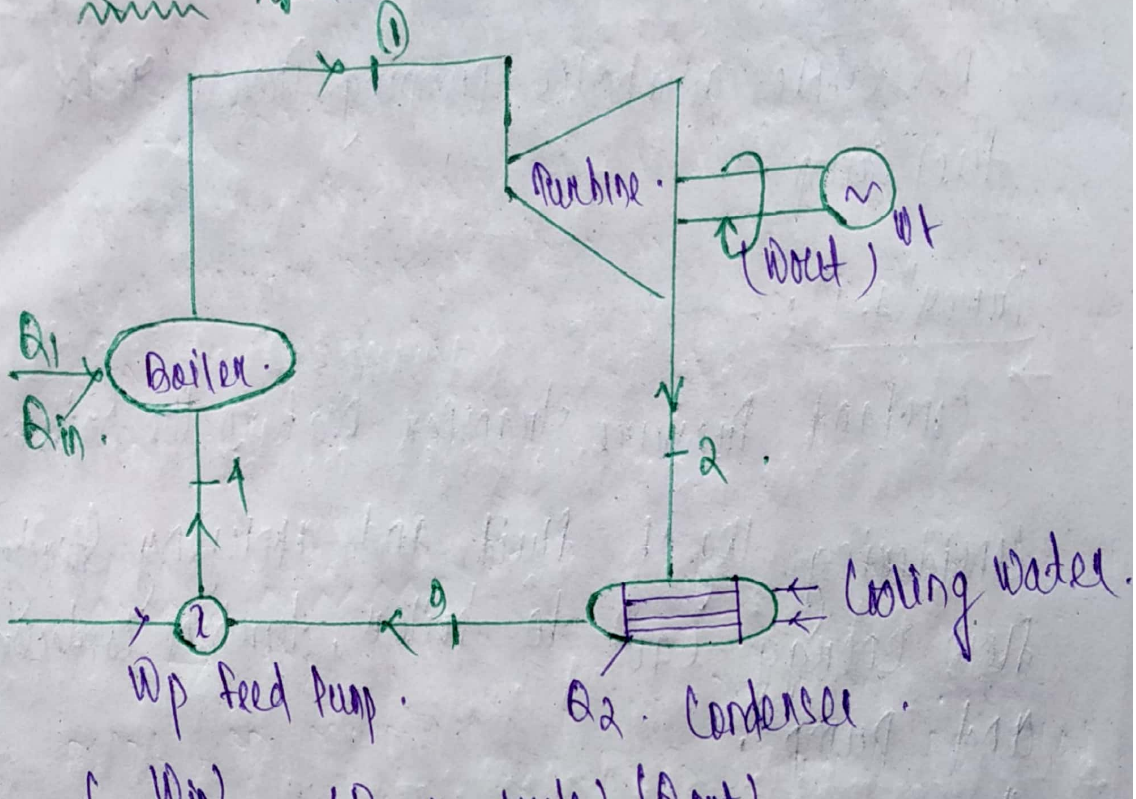
(11) Ash Precipitators.
(12) Boiler chimini.
(13) Force draft fan.
(14) Water treatment plant.
(15) Control room.
(16) Switch yard.

★ Essential requirement of Steam Power Plant Station design :-

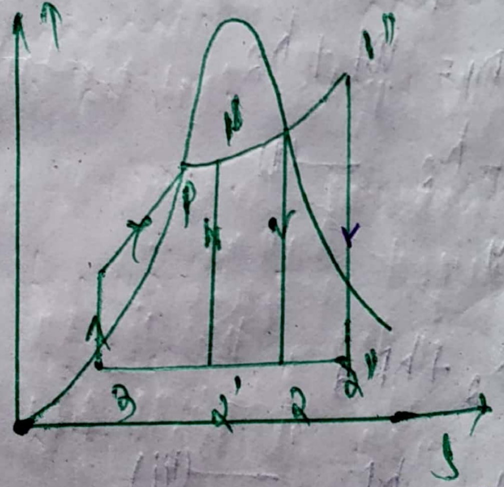
(i) Reliability.
(ii) min^n capital cost.
(iii) min^n operating and mentanance cost.
(iv) Capacity to meet peak Load effectively.
(v) min^n Losses of energy in transmition
(vi) Low cost of energy supply to the consumers
(vii) Reserve capacity to meet future demands.
(viii)



Rankine cycle:-



(Rankine cycle)



When the steam is enters the turbine. It may be way dry saturated or superheated.

