UNIT 1 INTRODUCTION TO POWER PLANTS

Structure

1.1 INTRODUCTION

Whenever, we are going to study about the power plants, we must know about the sources of energy. In this unit, we will be discussing the concepts of various power plants, their advantages and disadvantages. Fuels used in the power plants. The important fuels used in the power plants like, coal, diesel, steam, uranium, etc. are also clearly described here.

Objectives

After studying this unit, you should be able to

- understand the concept of power plant,
- understand the types of power plants,
- know the types of fuels, and
- describes the main components of power plants.

1.2 SOURCES OF ENEGY – FUELS

There are many different ways in which the abundance of energy around us can be stored, converted, and amplified for our use. To help understand the key energy sources that will play an important role in the world's future, it is required to familiarize with some of the history, theory, economics, and problems of the various types of energy.

The energy sources have been split into three categories: fossil fuels, renewable sources, and nuclear sources. The fossil fuels here are coal, petroleum, and natural gas. The renewable energy sources are solar, wind, hydroelectric, biomass, and geothermal power. The nuclear-powered sources are fission and fusion.

1.2.1 Types of Fuels

Fossil Fuels

Fossil fuels have been a widely used source of energy ever since the Industrial Revolution just before the dawn of the 20th century. Fossil fuels are relatively easy to use to generate energy because they only require a simple direct combustion. However, a problem with fossil fuels is their environmental impact. Not only does their excavation from the ground significantly alter the environment, but their combustion leads to a great deal of air pollution.

Theory

The theory behind fossil fuels is actually quite simple. Burning coal, natural gas, and petroleum releases energy stored in the fuel as heat. The energy contained by the fuels is derived from the energy of the sun.

The heat that is recovered upon combustion of the fuel can be used by us in several ways. Industrial processes that require extremely high temperatures may burn a great deal of very pure coal known as "coke" and use the energy released to directly heat a system. Some people make use of clean burning natural gas to heat their homes. Combustion of fossil fuels can also be used to generate electricity; the fuel is burned to heat water, and the steam from the boiling water spins turbines that power a generator, thereby manufacturing electricity:

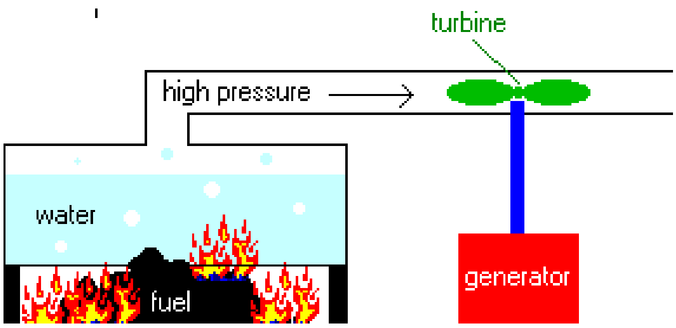

Figure 1.1 : Steam Power Generator

1.3 COAL

About 300 million years ago, enormous ferns and other prehistoric plants were common on the swamp-like earth. When those plants died and fell to the ground, they were covered with water and they slowly decomposed. As decomposition took place in the absence of oxygen, much of the hydrogen content of the matter was eroded away, leaving a material rich in carbon. The material was compressed over the years by sand and dirt, leaving the form of carbon known as coal.

Types

The nature of coal is such that the higher the carbon content, the more cleanly and brilliantly the coal burns. Thus "peat", which is the state of the decomposing plants before being compressed, is a weak, impure substance. The other states of coal from lowest carbon content to highest are lignite, bituminous coal, and anthracite coal. If the coal is heated and compressed even more, the result is graphite, almost completely pure carbon.

Nearly all the different forms of coal are used in some way or another. For instance, peat has been used for burning in furnaces, whereas bituminous coal is used extensively for the generation of electricity. "Coke", a very pure form of coal with high heat content is used primarily in the steel industry, where high temperatures are required.

1.4 POLLUTION

Global Warming

Scientists believe that global warming is caused by the Greenhouse effect. The greenhouse effect describes the accumulation of carbon dioxide in our earth's atmosphere. A layer of gas forms that traps heat inside the atmosphere, thereby acting as the glass ceiling of a greenhouse. Because heat is trapped by the carbon dioxide, it is believed that the earth is slowly warming. A potential danger of global warming is the melting of the so-called polar ice caps at the north and south poles. This occurrence would cause the ocean level to rise and perhaps flood many coastal cities.

