Pondicherry university Theory examination -FEB 2023
Fifth semester
Electrical and Electronics Engineering

ENERGY ENGINEERING

PART A (10 × 2 =20 MARKS)
ANSWER ALL THE QUESTIONS

1. **What is meant by renewable energy source.**

   Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. These sources of energy include solar energy, wind energy, geothermal energy, and hydroelectric power.

2. **Define the term gross domestic product.**

   - GDP is important because it gives information about the size of the economy and how an economy is performing.
   - The growth rate of real GDP is often used as an indicator of the general health of the economy.
   - In broad terms, an increase in real GDP is interpreted as a sign that the economy is doing well.

3. **Name the main parts of modern thermal power plant?**

   - Boiler.
   - Turbine.
   - Super-heater.
   - Condenser.
   - Economizer.
   - Feedwater pump.
   - Chimney.
   - Cooling tower.

4. **What is spinning resource?**

   The spinning reserve is the amount of unused capacity in online energy assets which can compensate for power shortages or frequency drops within a given period of time. Traditionally, the spinning reserve is a concept for large synchronous generators.

5. **What is the function of surge tank in hydro power plant.**

   Surge tanks are usually provided in high or medium-head plants when there is a considerable distance between the water source and the power unit, necessitating a long penstock. In short, the surge tank mitigates pressure variations due to rapid changes in velocity of water.

6. **Name any two hydraulic turbines?**

   - Pelton wheel turbine
   - Francis's turbine
   - Kaplan turbine

7. **How the winds are produced.**

   When the earth's surface is unevenly heated it leads to pressure difference and this pressure difference is the reason for the production of winds.
   Wind can be simply described as air which is in motion. Difference in atmospheric pressure leads to the movement of air or the blowing of wind. Wind always moves from high pressure to low pressure and because of this there are winds of various speeds.

8. **Mention the limitation of solar energy.**

   Additional area is required for such solar panels, as well as the cost is significant.
   Electricity output was significantly reduced throughout the winter as well as gloomy weather.

9. **What is meant by energy conservation.**

   Energy conservation can be broadly defined as the efficient use of energy. The reduction or elimination of unnecessary or unwanted energy use is referred to as energy conservation. It can be accomplished by using less energy to perform a given amount of work.

10. **Define the term energy quality index.**

    Energy quality is the relative economic usefulness per heat equivalent unit of different fuels and electricity. One way of measuring energy quality is the marginal product of the fuel, which is the marginal increase in the quantity of a good or service produced by the use of one additional heat unit of fuel.

PART B **(5 × 11 = 55 MARKS)**

UNIT I

11. Classify briefly the various energy sources?

Biomass:

- In recent years, the interest in using biomass as an energy source has increased and it represents approximately 14% of world final energy consumption.
- Estimates have indicated that 15–50% of the world's primary energy use could come from biomass by the year 2050.
- Biomass power generation in India is an industry that attracts investments of over Rs. 600 crores every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas.

Hydropower:

- Hydro-power is another source of renewable energy that converts the potential energy or kinetic energy of water into mechanical energy in the form of watermills, textile machines, etc., or as electrical energy (i.e., hydroelectricity generation).
- It refers to the energy produced from water (rainfall flowing into rivers, etc.).
- Hydro-power is the largest renewable energy resource being used for the generation of electricity. Only about 17% of the vast hydel potential of 150,000 MW has been tapped so far.
- In India, hydropower projects with a station capacity of up to 25 megawatts (MW) fall under the category of Small Hydropower (SHP). India has an estimated SHP potential of about 15,000 MW, of which about 11% has been tapped so far.
- The Ministry of New and Renewable Energy (MNRE) supports SHP project development throughout the country.

Wind Energy*:*

- Wind energy is being developed in the industrialized world for environmental reasons and it has attractions in the developing world as it can be installed quickly in areas where electricity is urgently needed.
- In many instances it may be a cost-effective solution if fossil fuel sources are not readily available.

In addition, there are many applications for wind energy in remote regions, worldwide, either for supplementing diesel power (which tends to be expensive) or for supplying farms, homes and other installations on an individual basis.

- Wind power accounts for nearly 10% of India's total installed power generation capacity and generated 52.67 TWh in the fiscal year 2017-18, which is nearly 3% of total electricity generation.
- The capacity utilization factor is nearly 16% in the fiscal year 2017-18 (19.62% in 2016-17 and 14% in 2015-16). 70% of wind generation is during the five months duration from May to September coinciding with Southwest monsoon duration.

Solar Energy:

- Solar energy is the most abundant permanent energy resource on earth and it is available for use in its direct (solar radiation) and indirect (wind, biomass, hydro, ocean, etc.) forms.
- Solar energy, experienced by us as heat and light, can be used through two routes: the thermal route uses the heat for water heating, cooking, drying, water purification, power generation, and other applications

- The photo voltaic route converts the light in solar energy into electricity, which can then be used for a number of purposes such as lighting, pumping, communications, and power supply in unelectrified areas.
- The Ministry of New and Renewable Energy (MNRE) has planned a detailed trajectory so as to meet the target of 100 GW by 2022. A capacity of 23.12 GW was installed up to July 2018.
- Projects of around 10 GW are under implementation and tenders for additional 24.4 GW are issued. India has a good level of solar radiation, receiving the solar energy equivalent of more than 5000 trillion kWh/yr.