Process 1-2:-

Riversible adiabatic expansion on the turbine.

Process 2-3:-

Constant Pressure transfer heat in condenser.

Process 3-4':-

Reversible adiabatic pumping Process in the feed pump.

Process "4-1":-

Constant Pressure transfer heat in the boiler.

Considering 1kg of fluid and applying steady flow energy equ to boiler, turbine, condenser and pump.

"for boiler" $h_{f_4} + Q_1 = h_1$

$Q_1 = h_1 - h_{f_4}$ —(i)

"for turbine" $h_1 = W_t + h_2$

$W_t = h_1 - h_2$ —(ii)

"for condenser"

$h_2 = Q_2 + h_{f_3}$

$Q_2 = h_2 - h_{f_3}$ —(iii)

"for the Feed Pump."

$h_{f_3} + W_p = h_{f_4}$

$W_p = h_{f_4} - h_{f_3}$ —(iv)

Efficiency of Rankine cycle :-

$$\eta_{rankine} = \frac{W_{net}}{Q_1}$$

$$= \frac{(W_t - W_p)}{Q_1}$$

$$= \frac{(h_1 - h_2 - h_{f4} - h_{f3})}{h_1 - h_{f4}}$$

→ The feedpump work 'W_p' being a small quantity in comparison with turbine work 'W_t' is usually neglated.

$$\eta_{rankine} = \frac{h_1 - h_2}{h_1 - h_{f4}}$$

Where,

h_1 = enthalphy of steam enters in the turbine. (inlet) or output of boiler.

h_2 = enthalphy of steam living the turbine.

h_3 = enthalphy of liquid entering to the boiler.

Work ratio :-

$$\text{Work ratio} = \frac{W_{net}}{W_{turbine}}$$

→ It's the ratio betⁿ net work output in the cycle to the workdone by the turbine.

$$W_{net} = \frac{W_t - W_p}{W_t}$$

★ Thermal power plant :-

→ Requires huges quantity of cole or oil.

→ A 400- Mg.watt thermal requireds around 7000 to 800 tons upto coal per day.

→ It's costly

→ Man power required large.

→ Initial investment is low. 1050 per kw.

→ It's internal power is high and life of plant not so long. (20-45 years) and also

→ Maintanance cost is high.

Side Selection :- Special side to met fuel and

→ Water & pollution required.

→ It's plant efficiency less 30-40 %, and it's erection time is about 3 years.

→ It's requires 1.5 hector / M-watt.

* **Nuclear power plant:-**

→ fuel consumption is very less.

→ heat about in 1kg of uranium is evolve equivalant to the combustion 3×10^{6} lit. of oil or 113350 quintal or high grade coke.

→ It's cost of energy cheep.

→ less man power required.

→ Initial investment is high that means 1700

→ It's internal power consumption is less and life of plant less than "80" years.

→ Erection time about "8" years.

→ plant efficiency 31-35%.

* **PWR and BWR power plant:-**

PWR - Pressurised Water Reactor.

BWR - Boiler Water Reactor.

→ There are various nuclear power plant situated in India such as

(i) Tarapur Power Plant. (Maharastra)

(ii) Ranapratap ~~Power~~ Sagar power plant (Kota Rajastan)

(iii) Calpakkam (Tamil nadu)

(iv) Narora power plant (UP)

(v) Kakrapara power plant (Gujarat)

(Q) A steam power plant is supply with dry saturated stream at a pressure of 30 Bar. and exust into a condenser at 0.2 Bar calculate the rankine efficieny by using stream table

Initial condition of stream

Pressure (P_1) = 18 Bar.

Dry saturated final condition of stream

exust stream pressure (P_2) = 0.2 Bar.

~~from stream table~~

Work done by turbine = $h_1 - h_2$

Work done by ~~heat~~ feed pump

$= h_{f_4} - h_{f_3}$.

Net work =

$W_{turbine} - W_{pump}$.

Rankine efficiency

$= \frac{W_{net}}{Q_1}$

$Q = h_1 - h_{f4}$.

(i) From Stream table Pressure $P_1 = 120$ Bar

$h_1 = 2700.87.9$ KJ/kg (enthalpy saturated vapour)

$S_1 = 6.49$ KJ/kg. KVD (entropy saturated vapour

at $P_2 = 0.02$ Bar.

