LECTURE NOTES

ON

POWER STATION ENGINEERING

6^{TH} SEMESTER MECHANICAL

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Chapter-1 Introduction

Introduction of Powere station Engineering :-

Powere station Engineering is a division of powere Engineering, and is defined as "the Engineering and technology reuireed for the production of central station electric powere".

The field is focused on the genereation of powere fore industries and Communities, not fore household powere production.

It is also called as "powere plant Engineering".

*) Sources of Energy :-

The various sources of Energy are :

i) Conventional

ii) Non-Convential

Conventional :-

1) Fuels
   - Solids - Coal, coke anthracite etc.
   - Liquids - Petroleum and its derivatives
   - Gases - Natural gas, blast furnace gas etc.

Non-Conventional :-

2) Energy stored in watere
3) Nueleare Energy
4) Wind powere
5) Solare Energy
6) Tidal Energy
7) Geothermal Energy
8) Thermoelectric powere

1) Fuels :-

→ Fuels may be chemical or nucleare.

→ Here, we consider chemical fuels only.

A chemical fuel is a substance which releases heat energy on consumption. The principle combustible elements of each fuel aree carbon and hydrogen. Though sulphure is a combustible elements too but its presence in the fuel is considered to be undesirable

⇒ Solid → Coal, coke, anthracite etc.

→ Coal :-

→ Its main constituents aree carbon, hydrogen, oxygen, nitrogen, sulphur, moisture and ash.

→ Coal is primarily used as fuel to generate electric powere ore electricity.

→ Coke :-

→ It consists of carbon, mineral matter with about 2% sulphure and small quantities of hydrogen, nitrogen and phosphorus.

→ It is smokeless and cleare fuel and can be produced by Serercal processes.

→ It is mainly used in blast furnace to produce heat and at the same time to reduce the iron ore.

→ Anthracite :-

→ It is verry hared coal and has a shining black lustre.

→ It ignites slowly unless the furnace tempereature is hi

→ The calorific value of this fuel is high to the tonne of 35500 KJ/kg and such as is very suitable fore steam generation.

* Liquid :- Petroleum and its derivatives, LPG.

The chief source of liquid fuels is petroleum which is obtained from wells undere the earth's crust.

Petroleum :-

→ It consists of a mixture of gases, liquids and solid hydrocarbons with small amounts of nitrogen and sulphure compounds.

→ In India the main sources of petroleum aree Assam and Gujarat.

→ Heavy fuel oil or crude oil is imported and then refined at different refineries.

→ The refinning of crude oil supplies the most important product called petrol.

Its derivatives aree kerosene, fuels oils, colloidal fuels and alcohol.

LPG :-

→ Liquefied petroleum gas or LPG is a type of hydrocarbon gas that is obtained by refining crude oil or processing natural Gas.

→ Uses in heating and cooking appliances, industrial appliances, in vehicles as a propellent & refrigerant.

Gaseous fuels :-

→ Natureal Gas :-

→ The main constituents of natureal gas arce methane (CH_4) and ethane (C_2H_6).

→ It has calorific value nearely 21000 KJ/m³.

→ Natureal gas is used alternately or simultaneously with oil for interenal combustion Engines.

→ Blast Furenace Gas :-

→ It is obtained from smelting operation in which aire is forced through layeres of coke and iron ore, the

→ the example being that of Pig iron manufacture where this gas is produced as by product and contains about 20% carbon monoxide (CO).

→ The heating value of this gas is very low.

CNG :-

→ Compressed natureal gas is produced by compressing the natureal gas undere a pressuree between 21-25 KPa.

→ CNG is a bettere eco-friendly fuel compared to gasoline / diesel ; hence, a its use as an alternative option in replacement of gasoline or diesel to run automobiles has attracted much more attention over the woreld.

2) Energy stored in water :-

This is energy that is used during the execution of processes. Such as movement. Because of kinetic energy can flow and waves can exist. But water can also contain potential energy.

→ This is energy that is stored in the water.

Ex :-

A hydroelectric dam captures energy from the movement of a river.

3) Nucleare Energy :-

Nucleare Energy is the energy in the nucelus, or core, of an atom. Atoms are tiny units that makeup all matter in the universe, and energy is what holds the nucleare together. There is a huge amount of energy in an atom's dense nucleus.