The Advent of Fossil Fuels

Before humans were around on the earth, there was a relatively even recycling of carbon dioxide and oxygen. Plants require carbon dioxide to live, and they emit oxygen in return. Animals, on the other hand, need oxygen, but exhale carbon dioxide. But as humans began to burn fossil fuels to create energy (especially beginning just before the 20th century during the Industrial Revolution), more and more carbon dioxide was emitted into the air until the balance was slowly destroyed.

How Do Fossil Fuels and Biomass Pollute?

All fossil fuels and biomasses consist of carbon and hydrogen atoms. When these fuels are burned, or combusted, carbon atoms unite with oxygen in the air to form carbon dioxide :

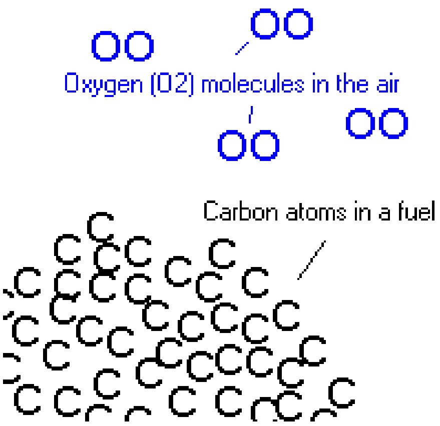

Figure 1.2 : Fossil Fuels

Other Polluting Byproducts of Fossil Fuel and Biomass Burning

Carbon dioxide is not the only byproduct of direct combustion of fuel. Small particulates that can become imbedded in the human respiratory system are also emitted. Particulates can cause coughing and damage to the lungs. Further, they can lead to cancer and lung disease.

Carbon monoxide is produced when less oxygen is available in the immediate area. Carbon monoxide is more directly harmful to humans because it is odorless, colorless, and reduces the body's ability to transport oxygen. This leads to fatigue, nausea, and headaches.

The Spectrum of Pollution

Materials on the low end of the energy scale such as wood and charcoal create the most pollution. Sources on the high end of the energy scale, such as natural gas burn very cleanly resulting in less air pollution.

1.5 HYDROELECTRIC

Man has utilised the power of water for years. Much of the growth of early colonial industry can be attributed to hydropower. Because fuel such as coal and wood were not readily available to inland cities, settlers were forced to turn to other alternatives. Falling water was ideal for powering sawmills and grist mills.

As coal became a better-developed source of fuel, however, the importance of hydropower decreased.

Theory

Hydroelectric systems make use of the energy in running water to create electricity. In coal and natural gas systems, a fossil fuel is burned to heat water. The steam pressure from the boiling water turns propellers called turbines. These turbines spin coils of wire between magnets to produce electricity. Hydro powered systems also make use of turbines to generate electrical power; however, they do so by using the energy in moving water to spin the turbines.

Water has kinetic energy when it flows from higher elevations to lower elevations. The energy spins turbines like as shown in Figure 1.3.

In larger scale hydroelectric plants, large volumes of water are contained by dams near the generator and turbines. The "forebay" is a storage area for water that must be deep enough that the penstock is completely submerged. The water is allowed to flow into the electricity-generating system through a passage called the penstock. The controlled high-pressure water spins the turbines, allowing the generator to produce an electric current. The powerhouse contains and protects the equipment for generating electricity. The high-pressure water exits the system through a draft tube. The fish ladder attempts to minimise the environmental impact of hydroelectric systems by providing a path for migrating fish to take.

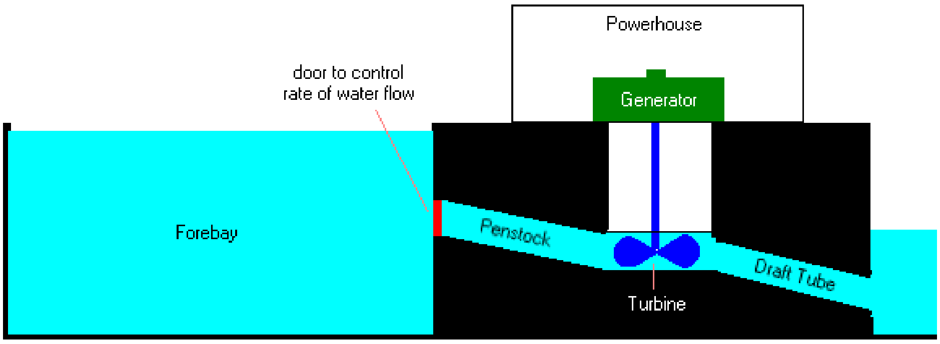

Figure 1.3 : Spinning Process of Turbine

1.5.1 Types of Hydroelectric Power Plants

Micro-Scale

As their name implies, micro-hydroelectric plants are the smallest type of hydroelectric energy systems. They generate between one kilowatt and one megawatt of power. The main application for these hydro systems is in small, isolated villages in developing countries. They are ideal for powering smaller services such as the operation of processing machines.