$h_{f2} = h_{f3} = 251.13$ KJ/Kg (Internal energy S. Liquid

$h_{fg2} = 2358.5$ KJ/kg (enthalpy evaporation)

$S_{f2} = 0.8212$ KJ/kg. K (entropy Saturated liquid

$S_{fg2} = 7.0784$ KJ/kg. K (Entropy evaporat

$V_f = 0.001017\ m^3$ S.V Saturated liquid

* Disel engine Power plant :-

→ Disel engine power plant installed where supply of cole and water is not available in sufficient quantity, or where to be small quantity of power generated in small quantity of power or require for continuity of supply such as cinemahall, Hospital and Radiostation.

→ It's capacity is 2-50 M.watt.

→ It's used central station for supply authorities.

→ The dimand of Disel power plant is increase for electric power generation.

→ The Disel unit used for electric generation are more reliable and long lived piece of equipments.

* Advantages of Disel power plant :-

(i) Design & Installation are very simple.

(ii) No problem of ash handling.

(iii) Occupies less space.

(iv) Can be started and put on load quick.

(v) require less quantity of water for

cooling purposes.
→ Overall capital cost is less than the stream power plant.
→ Can burn firelly wide range of fuels.
→ The Disel power plants are more efficient than stream power plant in the range of 150 M. watt.

* Dis. Advantages of Disel power plant :—

→ High operating cost.
→ High lubrication and mentanance cost
→ Disel unit capacity limited : there can't be ~~require~~ constructed large size.
→ In a disel power plant noise in a serious problem.
→ Disel plants can't supply over loads continiously where has stream power plant can work under 25 %. overload continiously
→ The disel power plants are not economically where fuel has to be imported.
→ The life of a Disel power plant is wide small (2-5 or less) as compaire to that a (25-30) stream p. plant

* Essential Componet of a disel Power plant.

(i) Engine.
(ii) Air intake system.
(iii) Exaust system.
(iv) fuel system.
(v) cooling system.
(vi) lubrication system.
(vii) Engine starting system.
(viii) Governing system.

(i) Engine :-

→ This system main componet of the plant which develope required power.

→ It's generally directly couple to the generator.

(ii) Air Intake System:

→ The air intake system conves fresh air through pipes or ducgs. to

(i) Air intake manifolt of 4 stroke engine.

(ii) Scadening. Pump inlet of a 2 stroke engine.

→ The supper charger inlet of a super charge engine.

→ The filter may be dry or oil bare.

→ electrostic Precipiter filter can be also use.

→ Oil impingement type of filter consist of the frame.

→ The dry type of filter is made of cloth, feat, glasswood etc.

→ In oil bare type of filter the air is swept over.

Precaution should be taken while constructing a suitable air intake system.

→ Air intakes main or be located inside the engine room.

→ Air should not be taken from confined space otherwise air pulsations, can cause serious vibration problem.

→ The air intake line used should neither have to small a diameter nor should be to long otherwise there may crock of engine starvation. Problem.

* Cooling System in Disel powerplant :-

→ During combustion Process the Pick gas in the tempure in the cylinder of an I.C Engi is of the order of 2500 K.g.v.

→ The gas temp. by a large no. of considerate and thus cooling for the cylinder head and piston, must be Provided.

→ During the combustion Period the heat Secess to the chamber walls can reach as a high as 10 M.watt per M^2. M watt/ m^2.

→ In resons of high heat flux thermal Stress must be kept below levels that to cause fatigue racing so temp must be less than about 400°c for cast Iron & 300°c for aluminium allows for water cool engine.

→ for air cool engine other values as 270°c & 200°c respectively.

→ Best on Cooling Medium 2 types of cooling System.

(i) Air as direct cooling System.

(ii) Liquid or indirect cooling System.

→ Air cooling is used in small engines and portable engines by providing fins of the cylinder. Big Disel engines are alway liquid cool.

→ Liquid cooling system are farther classified '4' types.

(i) open cooling system.
(ii) Natural saturation (Thermo system)
(iii) Force saturation system.
(iv) Evaporation cooling system.

(i) Open cooling system

→ The system is available or applicable only where planty of water is available.

→ The water from the storage tank is directly supply through an inlet valve to the engine cooling water jacket.