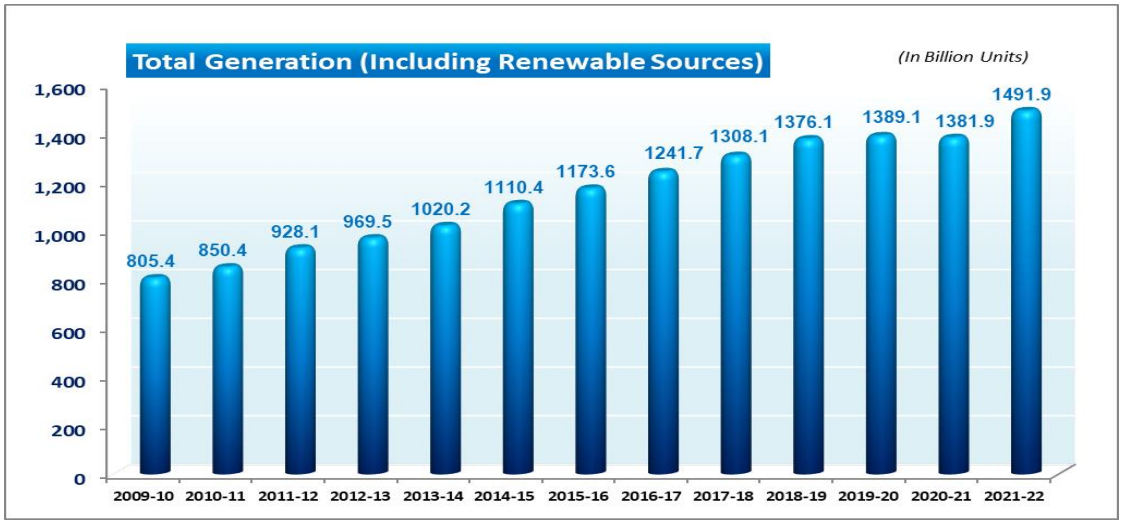
12. write short notes on India's power scenario?

The electricity generation target of thermal, hydro, nuclear & Bhutan import for the year 2021-22 has been fixed as 1356 billion Unit (BU). i.e., growth of around 9.83% over actual generation of 1234.608 BU for the previous year (2020-21). The generation from above categories during 2020-21 was 1234.608 BU as compared to 1250.784 BU generated during 2019-20, representing a negative growth of about 1.29%.

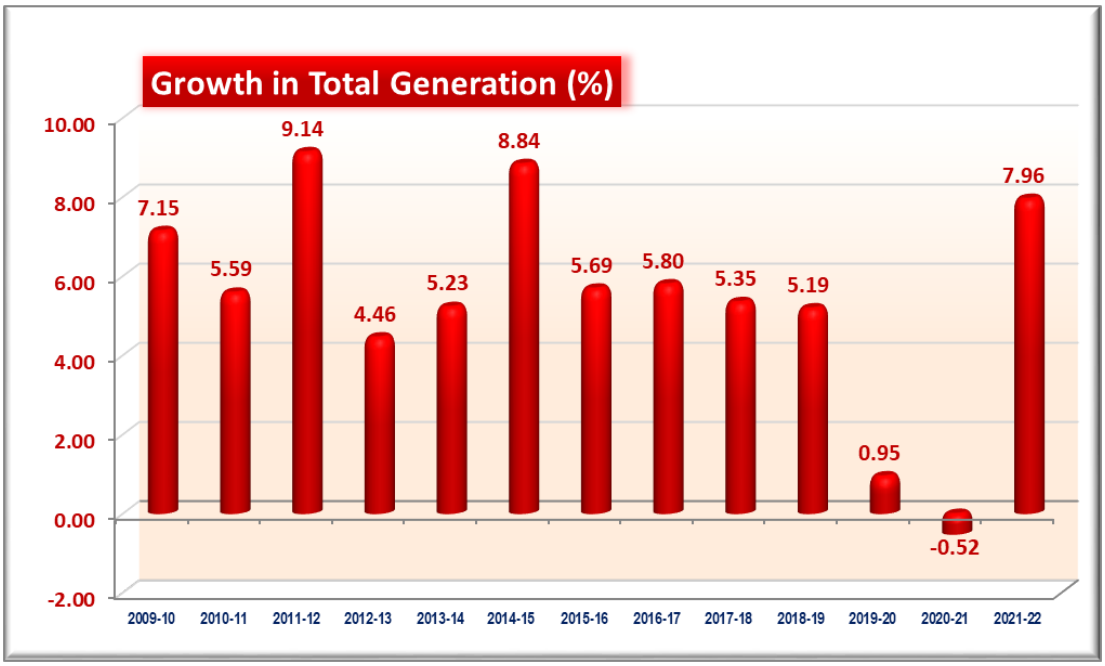
The Overall generation (Including generation from grid connected renewable sources) in the country has been increased from 1110.458 BU during 2014-15 to 1173.603 BU during the year 2015-16, 1241.689 BU during 2016-17, 1308.146 BU during 2017-18, 1376.095 BU during 2018-19, 1389.121 BU during 2019-20, 1381.855 BU during 2020-21 and 1491.859 BU during 2021-22. The performance of Category wise generation during the year 2021-22 was as follows: -

Thermal	Increased by	7.96 %
Nuclear	Increased by	9.49 %
Hydro	Increased by	0.88 %
Bhutan Import	Reduced by	14.51 %
Solar Wind & Other RES	Increased by	16.07 %
Overall Generation	**Increased by**	**7.96 %**

Generation (Billion Units)



Generation Growth (%)



UNIT II

13. (a) Discuss the Advantage and disadvantage of gas turbine plants.