Small-Scale

Small hydropower systems can supply up to 20 megawatts of energy. These systems are relatively inexpensive and reliable. They have the potential to provide electricity to rural areas in developing countries throughout the world. Small systems are especially important to countries that may not be able to afford the costs of importing fossil fuels such as petroleum from other countries.

Run-of-the-River

In some areas of the world, the flow rate and elevation drops of the water are consistent enough that hydroelectric plants can be built directly in the river. The water passes through the plant without greatly changing the flow rate of the river. In many instances a dam is not required, and therefore the hydroelectric plant causes minimal environmental impact on its surroundings. However, one problem with run-of-the-river plants is the obstruction of fish and other aquatic animals. This and other problems are discussed in the next section.

Problems with Hydroelectric Power

Although hydroelectric power is admittedly one of the cleanest and most environmentally-friendly sources of energy, it too has the capability to alter or damage its surroundings. Among the main problems that have been demonstrated by hydroelectric power is significant change in water quality. Because of the nature of hydroelectric systems, the water often takes on a higher temperature, loses oxygen content, experiences siltation, and gains in phosphorus and nitrogen content.

Another major problem is the obstruction of the river for aquatic life. Salmon, which migrate upstream to spawn every year, are especially impacted by hydroelectric dams. Fortunately, this problem has been dealt with by the production of fish ladders. These structures provide a pathway for fish to navigate past the hydroelectric dam construction.

Advantages and Disadvantages

Advantages

- Inexhaustible fuel source
- Minimal environmental impact
- Viable source--relatively useful levels of energy production
- Can be used throughout the world

Disadvantages

- Smaller models depend on availability of fast flowing streams or rivers.
- Run-of-the-River plants can impact the mobility of fish and other river life.

Note : Building a fish ladder can lessen this negative aspect of hydroelectric power.

1.6 SOLAR

The name solar power is actually a little misleading. In fact, most of the energy known to man is derived in some way from the sun. When we burn wood or other fuels, it releases the stored energy of the sun. In fact, there would be no life on earth without the sun, which provides energy needed for the growth of plants, and indirectly, the existence of all animal life. The solar energy scientists are interested in energy obtained through the use of solar panels. Although the field of research dealing with this type of solar power is relatively new, one should bear in mind that man has known about the energy of the sun for thousands of years.

Theory

The energy of the sun can be used in many ways. When plants grow, they store the energy of the sun. Then, when we burn those plants, the energy is released in the form of heat. This is an example of indirect use of solar energy.

The form we are interested in is directly converting the sun's rays into a usable energy source : electricity. This is accomplished through the use of "solar collectors", or, as they are more commonly known as, "solar panels".

There are two ways in which solar power can be converted to energy. The first, known as "solar thermal applications", involve using the energy of the sun to directly heat air or a liquid. The second, known as "photoelectric applications", involve the use of photovoltaic cells to convert solar energy directly to electricity.

There are two types of solar thermal collectors. The first, known as flat plate collectors, contain absorber plates that use solar radiation to heat a carrier fluid, either a liquid like oil or water, or air. Because these collectors can heat carrier fluids to around 80^oC, they are suited for residential applications. The second type of solar collectors is known as concentrating collectors. These panels are intended for larger-scale applications such as air conditioning, where more heating potential is required. The rays of the sun from a relatively wide area are focused into a small area by means of reflective mirrors, and thus the heat energy is concentrated. This method has the potential to heat liquids to a much higher temperature than flat plate collectors can alone. The heat from the concentrating collectors can be used to boil water. The steam can then be used to power turbines attached to generators and produce electricity, as in wind and hydroelectric power systems.

Photovoltaic cells depend on semiconductors such as silicon to directly convert solar energy to electricity. Because these types of cells are low-maintenance, they are best suited for remote applications.

Solar power has an exciting future ahead of it. Because solar power utilizes the sun's light, a ubiquitous resource (a resource that is everywhere), solar panels can be attached to moving objects, such as automobiles, and can even be used to power those objects. Solar powered cars are being experimented with more and more frequently now.

Problems with Solar Power

Solar power is actually one of the cleanest methods of energy production known. Because solar panels simply convert the energy of the sun into energy that mankind can use, there are no harmful byproducts or threats to the environment.