→ The hot water comming out of the engine is not cool for reused but it discharg

(ii) Natural Saturation :- and design flow
→ The system is closed
so that the water may circulate naturally because of the different in density of water at different temp.
→ It consist of a water jacket, radiator, and a fan.
→ Where water is heated it's density decreases and it tones to rise. Why the cooler modulular dense to sign.

(iii) Force Saturation System :-
→ In these cooling system which is close one
→ These system consist of pump, water jacket in the cylinder and fan.
→ The cooler is circulated through the cylinder jacket with the help of pump which is usally centrifugal time and driven by the engine.

(iv) Evaporation cooling system :–

→ In these cooling system of biger that a hot water is cool in a cooling towder and recirculated again.

→ These is a need of small quantity of cooling makeup water.

Chapter - 3 Nuclear Power Plant .

Atom :-

→ The Smallest Particle of the element is called atom

→ An elements ot defind as a Substance which can't be decomposed in other Substances.

→ Atom word derived from 'gric' wards It means indivisable and for a long time the atom was consider .

Dalton's atomic theory :-

→ It States that all the atoms of one elements are precisely alike . have the Same mass . But differs from the atoms of other elements .

→ The chemical combination consist of the union of small fixed number of atom of one elements with a small fixed of other elements .

Electron Cell :

→ The closest cell to the nucleus is called 1st cell or 'K' cell : followed by 2nd cell or 'L' cell . then the 3rd cell or 'M' cell .

→ The cell correspond to the principal quantum numbers (n= 1,2,3,4 ....) or are level with alphabatically with the letter used in 'X'- ray notasion.

→ Each cell can containe only a fixed no of electrons.

→ The 1st cell can hole upto 2 electrons

→ The 2nd cell can hole upto 8 electrons (2+6)
" 3rd " " " upto 18 electrons (2+6+10)
and show on.

→ The general formula is that nth cell can principle holed up to : $2(n^2)$

Valency cell:–

→ The electrons in the outer most occupied cell determine the chemical properties of atom is called valency cell.

→ Each cell consist of one or more sub cell & each sub cell consist of one or more atomic.

P-3

Various atomic models are proposed by scintist thompson's plump modeling, Rutherford's nuclar model, Borh's model Summerfelds model. Vector model. Wave mechanical model.

Automic mass unit :-

→ The mass of the atom is ~~exact~~ expre in terms of the mass of the electron.

→ The unit of mass has been considered as $\frac{1}{16}$ of the mass of nutral oxygen ato which containes 8 protons, 8 Nutron

→ The atomic mass unit (AMU) is equa to $\frac{1}{16}$ mass of O_2 Nutral atom.

* 1 AMU = 1.66×10^{-24} g.

Isotopes :-

→ In any atom the number of electrons equal to no. of protons.

→ These is independent of nutral in nucleous atoms have different number of neutrons that the number of proton are know as isotops.

Ex: Hydrogen Isotopes.

Deuterium:-

$_1H^2$

Tritium:-

$_1H^3$

Uranium:-

U^{234}, U^{235}, U^{238}

Radio activity:-

→ Radio activity was discovered by Becquerel in 1896.

→ These phenomenon is confine almost intirelly to the heaveast element from 83-106 in the periodic table.

→ The phenomenon of spontanious emition of powerfull radiations exhibited by heavy elements is called radio activity.

Scanned with CamScanner

Ex: Uranium, polonium, radium, Ionium, Torium, thronium, Actinium & Mesoonium.

→ The radio active radiations emited by the radio active elements are found ~~th~~ α-rays, β-ray, γ-ray or Photon.

→ Radio active may be natural or ~~[illegible]~~ artificial.

PPE

Advantages and disadvantages of steam turbine :-

Advantages

-> Thermal efficiency of a steam turbine is much higher than that of a steam engine.

-> The steam turbine developes power at a uniform rate and hence does not required flywheel.

-> If the steam turbine properly designed and constructed then it is the most durable prime mover.

-> ~~The~~ In a steam turbine there is no loss due to initial condensation of steam.

Disadvantages

-> High efficiency is ordinarily obtained only at high speed.

-> Gas turbine locomotives had similar problems, together with a range of other difficulties.

-> These devices are heavy and cumbersome

-> Turbines can rotate in only one direction.

Steam condenser

It is condenser which is used to condense steam.

-> steam condensers are mostly water cooled.

-> Its function to maintain condensing pressure below atmospheric for improving efficiency.

-> to supply hot and pure water to cycle again.