Advantages of gas turbine engines:

- Operating speed is high in this plant.
- In this plant there is no smoke combustion has occurred.
- Gas turbine power plant required less space.
- The capacity of work produced for 1 kg of air is high in this type of plants.
- In this plant the lubrication is process is simple.
- Capital cost is less compared to other power plants.
- In this there is no problem with ash content.
- It has higher mechanical efficiency.
- Required maintenance is less than another one.
- This plant has high reliability.
- At the time of operation, these plants are more flexible.

Disadvantages of gas turbine engines:

- In this plant there is a need of external energy to start a compressor before the turbine gets to start.
- This plant has the different type of metals required than other plants.
- Gas turbine power plant required a special type of cooling system or methods.
- The lifetime of gas turbine power plant is less.
- Layout of this plant is complex than diesel plant.
- Gas turbine plants are more danger or risk than diesel plants.

13. (b) Write short note on disposal of nuclear waste and effluent.

Nuclear Waste Disposal:

Many ends of radioactive wastes such as gaseous, liquid and solid are formed in the various phases of nuclear fuel cycle. These wastes must be disposed off in such a manner that there is no harm to human, animal or plant life. Solids of low and medium level wastes are buried at depths of few meters at carefully selected sites. Gaseous wastes are discharged to the atmosphere through high stacks. Liquids having low or medium level of radioactivity are given preliminary treatment to remove most of the activity in the form of solid precipitate and then discharged in dry wells or deep pits.

Different methods for various nuclear wastes disposed are discussed below:

1. Disposal of level solid waste: Low level solid waste requires little or no shielding. It is usually disposed off by keeping it in a steel or concrete tank. These tanks are buried either few meters below the soil or kept at the bed of the Ocean. This is shown is Fig.2.22.

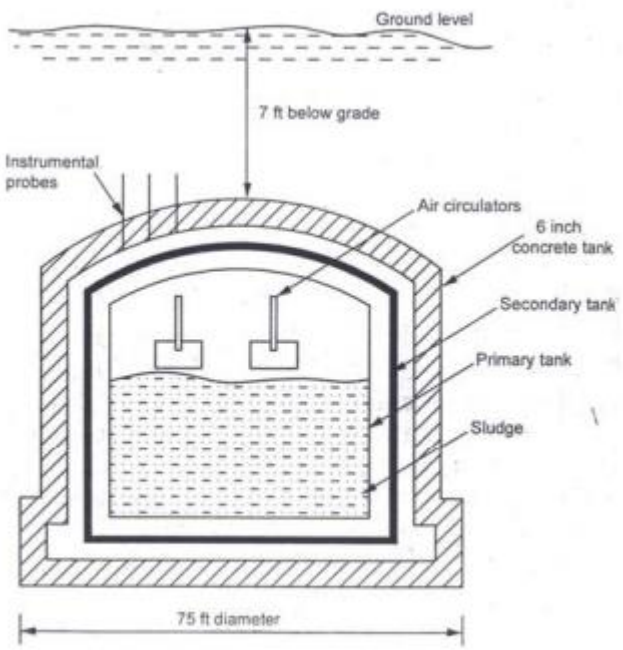


Fig.2.22 Low level solid waste disposal

2. Disposal of medium level solid waste: medium level wastes are mainly contaminated with neutron activation product isotopes. They are in corporate into cement cylinders and cement in non-combustible and provide shielding against external exposure. Cement is also having the ability of resistance to reach by ground water.

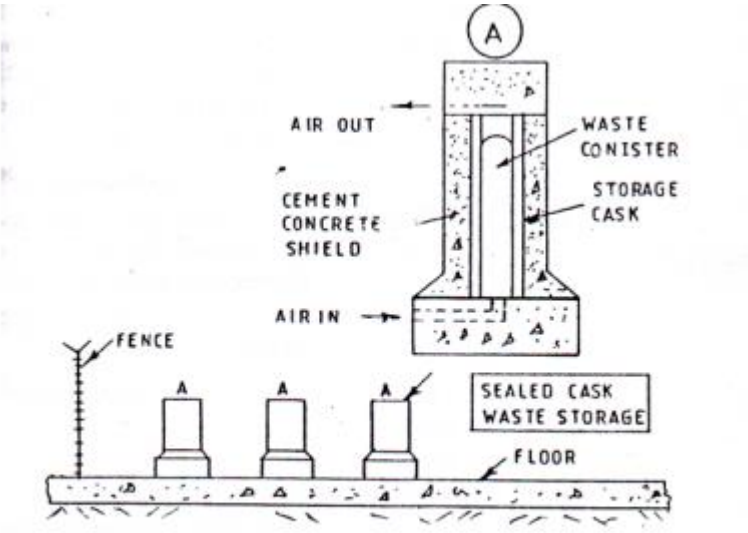


Fig.2.23 Surface storage of nuclear waste

3. Disposal of high-level wastes: Once uranium has been used to generate electricity, it becomes 'spent fuel'. This is the waste product of nuclear reactors and can be dealt with in several ways. As this spent fuel is highly radioactive, it cannot be, and definitely is not, simply dumped. It is often temporarily stored in special ponds that allow the fuel to 'cool down' and decrease its radioactivity. It cannot cause significant damage in these storage ponds. An important factor to address in storing different types of radioactive waste is how long they present a danger to society. Although the spent fuel can be stored in these special ponds for fairly long periods of time, eventually the fuel will need to be either reprocessed, or disposed of. Reprocessing involves separating the remaining uranium and plutonium from the waste products in the spent fuel, by cutting up the fuel rods and dissolving them in acid.

