

UNIT 4

IMPORTANT QUESTIONS

Q1. Discuss various biological energy sources along with their merits and demerits.

Ans. Various biological energy sources are as follows:

a. Solar Energy:

1. Solar energy is a clean, affordable, and abundant renewable energy source. It is also the most essential of the non-conventional energy sources because it is non-polluting and thus helps to reduce the greenhouse effect.
2. Solar energy can be used:
 - i. By direct conversion to a fuel by photosynthesis.
 - ii. By direct conversion to electricity by photovoltaic.
 - iii. By conversion to electricity via thermo-electric power system.
3. The sun emits vast amounts of energy as a result of the constant fusion reaction that occurs inside the solar.
4. The sun sends out the energy in the form of radiations at the rate of 3.7×10^{20} MW.
5. However, the energy intercepted by the earth is about 1.85×10^{11} MW.
6. This available energy is several times greater than all of the energy produced and consumed in the planet.

i. Merits:

1. Noiseless operation.
2. There is no need for storage vessels, therefore it takes up less floor area.

ii. Demerits:

1. Solar equipment does not work at night, on gloomy days, or during the rainy season.
2. Solar energy collecting at a useful rate necessitates a large amount of space.

b. Hydro Energy :

1. It is a type of renewable energy that is utilised to generate power.
2. Water flow or falling water from a height is used to generate hydropower.
3. Water trapped at a height behind a dam contains a lot of potential energy, which is transformed into mechanical and electrical energy.
4. The water is gradually released and allowed to descend under the gravity force, which drives hydraulic turbines.
5. The electricity is generated by generators linked to the turbine.

i. Merits :

1. During operation, hydropower does not harm the water or the air, and no waste products are produced.

ii. Demerits:

1. It causes ecological disruption, such as flooding, and has a negative impact on flora and animals.

c. Wind Energy:

1. Wind energy is a non-polluting renewable energy source with enormous potential that, if exploited, may easily meet a country's energy demands.

2. According to estimates, 2% of total solar energy falling on Earth is transformed to kinetic energy in the atmosphere.
3. 30% of this kinetic energy occurs in the lowest 1000 m of elevation, implying that wind has the most kinetic energy at the lowest kilometre, which can be transformed into mechanical energy and used to generate electricity or perform other useful tasks.
4. Because wind has energy due to its speed, the device used to harvest its energy should be capable of slowing down the wind.

i. Merits:

1. Abundance availability for no price.
2. Useful at remote places for electricity generation.

ii. Demerits:

1. Less favourable in city locations as the wind is available at higher locations.
2. It is unreliable and intermittent. It is not available regularly.

d. Wave Energy:

1. The movement of the sea surface in the form of wind waves generates energy.
2. Floating propellers are positioned in shallow seas near the coasts, and when the waves move, so do the propellers, and this kinetic energy can be used to drive turbines.

i. Merits :

1. This is cheap, clean and inexhaustible source of energy.
2. The collector size of wave machines is smaller than that of solar devices.

ii. Demerits:

1. Corrosion of materials used in plant.

e. Geothermal Energy:

1. Geothermal energy is the energy derived from the hot rocks found deep within the earth.
2. The temperature of the earth rises as one descends deeper beneath the surface.
3. As we move further from the planet's surface, the fission of radioactive material naturally existing in the rocks raises the temperature of the earth.
4. The earth's core contains hot molten rocks known as magma. This occasionally results in volcanic activity.
5. This hot steam is used to operate turbines to generate electricity.
6. It can also be harnessed artificially by digging heated rocks, causing hot water to pour out through pipelines, turning the turbine of the generator to produce power.

i. Merits:

1. It is cheap and clean source of energy.
2. Geothermal plants require little land area.

ii. Demerits:

1. The discharge of gases such as H₂S and NH₃ from steam waste causes air pollution.
2. The drilling operations cause noise pollution.

Q2. Write a short note on following:

i. Coal energy, and ii. Natural gas

Ans. i. Coal Energy:

1. Coal is a conventional energy source.

2. It is generated as a result of the decay of trees and plants buried beneath layers of silt.
3. It is composed of mainly carbon and hydrocarbons.
4. Uses of coal :
 - i. Electricity is generated using coal. Coal is used in power plants to heat water, which generates steam, which drives turbines to generate electricity.
 - ii. Coal is burnt in a furnace to produce coke, which is used to melt iron to produce steel.
5. Environmental problems:
 - i. Carbon dioxide is produced as a result of coal burning, which is responsible for global warming.
 - ii. Coal also emits sulphur dioxide, which contributes to acid rain.

ii. Natural Gas :

1. Natural gas is created by the decomposition of deceased animals and plants that have been buried beneath the earth.
2. It is mainly composed of methane (CH₄) with small amount of propane and ethane.
3. Natural gas is the most environmentally friendly fossil fuel.
4. Uses of natural gas:
 - i. It is used as a domestic and industrial fuel.
 - ii. It is also used to generate electricity in thermal power plants.
5. Advantages of natural gas:
 - i. Natural gas has a high calorific value and burns cleanly.
 - ii. It is easily transported through pipes.