INTRODUCTION

Hydroelectric Power -- what is it?
It's a form of energy … a renewable resource. Hydropower provides about 96 percent of the renewable energy in the United States. Other renewable resources include geothermal, wave power, tidal power, wind power, and solar power. Hydroelectric powerplants do not use up resources to create electricity nor do they pollute the air, land, or water, as other powerplants may. Hydroelectric power has played an important part in the development of this Nation's electric power industry. Both small and large hydroelectric power developments were instrumental in the early expansion of the electric power industry.

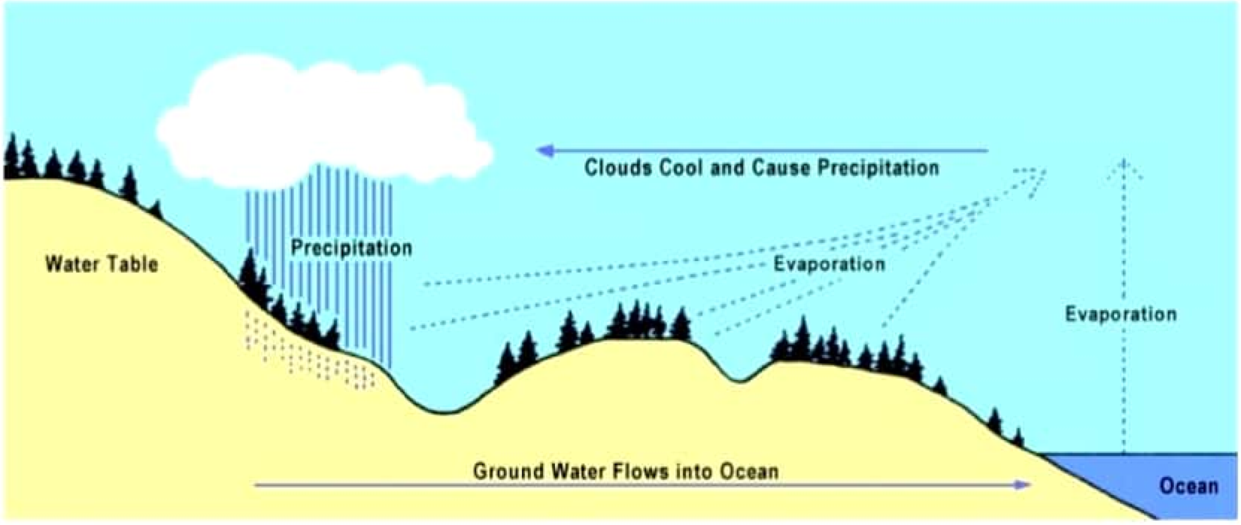
Hydroelectric power comes from flowing water … winter and spring runoff from mountain streams and clear lakes. Water, when it is falling by the force of gravity, can be used to turn turbines and generators that produce electricity.

Hydroelectric power is important to our Nation. Growing populations and modern technologies require vast amounts of electricity for creating, building, and expanding. In the 1920's, hydroelectric plants supplied as much as 40 percent of the electric energy produced. Although the amount of energy produced by this means has steadily increased, the amount produced by other types of powerplants has increased at a faster rate and hydroelectric power presently supplies about 10 percent of the electrical generating capacity of the United States. Hydropower is an essential contributor in the national power grid because of its ability to respond quickly to rapidly varying loads or system disturbances, which base load plants with steam systems powered by combustion or nuclear processes cannot accommodate.

Reclamation's 58 powerplants throughout the Western United States produce an average of 42 billion kWh (kilowatt-hours) per year, enough to meet the residential needs of more than 14 million people. This is the electrical energy equivalent of about 72 million barrels of oil. Hydroelectric powerplants are the most efficient means of producing electric energy. The efficiency of today's hydroelectric plant is about 90 percent. Hydroelectric plants do not create air pollution, the fuel--falling water--is not consumed, projects have long lives relative to other forms of energy generation, and hydroelectric generators respond quickly to changing system conditions. These favorable characteristics continue to make hydroelectric projects attractive sources of electric power.

HOW HYDROPOWER WORKS

Hydroelectric power comes from water at work, water in motion. It can be seen as a form of solar energy, as the sun powers the hydrologic cycle which gives the earth its water. In the hydrologic cycle, atmospheric water reaches the earth's surface as precipitation. Some of this water evaporates, but much of it either percolates into the soil or becomes surface runoff. Water from rain and melting snow eventually reaches ponds, lakes, reservoirs, or oceans where evaporation is constantly occurring.