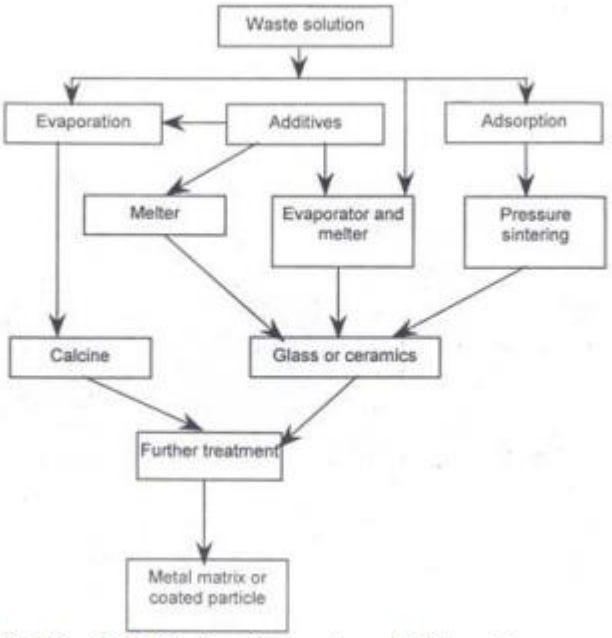


Fig.2.24 Basic high level waste solidification processes

The recovered uranium is then returned to the beginning of the nuclear fuel cycle, and the plutonium is mixed with this to produce more fuel. After reprocessing, the highly radioactive waste can be heated to produce a powder, a process called calcining. This powder is mixed with glass to encapsulate (or lock-in) the waste, a process called vitrification. The liquid glass is then poured into stainless steel canisters for storage and to this day, that is where the nuclear cycle ends.

14. (a) What considerations govern the selection of site for steam power plant. Discuss.

The factors to be considered while selecting a site for a steam power plant for economical and efficient generation are:

1. Nearness to the Load Centre

2. Supply of Water

3. Availability of Coal

4. Land Requirement

5. Type of Land

6. Transportation Facilities

7. Labour Supplies 8. Ash Disposal

1. Nearness to the Load Centre:
The power plant should be as near as possible to the centre of the load so that the transmission cost and losses are minimum. This factor is most important when dc supply system is adopted. However, in case of ac supply system when transformation of energy from lower voltage to higher voltage and vice versa is possible, power plant can be erected at places other than that of centre of load provided other conditions are favourable.

2. Supply of Water:

Large quantity of water is required in a steam power plant.

It is required:
(i) To raise the steam in boilers.

(ii) For cooling purposes such as in condensers.

(iii) As a carrying medium such as disposal of ash and

(iv) For drinking purposes.

In steam power plants approximately 1.26 × 106 kcals of heat per MW per hour has to be disposed of in the condenser. In case of direct circulation from the source of water 120 m3 of water is required per MW per hour for this purpose. In case cooling towers are used about 2.4 m3 of water per MW per hour will be required in addition as make-up water.

3. Availability of Coal:
A huge amount of coal is required for raising the steam (20,000 tonnes per day for a 2,000 MW station). Since the Government policy is to use only low-grade coal with 30 to 40% ash content for power generation purposes, the steam power plant should be located near the coal mines to avoid the transport of coal and ash.

4. Land Requirement:
The land is required not only for setting up the plant but for other purposes also such as staff colony, coal storage, ash disposal etc. For a 2,000 MW plant, the land requirement may be of the order of 200-250 acres. As the cost of the land adds up to the final cost of the plant, it should be available at a reasonable price. Land should be also available for future extension.

5. Type of Land:

Land should be of good bearing capacity since it is to withstand not only the dead load of the plant but also the forces transmitted to the foundations due to the operation of the plant and this total load may amount to about 7 kg per sq. cm. Moreover, the land should be reasonably level and not low lying.

6. Transportation Facilities:
The facilities must be available for transportation of heavy equipment and fuels e.g., near railway station.

7. Labour Supplies:
Skilled and unskilled labourers should be available at reasonable rates near the site of the plant.

8. Ash Disposal:
Ash is the main waste product of the steam power plant and with low grade coal, it may be 3.5 tonnes per day, hence some suitable means for disposal of ash should be thought of. It may be purchased by building contractors, or it can be used for brick making near the plant site.

14. (b) Write short note on fast breeder reactor?

Fast Breeder Reactor (FBR):

In fast breeder reactors, enriched Uranium (U^{235}) or Plutonium is kept in the casing without using moderator, The casing is surrounded by a thick blanket of fertile Uranium (U^{238}). This is known as *breeding material.* Fig.2.21. shows a schematic diagram of a fast breeder reactor. Fast moving neutrons are liberated due to fission of enriched uranium (U^{235}). The ejected excess neutrons are absorbed by the fertile Uranium (U^{238}) which is converted into fissionable material (PU^{239}). The fissionable material (P U^{239}) is capable of sustaining chain reaction.