One major concern is the cost of solar power. Solar panels (accumulators) are not cheap; and because they are constructed from fragile materials (semiconductors, glass, etc.), they must constantly be maintained and often replaced.

Further, since each photovoltaic panel has only about 40% efficiency, single solar panels are not sufficient power producers. However, this problem has been offset by the gathering together of many large panels acting in accord to produce energy. Although this setup takes up much more space, it does generate much more power.

Advantages and Disadvantages

Advantages

- Inexhaustible fuel source.
- No pollution.
- Often an excellent supplement to other renewable sources.
- Versatile is used for powering items as diverse as solar cars and satellites.

Disadvantages

- Very diffuse source means low energy production – large numbers of solar panels (and thus large land areas) are required to produce useful amounts of heat or electricity.
- Only areas of the world with lots of sunlight are suitable for solar power generation.

1.7 WIND

Mankind has made use of wind power since ancient times. Wind has powered boats and other sea craft for years. Further, the use of windmills to provide power for the accomplishment of agricultural tasks has contributed to the growth of civilization. This important renewable energy source is starting to be looked at again as a possible source of clean, cheap energy for years to come.

Theory

Differences in atmospheric pressure due to differences in temperature are the main cause of wind. Because warm air rises, when air fronts of different temperatures come in contact, the warmer air rises over the colder air, causing the wind to blow.

Wind generators take advantage of the power of wind. Long blades, or rotors, catch the wind and spin. Like in hydroelectric systems, the spinning movement is transformed into electrical energy by a generator.

The placement of wind systems is extremely important. In order for a wind-powered system to be effective, a relatively consistent wind-flow is required. Obstructions such as trees or hills can interfere with the rotors. Because of this, the rotors are usually placed atop towers to take advantage of the stronger winds available higher up. Furthermore, wind speed varies with temperature, season, and time of day. All these factors must be considered when choosing a site for a wind-powered generator.

Another important part of wind systems is the battery. Since wind does not always blow consistently, it is important that there be a backup system to provide energy. When the wind is especially strong, the generator can store extra energy in a battery.

There are certain minimal speeds at which the wind needs to blow. For small turbines it is 8 miles an hour. Large plants require speeds of 13 miles an hour.

Remote

Remote systems are small, relatively cheap sources of energy. They are best suited for rural environments because they can be left unattended for long periods of time. Further, they can operate under harsh conditions, and thus have potential for powering extremely remote regions

Hybrid

The very nature of wind-powered generators makes them ideal to use in conjunction with other sources of energy. Wind and solar generators have been extremely successful as supplements to one another. The presence of the wind generator means that the other energy source does not have to be producing as much of the time.

Grid Connected

Grid Connected systems are already in wide use in areas that are already hooked up to a utility grid. Their main use is as a supplement to other forms of energy. This is important because average wind turbines only generate electricity about 25% of the time

Utilities

Because individual wind-powered systems by themselves do not produce a great deal of energy, so-called wind farms have been developed. These collections of many wind generators gathered in one place provide a source of relatively high energy output.

Problems

One of the main problems with wind power is the space that is used up by the so-called wind farms. In some cases, the space taken up can seriously alter the environment.

The good news is that although wind farms require a great deal of square mileage, there is quite a bit of space between the actual wind machines. This space can be used for agricultural purposes.

Another problem with wind power is that relatively speaking, it does not generate very much energy for the price. Perhaps this setback is made up for in friendliness to the environment.

Advantages and Disadvantages

Advantages

- Inexhaustible fuel source.
- No pollution.
- Often an excellent supplement to other renewable sources.

Disadvantages

- Very diffuse source means low energy production – large numbers of wind generators (and thus large land areas) are required to produce useful amounts of heat or electricity.
- Only areas of the world with lots of wind are suitable for wind power generation.
- Relatively expensive to maintain.

1.8 GEOTHERMAL

The center of the earth can reach **12000** degrees Fahrenheit. Just imagine if we could tap that heat for our own use. Well, geothermal systems do just that. Convection (heat) currents travel quite near the surface in some parts of the world.

Theory

The earth's crust is heated by the decay of radioactive elements. The heat is carried by magma or water beneath the earth's surface. Some of the heat reaches the surface and manifests itself in geysers and hot springs throughout the world.

Geothermal power can be used to directly heat buildings. Further, the pressurised steam from superheated water beneath the earth's surface can be used to power turbines and thus generate electricity.