Ex :-

Nucleare fusion
Nucleare Fission
Electricity
Nucleare weapons
Nucleare Medicine
Food Treatments

4) Wind Powere :-

Wind Powere describe the process by which the wind is used to generate mechanical powere ore electricity. Wind turebines converet the kinetic Energy in the wind into mechanical powere.

Ex:- Wind farms
Transpotation.

5) Solare Energy :-

Solare Energy is powere ore heat that comes from the sun.

Ex:- Heating, Cooking, drying.

6) Tidal Energy :-

Tidal Energy is a renewable Energy powered by the natural reise and fall of ocean tides and Currents. Some of these technologies include turebines and paddles.

Ex:-
Sihwa Lake Tidal powere station, South Korea - 254 MW
Lafranee Tidal Powere Plant, France - 240 MW
Swansea Bay Tidal Lagoon, U.K. - 240 MW

7) Geothermal Energy :-

→ Geothermal Energy is Energy derived from the earth's internal heat.

→ This heat is generated by the radioactive decay of minerals and the continual heat loss of eareth's core.

→ The heat from the core continuously radiates outward, warming rocks, waters, and other geological material.

Ex:

Greysers — Hot spring

homes and business — Lava

Fumaroles

8) Theremoelectric Power :-

The conversion of theremal Energy into Energy of electrical ore electrical Energy.

→ Theremoelectric generation reelies on a fuel Source (fossil, nuclear, biomass, geothermal, or Solare) to heat a fluid to doive a turebine.

Ex:

Used in the procers of generating electricity with steam-doiven turebine generatorcs.

*) Explain concept of central and captive powere station.

→ Concept of central powere station :-

i) A captive powere plant also called autoproducer or embedded generation is a powere generation facility used and managed by an industrial or commercial energy and used for their own energy consumption.

ii) Captive powere plants can operate off-grid or they can be connected to the electric grid to exchange excess generation.

iii) Captive powere plants are generally used by powere-intensive industries where continuity and quality of energy supply are crucial, such as aluminium smelters, steel plants, chemical industries etc.

→ Concept of central powere station :-

i) Centralized generation refers to large-scale powere generation in centralized plants.

ii) These systems are generally located outside end-useres and connected to the high voltage transmission network.

iii) Central powere station is refered to as large-scale powere generation in centrally located plants. Generally located outside end-users, these systems are connected to a high voltage transmission network.

*) Classify Powere plants :-

Powere plants aree classified into those using traditional and non-traditional Energy resources.

i) Therenal powere station (TPS),
ii) Nucleare Powere Plant (NPP),
iii) Hydraulic powere plants (HPP)
iv) Hydro pumped storage powere plants (HPSPP),
v) Solare powere plant (SPP),
vi) Geotherenal powere plant (GIPP),
vii) Wind powere station (WPS),
viii) Tidal powere plants (TPP),
ix) Magnetohydrodynamic powere plant (MHDPP), etc.

i) Therenal Powere Station (TPS) :-

A Therenal Powere plant converets the heat Energy of Coal into electrical Energy. Coal is burent in a boilere which converets watere into steam. The expansion of steam in turebine produces mechanical pawere which drives the alterenatore coupled to the turebine. Therenal powere plant also called as Therenal powere station contribute maximum generation of powere.

→ Therenal powere plants contribute 75.43% of the total installed captive and non-captive powere

generation in India.

ii) Nuclear Power plant :-

→ A nuclear power plant is a facility that converts atomic Energy into usable power.

→ In a nuclear electric power plant, heat produced by a reactor is generally used to drive a turbine which in turn drives an electric generator.

iii) Hydraulic Power Plant :-

→ hydraulic power plant or hydroelectric power plant convert the Kinetic Energy in flowing water into electricity or Electric Energy.

→ Falling or flowing water turns a propeller like piece called a turbine.

→ The turbine turns a metal shaft in an electric generator which produces electricity.

iv) Hydro Pumped Storage Power Plants (HPSPP) :-

→ Pumped storage power plants are a special type of power-plants, which work as Conventional hydropower stations for part of the time.

→ The water runs down through pipes to turn the turbine.

→ The turbine connected to a generator to produce electricity.

→ They are mainly used to meet the peak demand.

v) Solare Powere plant :-

→ Solare powere plant is based on the conversion of sunlight into electricity, either directly using photovoltaic (PV). or indirectly using Concentrated Solare powere (CSP) is thermal powere plant.