The reactor employs two liquid metal coolant circuits as shown in Fig.2.21. Liquid sodium (Na) is used as primary coolant. Sodium potassium (NaK) alloy is used as secondary coolant.

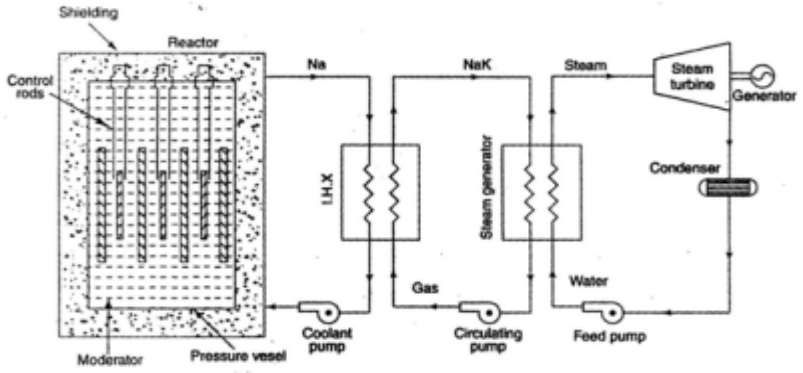


Fig.2.21 Fast Breeder Reactor

There are two heat exchangers used in this power plant. One is intermediate heat exchanger (IHE) and other is steam generator. The intermediate heat exchanger is used to transfer heat from primary coolant (Na) to secondary coolant (Na K). The feed water is heated in the steam generator by the hot secondary coolant. The steam produced in the steam generator is then utilized for power generation.

Advantages:

1. No moderator is required.
2. High efficiency in the order of 40% can be obtained.
3. Better fuel utilization.

UNIT III

15.(a) discuss the merits and limitation of ocean energy conversion plants.

merits of ocean energy conversion

- Power developed is continuous and it is independent of weather.
- There is a small variation in power output from season to season.
- The system uses conventional power plants needing only small changes in design.
- It can produce simultaneously the desalinated water and nutrients for agriculture.
-

limitation of ocean energy conversion

- Capital cost is very high.
- Efficiency of energy conversion is very low.
- Needs very large sized turbines due to use of low pressure of steam having high specific volume in case of open cycle.
- It uses expensive power working fluids in case of closed cycle.
- Cost of electric power generation per kWh is very high.

15. (b) Why is it necessary to operate hydro and thermal plant in combination? Discuss.

Socio-economic development through industrialization and improvement in living standard with ever increasing population needs huge energy requirement for its sustainable growth. Securing a cheap energy supply and minimizing adverse environmental impact is the primary goal of any country. Coal is the primary source of energy in India whose reserve is about 6.8% of the world's total reserve and about 65% of the total power generation is from coal-based thermal power plants. Thermal power plants are running with less efficiency due to large amount of heat energy being rejected from condenser through its cooling system. This depletes not only the natural resources (i.e. mainly coal) but also creates environmental hazards. These difficulties may be reduced through implementation of an alternative technology for power generation.

Hydro-power generation technology is the one of the best solutions as it is well developed technology. Availability of suitable site and its location from consumers are the key issues for hydro-power installation in India. In this context, hydro-power plant installation in thermal power plant may be one of the best solutions for plant capacity addition. A 500MWe coal-fired thermal power plant continuously uses clarified water with flow rate of about 16.25 m3 /s and 0.972 m3 /s for its condenser and demineralized (DM) water cooling system respectively. This large amount of hot cooling water from condenser and plate type heat exchanger (PHE) is fed to cooling tower (CT) for recycling it into the CW basin from CT basin with the gross head difference of 1.5m for avoiding the hydraulic jump and vortex effect.

16. (a) write short note on environmental aspects of hydro power plant?

Environmental aspects of hydro power

Although the hydro power plants emit no air pollution and sewage however barrage construction has considerable environmental impact. Construct across the river structures provide to eco-system changes in wide area, specially endangered species of plants and animals. To allow for fish migration, barrage has special ducts but that solution is related with additional costs and decrease units' efficiency. Therefore, in special case fish like trout are delivered to the upper reaches by human.

Local society is polarized. Proponents of ecology usually against hydro power plant in their region. That group also consist of people who can lost their realty or land (what is related with project), people whom business can suffer if would operate in their neighbourhood and generally the smallest group undecided people which opt for the most. However, such a hydro investment has also many followers due to power plant brings a lot of benefit for a region. In case of large units, a barrage can be used as a bridge what improves community values. Dam can also be a tourist attraction especially in case of pump storage unit which usually has large upper reservoir. The reservoir may support local tourism market what is related with workplace increase. Security of local supply is the next advantage. Moreover, new workplaces for technicians and engineers are related with power plant. On flood areas barrage also improve management of water resource what may prevent local society against floods.

16. (b) Discuss the importance of short term hydro thermal coordination?

Modern Power system consists of a large number of thermal and hydel plants connected at various load centre through a transmission network.

Our important objective is generate and transmit power to meet the load demand at minimum cost by optimal mix of different types of plants.

Therefore the study of the optimal scheduling for power generation at different plants in a power system is of high importance.

Thermal Power Plant	Hydel Power Plant
▶ It is non-renewable source of energy	▶ It is renewable source of energy
▶ Initial cost is low	▶ Initial cost is high
▶ But operational cost is high	▶ But operational cost is low
▶ It produces air pollution	▶ It is a clean source of energy

The operating cost of thermal plant is very high , though their initial cost is low.