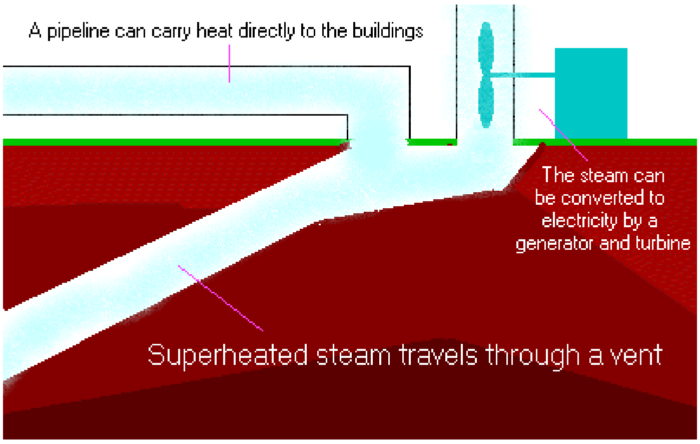

Figure 1.4 : Geothermal Energy Process

Although geothermal power seems ideal in that it is naturally occurring and does not require structures to trap or collect the energy (as in solar panels or windmills), it does have limitations. The greatest drawback is that naturally occurring geothermal vents are not widely available. Artificial vents have been successfully drilled in the ground to reach the hot rocks below and then injected with water for the production of steam. However, oftentimes the source of heat is far too deep for this method to work well. Nor can geothermal power realistically generate enough electricity for the entire country or any large industrialised nation. A good-sized hot spring can power at most a moderate sized city of around 50,000 people. And there just isn't enough viable hot springs to power all the cities in any large country.

Advantages and Disadvantages

Advantages

- Theoretically inexhaustible energy source.
- No pollution.
- Often an excellent supplement to other renewable sources.
- Does not require structures such as solar panels or windmills to collect the energy – can be directly used to heat or produce electricity (thus very cheap).

Disadvantages

- Not available in many locations.
- Not much power per vent.

1.9 OCEAN ENERGY

1.9.1 Tidal Energy

Tides are caused by the gravitational pull of the moon and sun, and the rotation of the earth. Near shore, water levels can vary up to 40 feet. Only a few locations have good inlets and a large enough tidal range- about 10 feet- to produce energy economically. The simplest generation system for tidal plants involves a dam, known as a barrage, across an inlet. Sluice gates on the barrage allow the tidal basin to fill on the incoming high tides and to empty through the turbine system on the outgoing tide, also known as the ebb tide. There are two-way systems that generate electricity on both the incoming and outgoing tides.

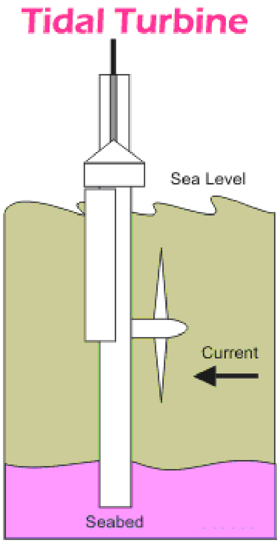

Figure 1.5 : Tidal Energy

Tidal barrages can change the tidal level in the basin and increase turbidity in the water. It can also affect navigation and recreation. Potentially the largest disadvantage of tidal power is the effect a tidal station can have on plants and animals in the estuaries.

Tidal fences can also harness the energy of tides. A tidal fence has vertical axis turbines mounted in a fence. All the water that passes is forced through the turbines. They can be used in areas such as channels between two landmasses. Tidal fences have less impact on the environment than tidal barrages although they can disrupt the movement of large marine animals. They are cheaper to install than tidal barrages too.

Tidal turbines are a new technology that can be used in many tidal areas. They are basically wind turbines that can be located anywhere there is strong tidal flow. Because water is about 800 times denser than air, tidal turbines will have to be much sturdier than wind turbines. They will be heavier and more expensive to build but will be able to capture more energy.

1.9.2 Wave Energy

Waves are caused by the wind blowing over the surface of the ocean. There is tremendous energy in the ocean waves. The total power of waves breaking around the world's coastlines is estimated at 2-3 million megawatts. The west coasts of the US and Europe and the coasts of Japan and New Zealand are good sites for harnessing wave energy.

One way to harness wave energy is to bend or focus the waves into a narrow channel, increasing their power and size. The waves can then be channeled into a catch basin or used directly to spin turbines. There are no big commercial wave energy plants, but there are a few small ones. Small, on-shore sites have the best potential for the immediate future; they could produce enough energy to power local communities. Japan, which imports almost all of its fuel, has an active wave-energy program.