Moisture percolating into the soil may become ground water (subsurface water), some of which also enters water bodies through springs or underground streams. Ground water may move upward through soil during dry periods and may return to the atmosphere by evaporation.

Water vapor passes into the atmosphere by evaporation then circulates, condenses into clouds, and some returns to earth as precipitation. Thus, the water cycle is complete. Nature ensures that water is a renewable resource.

Generating Power

In nature, energy cannot be created or destroyed, but its form can change. In generating electricity, no new energy is created. Actually one form of energy is converted to another form.

To generate electricity, water must be in motion. This is kinetic (moving) energy. When flowing water turns blades in a turbine, the form is changed to mechanical (machine) energy. The turbine turns the generator rotor which then converts this mechanical energy into another energy form -- electricity. Since water is the initial source of energy, we call this hydroelectric power or hydropower for short.

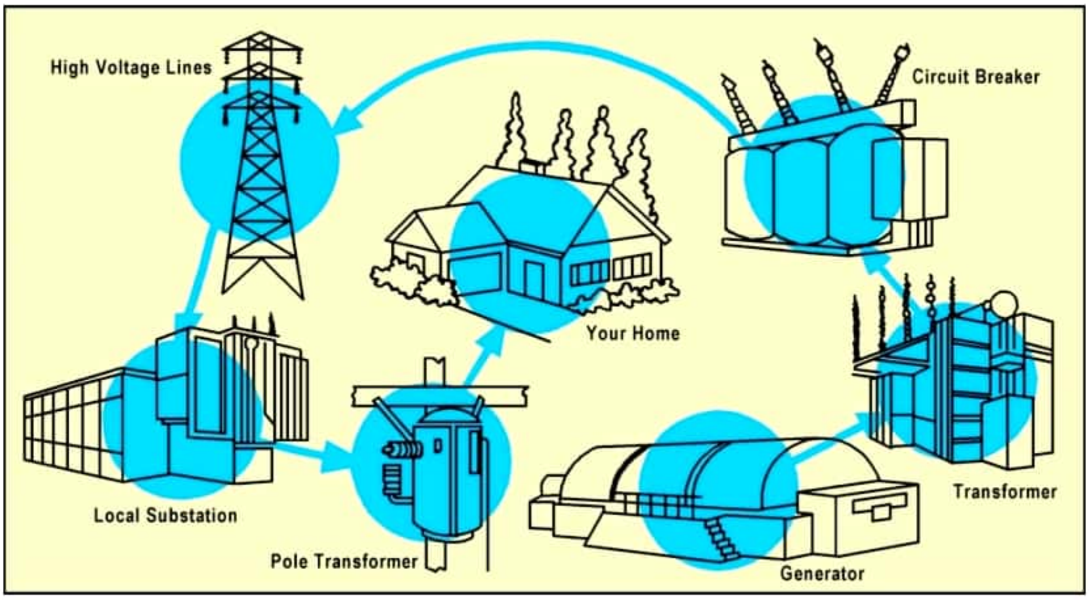
At facilities called hydroelectric powerplants, hydropower is generated. Some powerplants are located on rivers, streams, and canals, but for a reliable water supply, dams are needed. Dams store water for later release for such purposes as irrigation, domestic and industrial use, and power generation. The reservoir acts much like a battery, storing water to be released as needed to generate power.

Transmitting Power

Once the electricity is produced, it must be delivered to where it is needed -- our homes, schools, offices, factories, etc. Dams are often in remote locations and power must be transmitted over some distance to its users.

Vast networks of transmission lines and facilities are used to bring electricity to us in a form we can use. All the electricity made at a powerplant comes first through transformers which raise the voltage so it can travel long distances through powerlines. (Voltage is the pressure that forces an electric current through a wire.) At local substations, transformers reduce the voltage so electricity can be divided up and directed throughout an area.

Transformers on poles (or buried underground, in some neighborhoods) further reduce the electric power to the right voltage for appliances and use in the home. When electricity gets to our homes, we buy it by the kilowatt-hour, and a meter measures how much we use.