On the other hand the operating cost is low in case of hydroelectric generation

Due the low operating cost in case of hydel plants so we can operate it in conjuction with thermal plants which will lead to save fuel

So Hydrothermal scheduling is a power system optimization problem which gives us idea how to manage the hydel and thermal plant combinely.

Hydrothermal scheduling is classified into two parts , that are

- a)Long range Problem : This type of scheduling having the scheduling interval of a month or a year.
- b)Short range Problem : This type of scheduling having the scheduling interval of a day or a week.

According to this different mathematical formulations are made

Generally optimization is a technique in which we try to maximize our profit or gain and to minimize loss or expenditure under some pratical conditions known as constraints.

In load flow analysis we know that every bus associated with four operational variables like P,Q,|V| and δ.Out of these four,two are specified variable and other two are not given.

According to these two specified variables we have three types bus that are PQ bus(Load bus),PV bus(Generator Bus),Slack bus.

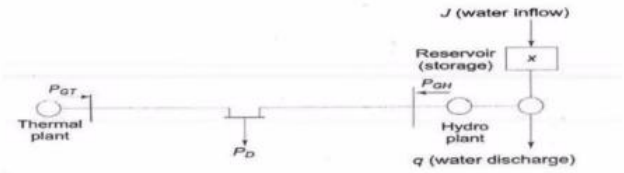
Operation of the system having both hydro and thermal power plants is a complex method.

We perform static optimization when the plant is thermal power plant

But hydro thermal scheduling is a dynamic optimization due to the water constraint i.e. water availability.

There are basically three types of hydroelectric plant but we use storage type because optimization possible in storage tank

For easy analysis we consider one hydro and one thermal power plant supplying power to load and it is called as fundamental system given as below



UNIT IV

17. With a help of neat diagram explain the various components of wind energy conversion system?

Main Components of a wind-mill:

Following Fig.4.4 shows typical components of a horizontal axis wind mill.

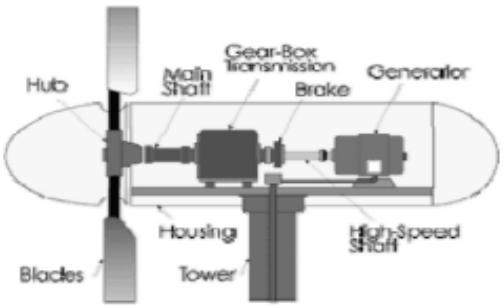


Fig.4.4 Typical components of a horizontal axis wind mill

Rotor:

The portion of the wind turbine that collects energy from the wind is called the rotor. The rotor usually consists of two or more wooden, fiberglass or metal blades which rotate about an axis (horizontal or vertical) at a rate determined by the wind speed and the shape of the blades. The blades are attached to the hub, which in turn is attached to the main shaft.

Drag Design :

Blade designs operate on either the principle of drag or lift. For the drag design, the wind literally pushes the blades out of the way. Drag powered wind turbines are characterized by slower rotational speeds and high torque capabilities. They are useful for the pumping, sawing or grinding work. For example, a farm-type windmill must develop high torque at start-up in order to pump, or lift, water from a deep well.

Lift Design:

The lift blade design employs the same principle that enables airplanes, kites and birds to fly. The blade is essentially an airfoil, or wing. When air flows past the blade, a wind speed and pressure differential is created between the upper and lower blade surfaces. The pressure at the lower surface is greater and thus acts to "lift" the blade. When blades are attached to a central axis, like a wind turbine rotor, the lift is translated into rotational motion. Lift-powered wind turbines have much higher rotational speeds than drag types and therefore well suited for electricity generation.

Following Fig.4.5 gives an idea about the drag and lift principle.

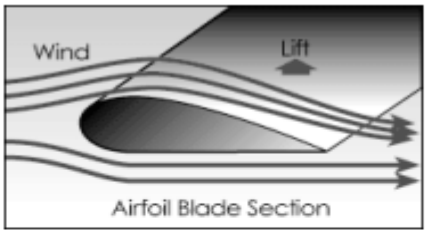


Fig.4.5 Drag and lift principle

Tip Speed Ratio:

The tip-speed is the ratio of the rotational speed of the blade to the wind speed. The larger this ratio, the faster the rotation of the wind turbine rotor at a given wind speed. Electricity generation requires high rotational speeds. Lift-type wind turbines have maximum tip-speed ratios of around 10, while drag-type ratios are approximately 1. Given the high rotational speed requirements of electrical generators, it is clear that the lift-type wind turbine is most practical for this application.

The number of blades that make up a rotor and the total area they cover affect wind turbine performance. For a lift-type rotor to function effectively, the wind must flow smoothly over the blades. To avoid turbulence, spacing between blades should be great enough so that one blade will not encounter the disturbed, weaker air flow caused by the blade which passed before it. It is because of this requirement that most wind turbines have only two or three blades on their rotors.

Generator:

The generator is what converts the turning motion of a wind turbine's blades into electricity. Inside this component, coils of wire are rotated in a magnetic field to produce electricity. Different generator designs produce either alternating current (AC) or direct current (DC), and they are available in a large range of output power ratings. The generator's rating, or size, is dependent on the length of the wind turbine's blades because more energy is captured by longer blades.