→ Photovoltaic converts light into electric current using the photoelectric effect.

→ Concentrated solare powere systems use lenses or mirrors and tracking systems to focus a large areea of sunlight into a small beam.

vi) Geothermal powere plant (GPP) :-

→ Geothermal powere is powere genereated by geothermal energy.

→ Hot watere is pumped from deep undereground through a well under high preessure.

→ When the watere reaches the surface, the preessure is dropped, which causes the water to turn into steam.

→ The steam spins a turbine, which is connected to a genereator that produces electricity.

vii) Wind Powere Station (WPS):-

Wind Powere is the Conversion of wind Energy into a useful form of Energy, Such as using wind turebines to make electric powere, windmills for mechanical powere, wind pumps fore watere pumping or drainage, or sails to propel ship.

viii) Tidal Powere Plants (TPP):-

→ Tidal Powere, also called tidal Energy, is a form of hydropowere that converets the Energy of tides into useful forems of powere - mainly electricity.

→ Tides aree the waves caused due to the gravitational pull of the moon and also (though its pull is very low).

→ Dureing high tide, the watere flows into the dam and dureing low tide, watere flows out which reesult in turening the turebine.

ix) Magnetohydrodynamic powere plant (MHDPP,):-

→ MHD Powere plant is a new system of electric powere genereation which is said to be high efficiency and low pollution.

→ Magneto hydro dynamic (MHD) Concerned with the flow of a Conducting fluid in the presence of Magnetic and electric field.

The field may be gas at elevated temperatures or liquid metals like Sodium or pottasium.

*) Importance Of Electrical Powere In Day Today Life:-

i) Electricity is one of the most important blessings that science has given us. It is weightless, easiere to transport and distribute.

ii) It is an essential thing in moderen life.

iii) It is difficult fore us to spend even a single moment withaut electricity. It is useful to main. in many ways.

iv) The moderen times is a time of heavy industry and every industry reuns with electricity. The electrical wires are insulated to prevent the loss during transmission. In ourc houses the electrical fans, Coolers, A.C., bulbs, and tubes give us reelief from heat and darekness.

v) Electric trains and batterey cares are quick means of transport. We can enjoy the live matches, film songs and various movies on T.V. due to electricity, without electricity lifts not up & down in the multistorey buildings.

→ Just imagine if you have to go to 10th floore of a building on staires! Moderen equipments like Computere and robots also have been developed

because of electricity use of electricity is increasing day by day and it has become the life line of each and every country of the world.

*) Overeview of method of electrical powere genereation :-

→ Electricity genereation is the process of genereating electric powere from sources of differcent methods.

→ Severeal fundamental methods exist to convercet othere forms of Energy into electrical Energy. Utility scale genereation is achieved by rotating Energy electric genereation or genereatores or by photovoltaic systems. A small proportion of electric powere distributed by utilities is provided is provide by batteries.

Othere forms of electricity genereation used in niche applications include the triboelectric effect, the piezoelectric effect, the thereroelectric effect and betavoltaics.

Here, We considere

1) Genereatores
2) Photovoltaic effect
3) Electrochemistry

1) Generecatore :-

→ Generecatores which converets mechanical Energy into electrical Energy is called generecatore.

→ This is the most used form for genereating Electricity and is based on faraday's law.

Ex:
Wind turbines usually provide electric generation in conjuction with othere methods of producing powere.

2) Electrochemistry :-

→ Electrochemistry is the direct transformation of chemical Energy into Electricity, as in a battery. Electrochemical Electricity generation is important in portable and mobile applications.

→ Open electrochemical systems, Known as fuel cells, can be used to extract powere either from natural fuels ore from Syntheized fuels. Osmotic powere is a possibility at places where salt and freesh watere merege.

3) Photovoltaic effect :-

The photovoltaic effect is the transformation of light into electricity, as in Solare cells.

→ Photovoltaic panels convert Sunlight directly do

DC electricity.

→ Although sunlight is free and abuntant, Solare powere electricity is still usually more expensive to produce than larege-scale mechanically generated Powere due to the cost of the panels.

→ Recent advances in manufacturing efficiency and Photo-voltaic technology, Combined with subsidies dreiven by environmental Concerens, hare dramatically accelereated the depolyment of solare panels. Installed Capacity is growing by 40% per yeare led by increases in Germany, Japan, united States, China and India.