Q3. State Bernoulli's theorem for fluid flow

Ans.

1. Bernoulli's theorem asserts that the total energy at any point in an incompressible fluid in a steady, ideal flow is constant.
2. It can be mathematically stated as given below,
Pressure energy + Kinetic energy + Potential energy = Constant
3. Bernoulli's equation for real fluids is,

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + h_L$$

Where, h_L = Loss of energy.

Q4. Explain the following:

- i. Steady and unsteady flows,
- ii. Laminar and turbulent flows,
- iii. Rotational and irrotational flows,
- iv. Compressible and incompressible flows, and
- v. Uniform and non-uniform flows.

Ans. i. Steady and Unsteady Flows:

1. A steady flow is one in which the fluid parameters, such as velocity, pressure, density, and so on, do not change over time.
2. Unsteady flow is defined as flow in which the velocity, pressure, density, and so on at a given point change over time.

ii. Laminar and Turbulent Flows:

1. Laminar flow occurs when fluid particles move along well-defined routes or stream lines that are all straight and parallel.
2. Turbulent flow is characterised by particles moving in a zig – zag pattern.

iii. Rotational and Irrotational Flows:

1. Rotational flow is a type of flow in which fluid particles spin on their own axis while flowing along stream lines.
2. Irrotational flow occurs when fluid particles do not rotate about their own axis while flowing along stream lines.

iv. Compressible and Incompressible Flows:

1. Compressible flow is defined as flow in which the fluid density varies from point to point.
2. Incompressible flow is defined as flow in which the density of the fluid remains constant.

v. Uniform and Non-uniform Flows:

1. Uniform flow is defined as flow in which the velocity does not change with regard to space at any given moment.
2. Non-uniform flow is defined as flow in which the velocity fluctuates with regard to space at any given time.

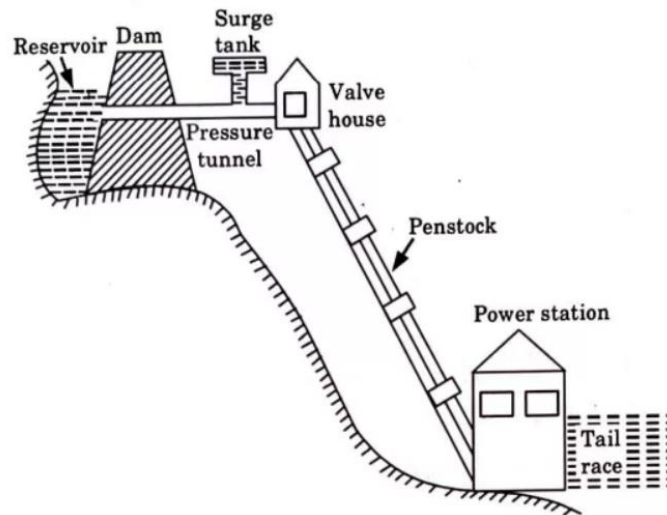
Q5. Write a short note on wind farms.

Ans.

1. Wind farms or wind parks frequently have a large number of turbine generator units.
2. Wind farms are located in open places away from forests, cities, and mountains, with an average yearly wind speed of no less than 7 m/s and close to the distribution centre.
3. Because each turbine captures a portion of the wind's energy, sufficient spacing between turbines is critical to avoid excessive energy loss.
4. A wind farm can have anywhere from 10 to 50 turbines depending on its size.
5. To minimise loss inefficiency, turbines are separated three to five rotor diameters apart perpendicular to the prevailing wind, and five to ten rotor diameters apart in the direction of the prevailing wind.

Q6. Give general layout and function of essential element of hydroelectric power plant.

Ans. A. General Layout: Fig. depicts a generic structure of a hydroelectric power plant, including an artificial storage reservoir built by constructing a dam.



B. Functions of Essential Element of Hydroelectric Power Plant :

- i. Reservoir:** Its purpose is to store water that can be used to power the prime mover and generate electricity.
- ii. Dam:** The dam's function is to provide a head of water for use in the water turbine.
- iii. Trash Rack:** The goal of installing a garbage rack is to prevent entrance debris from damaging the wicket gates and turbine runners or choking the impulse turbine nozzles.
- iv. Forebay:** The forebay functions as a regulating reservoir, temporarily storing water when the plant's load is lowered and providing water for initial increase due to growing load, during which time water in the canal is accelerated.
- v. Surge Tank :** This is an additional storage space near the turbine that is typically given in high head, medium head plants when there is a significant distance between the water source and the turbine, necessitating a long penstock.
- vi. Penstock:** It is a water conveyance system that transports water from the intake works and forebay to the turbines.
- vii. Spillway:** This could be thought of as a dam's safety valve. A spillway is used to drain surplus water from a reservoir that exceeds the maximum allowable level.
- viii. Power House:** It is normally positioned near the storage reservoir and at the foot of the dam.
- ix. Prime mover:** The prime mover's aim is to transform the kinetic energy of water into mechanical energy.