It is important to select the right type of generator to match intended use. Most home and office appliances operate on 240 volt, 50 cycles AC. Some appliances can operate on either AC or DC, such as light bulbs and resistance heaters, and many others can be adapted to run on DC. Storage systems using batteries store DC and usually are configured at voltages of between 12 volts and 120 volts.

Generators that produce AC are generally equipped with features to produce the correct voltage of 240 V and constant frequency 50 cycles of electricity, even when the wind speed is fluctuating.

Transmission:

The number of revolutions per minute (rpm) of a wind turbine rotor can range between 40 rpm and 400 rpm, depending on the model and the wind speed. Generators typically require rpm's of 1,200 to 1,800. As a result, most wind turbines require a gear-box transmission to increase the rotation of the generator to the speeds

necessary for efficient electricity production. Some DC-type wind turbines do not use transmissions. Instead, they have a direct link between the rotor and generator. These are known as direct drive systems. Without a transmission, wind turbine complexity and maintenance requirements are reduced, but a much larger generator is required to deliver the same power output as the AC-type wind turbines.

Tower:

The tower on which a wind turbine is mounted is not just a support structure. It also raises the wind turbine so that its blades safely clear the ground and so it can reach the stronger winds at higher elevations. Maximum tower height is optional in most cases, except where zoning restrictions apply. The decision of what height tower to use will be based on the cost of taller towers versus the value of the increase in energy production resulting from their use. Studies have shown that the added cost of increasing tower height is often justified by the added power generated from the stronger winds. Larger wind turbines are usually mounted on towers ranging from 40 to 70 meters tall.

Towers for small wind systems are generally "guyed" designs. This means that there are guy wires anchored to the ground on three or four sides of the tower to hold it erect. These towers cost less than freestanding towers, but require more land area to anchor the guy wires. Some of these guyed towers are erected by tilting them up. This operation can be quickly accomplished using only a winch, with the turbine already mounted to the tower top. This simplifies not only installation, but maintenance as well. Towers can be constructed of a simple tube, a wooden pole or a lattice of tubes, rods, and angle iron. Large wind turbines may be mounted on lattice towers, tube towers or guyed tilt-up towers.

Towers must be strong enough to support the wind turbine and to sustain vibration, wind loading and the overall weather elements for the lifetime of the wind turbine. Their costs will vary widely as a function of design and height.

18. Discuss the role distributed generation in electric power system? Bring out its applications and advantages.

About Distributed Generation

Distributed generation refers to a variety of technologies that generate electricity at or near where it will be used, such as solar panels and combined heat and power. Distributed generation may serve a single structure, such as a home or business, or it may be part of a microgrid (a smaller grid that is also tied into the larger electricity delivery system), such as at a major industrial facility, a military base, or a large college campus. When connected to the electric utility's lower voltage distribution lines, distributed generation can help support delivery of clean, reliable power to additional customers and reduce electricity losses along transmission and distribution lines.

In the residential sector, common distributed generation systems include:

- Solar photovoltaic panels
- Small wind turbines
- Natural-gas-fired fuel cells
- Emergency backup generators, usually fuelled by gasoline or diesel fuel

In the commercial and industrial sectors, distributed generation can include resources such as:

- Combined heat and power systems
- Solar photovoltaic panels
- Wind
- Hydropower

- Biomass combustion or cofiring
- Municipal solid waste incineration
- Fuel cells fired by natural gas or biomass
- Reciprocating combustion engines, including backup generators, which are may be fueled by oil

Application:

Results will allow for the ability to reduce peak heating and cooling loads, among other loads

To design an alternate means to DSM for heating/cooling, lighting etc, that is more energy efficient than current methods.

Energy usage during system peaks can be reduced considerably.

System is noiseless and environmentally friendly, with minimal emissions.

Provides a solution to unpredictable event of power outage from the electricity utility.

Advantages:

Proximity of DG installation to the customer

DG can eliminate the need for customer to upgrade existing T&D networks to handle extra power requirements.

Provides customer with adequate power quality and increased reliability of supply

Allows for customer to participate in competitive electric power markets.

Mitigate congestions in transmission lines

Influence price fluctuations, strengthen energy security and provide stability to electricity grid.

UNIT V

19. (a) Explain how the energy conservation method can be implemented to heat exchanger?

Heat exchangers are equipment that transfer heat from one medium to another. The proper design, operation and maintenance of heat exchangers will make the process energy efficient and minimize energy losses. Heat exchanger performance can deteriorate with time, off design operations and other interferences such as fouling, scaling etc. It is necessary to assess periodically the heat exchanger performance in order to maintain them at a high efficiency level. This section comprises certain proven techniques of monitoring the performance of heat exchangers, coolers and condensers from observed operating data of the equipment.

Purpose of the Performance Test To determine the overall heat transfer coefficient for assessing the performance of the heat exchanger. Any deviation from the design heat transfer coefficient will indicate occurrence of fouling.

Instruments for monitoring: The test and evaluation of the performance of the heat exchanger equipment is carried out by measurement of operating parameters upstream and downstream of the exchanger. Due care needs to be taken to ensure the accuracy and correctness of the measured parameter. The instruments used for measurements require calibration and verification prior to measurement.