While hydroelectric powerplants are one source of electricity, other sources include powerplants that burn fossil fuels or split atoms to create steam which in turn is used to generate power. Gas-turbine, solar, geothermal, and wind-powered systems are other sources. All these powerplants may use the same system of transmission lines and stations in an area to bring power to you. By use of this "power grid," electricity can be interchanged among several utility systems to meet varying demands. So the electricity lighting your reading lamp now may be from a hydroelectric powerplant, a wind generator, a nuclear facility, or a coal, gas, or oil-fired powerplant … or a combination of these.

Advantages of Hydroelectric Power plants

- No Fuel charges No fuel transportation
- Highly reliable
- Operation and maintenance cost is less
- Plant efficiency does not change with age
- It takes a few minutes to run and synchronize the plant
- Less manual supervision required
- Plant has comparatively long life

Disadvantage of hydroelectric power plant:-

→ The hydroelectric power plant can be developed only where the large quantity of water is available

→ The hydroelectric power plant cannot be used where there is lack of water supply.

→ Dams may fail which may cause flooding.

→ The capital cost of the generator is high.

→ The distance between the hydroelectric power plant and load center is more so the longer transmission line is required which increases costs.

→ initial civil engineering costs may be high.

→ These are some advantages of hydroelectric power plant.

4.3 FUEL INJECTION SYSTEM

Fuel injection is a system for mixing fuel with air in an internal combustion engine. A fuel injection system is designed and calibrated specifically for the type of fuel it will handle. Most fuel injection systems are for diesel applications. With the advent of electronic fuel injection (EFI), the diesel gasoline hardware has become similar. EFI's programmable firmware has permitted common hardware to be used with different fuels. Carburetors were the predominant method used to meter fuel before the widespread use of fuel injection. A variety of injection systems have existed since the earliest usage of the internal combustion engine.

The primary difference between carburetors and fuel injection is that fuel injection atomizes the fuel by forcibly pumping it through a small nozzle under high pressure, while a carburetor relies on low pressure created by intake air rushing through it to add the fuel to the air stream.

The fuel injector is only a nozzle and a valve: the power to inject the fuel comes from a pump or a pressure container farther back in the fuel supply.

Objectives

The functional objectives for fuel injection systems can vary. All share the central task of supplying fuel to the combustion process, but it is a design decision how a particular system will be optimized. There are several competing objectives such as :

- power output,
- fuel efficiency,
- emissions performance,
- reliability,
- smooth operation,

4.3.1 Basic Function

The process of determining the necessary amount of fuel, and its delivery into the engine, are known as fuel metering. Early injection systems used mechanical methods to meter fuel (non electronic or mechanical fuel injection). Modern systems are nearly all electronic, and use an electronic solenoid (the injector) to inject the fuel. An electronic engine control unit calculates the mass of fuel to inject.

Modern fuel injection schemes follow much the same setup. There is a mass airflow sensor or manifold absolute pressure sensor at the intake, typically mounted either in the air tube feeding from the air filter box to the throttle body, or mounted directly to the throttle body itself. The mass airflow sensor does exactly what its name implies; it senses the mass of the air that flows past it, giving the computer an accurate idea of how much air is entering the engine. The next component in line is the Throttle Body. The throttle body has a throttle position sensor mounted onto it, typically on the butterfly valve of the throttle body. The throttle position sensor (TPS) reports to the computer the position of the throttle butterfly valve, which is used to calculate the load upon the engine. The fuel system consists of a fuel pump (typically mounted in-tank), a fuel pressure regulator, fuel lines (composed of either high strength plastic, metal, or reinforced rubber), a fuel rail that the injectors connect to, and the fuel injector(s). There is a coolant temperature sensor that reports the engine temperature, which the engine uses to calculate the proper fuel ratio required. In sequential fuel injection systems there is a camshaft position sensor to determine which fuel injector to fire.

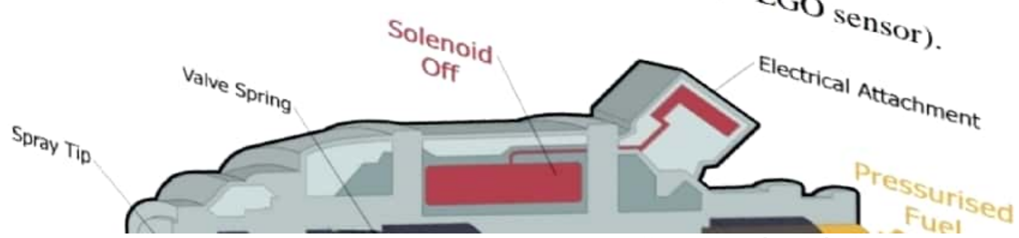
The fuel injector acts as the fuel-dispensing nozzle. It injects liquid fuel directly into the engine's air stream. In almost all cases this requires an external pump. The pump and injector are only two of several components in a complete fuel injection system.