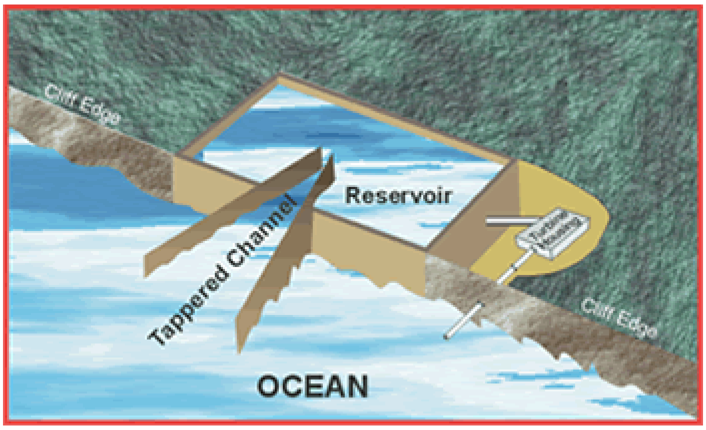

Figure 1.6 : Wave Energy

1.10 NUCLEAR ENERGY

In a universe, energy and matter have a common origin.

None the energy nor the matter can be created or destroyed; instead they just change their state. As well, they are convertible to each other.

Albert Einstein was the first man who explained this relation by the well known formula :

$$E = mC^2$$

This equation defines :

E (Energy) equals to *m* (mass) times C^2 (C stands for speed of light).

By looking in close, we may find the enormous energy exist in a small piece of material.

The name of atom comes from Greek language, referring to smallest part of nature.

Nowadays we have a better knowledge on atom structure, and we know a nucleus, surrounded by electrons, form the atoms. This structure is somehow similar to our solar system.

Nuclear Fission

Any try for splitting a part a nucleus will cause a tremendous energy be released. This energy would be released in both forms of heat and light.

In a harnessed, controlled way of doing this, a useful energy for producing electricity is possible. Doing this at once would result to a big explosion, as seen in an automatic bomb.

In a nuclear power plant, uranium is the element used as fuel. Uranium is found in many parts of the world but in a low quantity. It is loaded in to the reactor in a tiny pallet form inside long rods.

Fission meaning splitting a part is what happens in a reactor. Here uranium atoms are split in a paced controlled chain of reactions.

Inside a reactor the intensity of crashes are harnessed by inserting-taking of control roads.

In an atomic bomb a different process occurs, by using almost pure pieces of elements-uranium 235 or plutonium, in a precise mass and shape, burning them together in a great force. As we see there is no requisite like this in a reactor.

Byproducts of such reactions are radioactive materials. If released, they would be gravely harmful. Knowing this, strong structures must keep the materials in the case of any accident.

The released heat energy would be used for boiling water in the core of reactor. So instead of burning fuel, we may use the heat of reactor core.

By sending the hot water around the nuclear to the heat exchanger section, water filled pipes produce steam needed for steam turbine.

Nuclear Fusion

In another form of nuclear reaction, joining of smaller nuclei makes a larger nucleus. Such a process in sun changes the hydrogen atoms to helium. The result heat and light we receive in earth.

In a more detailed explanation, two different types of atoms, deuterium and tritium, combine to make a helium plus and extra particle called neutron.

There has been a fierce competition among scientists, but to their frustration, they have yet trouble in controlling reaction in a closed space.

The advantage of fusion is its abundance of supply (hydrogen) as well as its less radioactive material than fission.

1.11 CLASSIFICATION OF POWER PLANTS

Power plants are classified by the type of fuel and the type of prime mover installed.

By Fuel

- In thermal power stations, mechanical power is produced by a heat engine, which transforms thermal energy, often from combustion of a fuel, into rotational energy
- Nuclear power plants use a nuclear reactor’s heat to operate a steam turbine generator.
- Fossil fuel powered plants may also use a steam turbine generator or in the case of Natural gas fired plants may use a combustion turbine.
- Geothermal power plants use steam extracted from hot underground rocks.

- Renewable energy plants may be fuelled by waste from sugar cane, municipal solid waste, landfill methane, or other forms of biomass.
- In integrated steel mills, blast furnace exhaust gas is a low-cost, although low-energy-density, fuel.
- Waste heat from industrial processes is occasionally concentrated enough to use for power generation, usually in a steam boiler and turbine.