Parameters	Units	Instruments used
Fluid flow	kg/h	Flow can be measured with instruments like Orifice flow meter, Vortex flow meter, Venturi meters, Coriollis flow meters, Magnetic flow meter as applicable to the fluid service and flow ranges
Temperature	°C	Thermo gauge for low ranges, RTD, etc.
Pressure	Bar g	Liquid manometers, Draft gauge, Pressure gauges Bourdon and diaphragm type, Absolute pressure transmitters, etc.
Density	kg/m^3	Measured in the Laboratory as per ASTM standards, hydrometer, etc
Viscosity	MpaS	Measured in the Laboratory as per ASTM standards, viscometer, etc.
Specific heat capacity	J/(kg.K)	Measured in the Laboratory as per ASTM standards
Thermal conductivity	W/(m.K)	Measured in the Laboratory as per ASTM standards
Composition+	%wt (or) % Vol	Measured in the Laboratory as per ASTM standards using Chemical analysis, HPLC, GC, Spectrophotometer, etc.

19. (b) Discuss the role and responsibility of energy manager.

Energy manager occupies an important position and is a focal point of all the activities pertaining to energy management in the organization. The energy manager provides leadership in the development of policy on energy management action plan and plays a key role in the formulation of corporate energy policy. Energy managers also perform the activities related with plant energy management, project management, personnel management and financial management at the plant level. He also prepares the information to be submitted to the designated agency with

regard to the energy consumed and action taken on the recommendation of the accredited energy auditor. Bureau of Energy Efficiency (BEE) has taken up the challenge of creating a cadre of professionally qualified energy managers with expertise in energy management, project management, financing and implementation of energy efficiency projects, and policy analysis. BEE has been empowered by the law for directing designated consumers (power intensive

industries) to designate or appoint certified energy managers in charge of activities for efficient use of energy and its conservation. According to Mr. K. K. Chakarvarti, Energy Economist, Bureau of Energy Efficiency, the responsibilities and duties of an energy manager are as follows:

Responsibilities:

• Prepare an annual activity plan and present to management concerning financially attractive investments to reduce energy costs.

• Establish an energy conservation cell within the firm with management's consent about the mandate and task of the cell.

• Initiate activities to improve monitoring and process control to reduce energy costs.

• Analyze equipment performance with respect to energy efficiency.

• Ensure proper functioning and calibration of instrumentation required to assess level of energy consumption directly or indirectly.

• Prepare information material and conduct internal workshops about the topic for other staff.

• Improve disaggregating of energy consumption data down to shop level or profit center of a firm.

• Establish a methodology how to accurately calculate the specific energy consumption of various products/services or activity of the firm.

• Develop and manage training programmed for energy efficiency at operating levels.

• Co-ordinate nomination of management personnel to external program.

• Create knowledge bank on sectoral, national and international development on energy efficiency technology and management system and information dissemination.

• Develop integrated system of energy efficiency and environmental upgradation.

• Co-ordinate implementation of energy audit/efficiency improvement projects through external agencies.

20. (a) Write short note on cogeneration?

Definition and Need:

In conventional power plant, efficiency is only 35% and remaining 65% of energy is lost. Also, further losses of around 10-15% are associated with the transmission and distribution of electricity in the electrical grid. These losses are greatest when electricity is delivered to the smallest consumers. Cogeneration is the simultaneous generation of heat and power, both of which are used. In cogeneration system efficiency can go up to

90% and above. Since, electricity generated by cogeneration plant is normally used locally and hence the transmission and distribution losses are negligible.

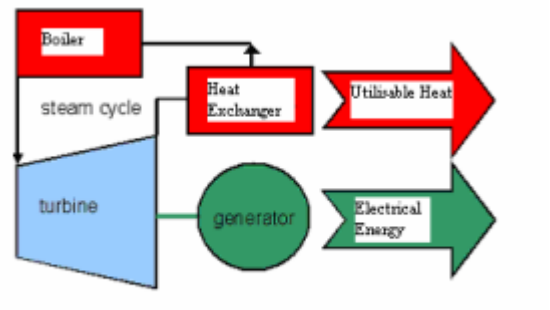


Fig.5.3 Cogeneration system

When steam or gas expands through a turbine, nearly 60 to 70% of the input energy escapes with the exhaust steam or gas. If this energy in the exhaust steam or gas is utilized for meeting the process heat requirements, the efficiency of utilization of the fuel increases. Such an application, where the electrical power and process heat requirements are met from the fuel, is termed as "Cogeneration". Since, most of the industries need both heat and electrical energy, cogeneration can be a sensible investment for industries. Cogeneration is also known as 'Combined Heat and Power (CHP)' and 'Total Energy System'. Cogeneration therefore offers energy savings ranging between 15-40% when compared against the supply of electricity and heat from conventional power stations and boilers. The following example gives comparison between cogeneration system and separate heat and power generation.

20. (b) Discuss the objectives of energy management program?

The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization, throughout the organization and:

• To minimize energy costs / waste without affecting production & quality

• To minimize environmental effects.

Designing an Energy Management Program Fundamental to the effective implementation of energy efficiency is good management. Like any resource that an organization employs, energy will only be used efficiently if it is managed properly. Good energy management, in itself saves energy.

Energy management can be broken down into a number of key areas:

• Preparation of Policy Statement

• Appointment of Energy Manager

• Planning and organizing

• Monitoring and control

• Conducting an Energy Audit

• Motivating People

• Reporting and review

• Formalized an energy Management Policy Statement

All these steps are necessary for effective energy management. However, the extent of criticality and type of approach would depend on the nature and size of the organization. Energy management is a highly cost-effective tool requiring very little capital. None-the less effective application needs total commitment from the top management, allocation of requisite time and patience.