An EFI system requires several peripheral components in addition to the injector(s), in order to duplicate all the functions of a carburetor. A point worth noting during times of fuel metering repair is that early EFI systems are prone to diagnostic ambiguity. A single carburetor replacement can accomplish what might require numerous repair attempts to identify which one of the several EFI system components is malfunctioning. Newer EFI systems can be very easy to diagnose due to the increased ability to monitor the realtime data streams from the individual sensors.

Typical EFI Components

- Animated cut through diagram of a typical fuel injector
- Injectors
- Fuel Pump
- Fuel Pressure Regulator

- ECM – Engine Control Module; includes a digital computer and circuitry to communicate with sensors and control outputs
- Wiring Harness
- Various Sensors (Some of the sensors required are listed here)
- Crank/Cam Position (Hall effect sensor)
- Airflow (MAF sensor)
- Exhaust Gas Oxygen (Oxygen sensor, EGO sensor, UEGO sensor).



- initial cost,
- maintenance cost,
- diagnostic capability, and
- range of environmental operation.

Certain combinations of these goals are conflicting, and it is impractical for a single engine control system to fully optimize all criteria simultaneously. In practice, automotive engineers strive to best satisfy a customer's needs competitively. The modern digital electronic fuel injection system is far more capable at optimizing these competing objectives consistently than a carburetor. Carburetors have the potential to atomize fuel better.

Benefits

Operational benefits include smoother and more dependable engine response during quick throttle transitions, easier and more dependable engine starting, better operation at extremely high or low ambient temperatures, increased maintenance intervals, and increased fuel efficiency. On a more basic level, fuel injection does away with the choke which on carburetor-equipped systems must be operated when starting the engine from cold and then adjusted as the engine warms up.

An engine's air/fuel ratio must be precisely controlled under all operating conditions to achieve the desired engine performance, emissions, and fuel economy. Modern electronic fuel-injection systems meter fuel very accurately, and use closed loop fuel-injection quantity-control based on a variety of feedback signals from an oxygen sensor, a mass airflow (MAF) or manifold absolute pressure (MAP) sensor, a throttle position (TPS), and at least one sensor on the crankshaft and camshaft to monitor the engine's rotational position. Fuel injection systems can react rapidly to changing inputs and control the amount of fuel injected to match the engine's dynamic needs across a wide range of operating conditions such as engine load, ambient air temperature, engine temperature, fuel octane level, and atmospheric pressure.

A multipoint fuel injection system generally delivers a more accurate and equal mass of fuel to each cylinder, thus improving the cylinder-to-cylinder distribution. Exhaust emissions are cleaner because the more precise and accurate fuel metering reduces the concentration of toxic combustion byproducts leaving the engine, and because exhaust cleanup devices such as the catalytic converter can be optimized to operate more efficiently since the exhaust is of consistent and predictable composition.

Fuel injection generally increases engine fuel efficiency. With the improved cylinder-to-cylinder fuel distribution, less fuel is needed for the same power output. When cylinder-to-cylinder distribution is less than ideal, as is always the case to some degree with a carburetor or throttle body fuel injection, some cylinders receive excess fuel as a side effect of ensuring that all cylinders receive sufficient fuel. Power output is asymmetrical with respect to air/fuel ratio; burning extra fuel in the rich cylinders does not reduce power nearly as quickly as burning too little fuel in the lean cylinders. However, rich-running cylinders are undesirable from the standpoint of exhaust emissions, fuel efficiency, engine wear, and engine oil contamination. Deviations from perfect air/fuel distribution, however subtle, affect the emissions, by not letting the combustion events at the chemically ideal (stoichiometric) air/fuel ratio. Grosser distribution problems eventually begin to reduce efficiency, and the grossest distribution issues finally affect power. Increasingly poorer air/fuel distribution affects emissions, efficiency, and power, in that order. By optimizing the homogeneity of cylinder-to-cylinder mixture distribution, all the cylinders approach their maximum power potential and the engine's overall power output improves.