By Prime Mover

- Steam turbine plants use the pressure generated by expanding steam to turn the blades of a turbine.
- Gas turbine plants use the heat from gases to directly operate the turbine. Natural-gas fuelled turbine plants can start rapidly and so are used to supply peak energy during periods of high demand, though at higher cost than base-loaded plants.
- Combined cycle plants have both a gas turbine fired by natural gas, and a steam boiler and steam turbine which use the exhaust gas from the gas turbine to produce electricity. This greatly increases the overall efficiency of the plant, and most new base load power plants are combined cycle plants fired by natural gas.
- Internal combustion Reciprocating engines are used to provide power for isolated communities and are frequently used for small cogeneration plants. Hospitals, office buildings, industrial plants, and other critical facilities also use them to provide backup power in case of a power outage. These are usually fuelled by diesel oil, heavy oil, natural gas and landfill gas.
- Microturbines, stirling engine and internal combustion reciprocating engines are low cost solutions for using opportunity fuels, such as landfill gas, digester gas from water treatment plants and waste gas from oil production.

Steam Turbine Power Station

The conversion from coal to electricity takes place in three stages :

Stage 1

The first conversion of energy takes place in the boiler. Coal is burnt in the boiler furnace to produce heat. Carbon in the coal and Oxygen in the air combine to produce Carbon Dioxide (CO^2) and heat.

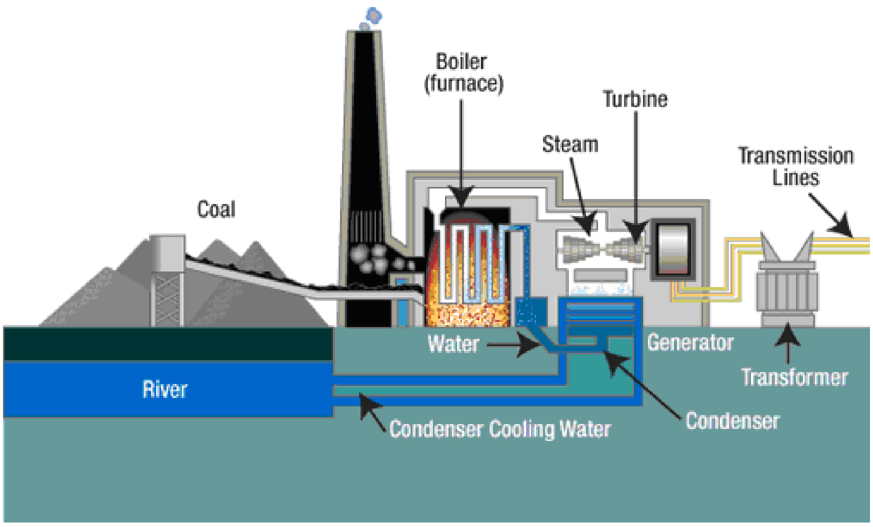

Figure 1.7 : Steam Turbine Power Station

Stage 2

The second stage is the thermodynamic process :

(a) The heat from combustion of the coal boils water in the boiler to produce steam. In modern power plant, boilers produce steam at a high pressure and temperature.

(b) The steam is then piped to a turbine.

(c) The high pressure steam impinges and expands across a number of sets of blades in the turbine.

(d) The impulse and the thrust created rotate the turbine.

(e) The steam is then condensed and pumped back into the boiler to repeat the cycle.

Stage 3

In the third stage, rotation of the turbine rotates the generator rotor to produce electricity based of Faraday's Principle on electromagnetic induction.

Gas Turbine Power Station

The schematic arrangement of a gas turbine power plant is shown in Figure 1.8. The main components of plants are :

- Compressor
- Regenerator
- Combustion Chamber
- Gas Turbine
- Alternator
- Starting motor

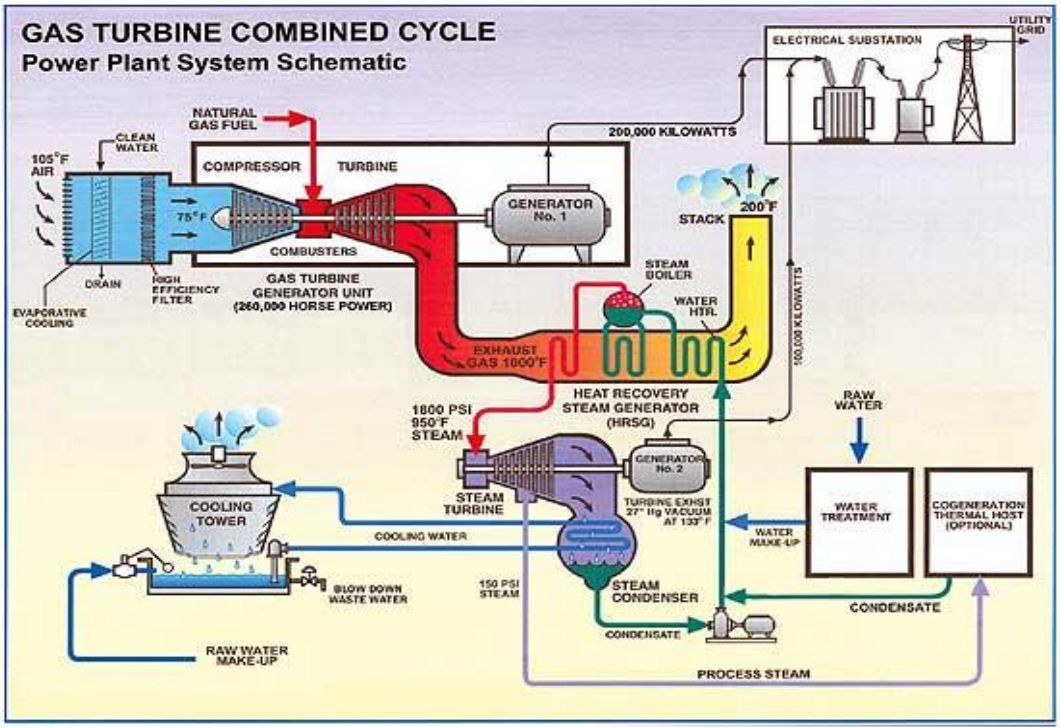

Figure 1.8 : Gas Turbine Power Station

Compressor

The compressor used in the plant is generally of rotatory type. The air at atmospheric pressure is drawn by the compressor via the filter which removes the dust from the air. The rotatory blades of the compressor push the air between stationary blades to raise its pressure. Thus air at high pressure is available at the output of the compressor.

Regenerator

A regenerator is a device which recovers heat from the exhaust gases of the turbine. The exhaust is passed through the regenerator before wasting to atmosphere. A regenerator consists of a nest of tubes contained in a shell. The compressed air from the compressor passes through the tubes on its way to the combustion chamber. In this way compressor is heated by the hot exhaust gases.

Combustion Chamber

The air at high pressure from the compressor is led to the combustion chamber via the regenerator. In the combustion chamber, heat is added to the air by burning oil. The oil is injected through the burner into the chamber at high pressure ensure atomisation of oil and its thorough mixing with air. The result is that the chamber attains a very high temperature. The combustion gases are suitably cooled and then delivered to gas turbine.

Gas Turbine

The products of combustion consisting of a mixture of gases at high temperature and pressure are passed to the gas turbine. These gases in passing over the turbine blades expand and thus do the mechanical work. The temperature of the exhaust gases from the turbine is about 900^{o}F.

Alternator

The gas turbine is coupled into the alternator. The alternator converts the mechanical energy of the turbine into electrical energy. The output of the alternator is given to the bus-bars through transformers, isolators and circuit breakers.

Starting Motor

Before starting the turbine, compressor has to be started. For this purpose, an electric motor is mounted on the same shaft as that of the turbine. The motor is energised by the batteries. Once the unit starts, a part of the mechanical power of the turbine drives the compressor and there is no need of the motor now.

Internal Combustion Engines Plant

It is a plant in which the prime mover is an internal combustion engine. An internal combustion engine has one or more cylinders in which the process of combustion takes place, converting energy released from the rapid burning of a fuel-air mixture into mechanical energy. Diesel or gas-fired engines are the principal types used in electric plants. The plant is usually operated during periods of high demand for electricity.

SAQ 1

(a) What are the various sources of energy?

(b) Describe the different types of power plants.

(c) Explain the advantages and disadvantages of different power plants.

(d) Explain the various components of gas turbine power plant.

1.12 SUMMARY

In this unit, we have learnt about the various energy sources, different types of fuels used in the power plants for power generation. This unit also discussed the concepts of solar energy, wind energy, tidal energy, geothermal energy, etc. Their advantages and disadvantages also described.

This unit gives the knowledge about the various types of power plants and the generation process of electricity.

1.13 KEY WORDS

Energy Sources	**:**	There are different types of energy sources are available which includes, solar, wind, tidal and geothermal sources of energy.
Fuels	**:**	Fuels are utilised to generate the energy of power or electricity.
Coal	**:**	It is a fuel, used to generate the steam, used for power plants.

1.14 ANSWERS TO SAQs

Refer the preceding text for all the Answers to SAQs.