Mr. Nitin S. Patil
Electrical Engineering Department
Sanjay Ghodawat Polytechnic, Atigre

Basics of Power Generation
Topic No. 1

Basics of Power Generation

Hours: 03
Marks: 06

INDEX

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Particulars</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Importance of Electrical Energy in day today life</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Generation of Electrical Energy</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Comparism between various sources of energy</td>
<td>4-6</td>
</tr>
<tr>
<td>4</td>
<td>Sources of Electrical Energy</td>
<td>7-12</td>
</tr>
<tr>
<td>5</td>
<td>Overview of Electrical Power Generation in India &amp; future perspectives</td>
<td>7-12</td>
</tr>
</tbody>
</table>
1. **Importance of Electrical Energy in day today life:**

   We know that, electrical energy is superior to all other forms of energy due to following reasons:

   a. **Convenient form:**
   
      Electrical energy is a very convenient form of energy. It can be easily converted into other forms of energy. For example, if we want to convert electrical energy into heat, the only thing to be done is to pass electrical current through a wire of high resistance.

   b. **Easy Control:**
   
      The electrically operated machines have simple & convenient starting, control & operation. For instance, an electric motor can be started or stopped by turning on or off a switch.

   c. **Greater Flexibility:**
   
      One important reason for preferring electrical energy is the flexibility that it offers. It can be easily transported from one place to other place with the help of conductors.

   d. **Cheapness:**
   
      Electrical energy is much cheaper than other forms of energy to domestic, commercial & Industrial consumers.

   e. **Cleanliness:**
   
      Electrical energy is not associated with smokes, fumes & poisonous gases.

   f. **High Transmission Efficiency:**
   
      The electrical energy can be transmitted conveniently & efficiently from the centers of generation to the consumers with the help of overhead conductors, it is also known as transmission line.
2. Generation of Electrical Energy:

The conversion of energy available in different forms in nature into electrical energy is known as generation of electrical energy.

Energy is available in various forms from different natural sources such as pressure head of water, chemical energy of fuels, nuclear energy of radioactive waste etc. all the forms of energy is converted into electrical energy by the use of suitable arrangement which is as shown below in fig-1.

From this figure it is clear that, the alternator is mechanically coupled to prime mover. The prime mover is driven by the energy obtained from the various sources. By using any source of energy given to prime mover, it converts mechanical energy into electrical energy.

![Diagram of energy generation process]

3. Comparism between various sources of energy.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Particular</th>
<th>Water-power</th>
<th>Fuels</th>
<th>Nuclear energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initial cost</td>
<td>High</td>
<td>Low</td>
<td>Highest</td>
</tr>
<tr>
<td>2.</td>
<td>Running cost</td>
<td>Less</td>
<td>High</td>
<td>Least</td>
</tr>
<tr>
<td>3.</td>
<td>Reserves</td>
<td>Permanent</td>
<td>Exhaustable</td>
<td>Inexhaustible</td>
</tr>
<tr>
<td>4.</td>
<td>Cleanliness</td>
<td>Cleanest</td>
<td>Dirtiest</td>
<td>Clean</td>
</tr>
<tr>
<td>5.</td>
<td>Simplicity</td>
<td>Simplest</td>
<td>Complex</td>
<td>Most complex</td>
</tr>
<tr>
<td>6.</td>
<td>Reliability</td>
<td>Most reliable</td>
<td>Less reliable</td>
<td>More reliable</td>
</tr>
</tbody>
</table>
4. Sources of Electrical Energy:

Sources of Electrical Energy

Conventional Energy Sources
- Water
- Fuel
- Nuclear Energy

Non-Conventional Energy Sources
- Sun
- Wind
- Tidal
- Biomass
- Geothermal

a. Conventional Energy Sources:

1. Water:

When water is stored at a suitable place, it possesses potential energy because of the head or height created. Whenever this water flows towards turbine the potential energy is converted into kinetic energy. After that turbine starts to rotate, at this time kinetic energy is converted into mechanical energy. The water turbine & generator are mechanically coupled, when turbine starts to rotate simultaneously generator starts to rotate, the mechanical energy is converted into electrical energy. This type arrangement is done in hydro-electric power plant.

2. Fuel:

The main source of energy is fuels. The fuels can be classified as solid fuel as a coal, liquid fuel as a diesel & gaseous fuel as a natural gas. By using this fuel with the help of heat energy, the high pressure & high temperature steam is generated. This steam is flows towards turbine or prime-mover. By using this steam turbine or prime mover & generator starts to rotate & produced electrical energy.
3. **Nuclear Energy:**

The energy obtained from nuclear materials like uranium, thorium etc. are known as Nuclear energy. With the help of fission process of these materials an heat energy is obtained, this heat energy is useful for the production of steam at high pressure & temperature. The generated steam is passes to turbine & generator set, then we have to produced a electrical energy.

b. **Non-Convectional Energy Sources:**

1. **Solar Energy:**

   The solar energy is obtained from sun. There are two methods to produce an electrical energy by using sun. In one method sun rays are concentrated over a water tank placed at the focal length of lens & water is made to boil, to produce steam, which is used to run steam turbines, which are used to run generators. In another method; reflectors are used to concentrate sun rays to focal point & they turn along with the sun so that sun energy can be utilized to produce steam, which is used to run steam turbines connected to generators.

2. **Wind Power:**

   By using wind mills the wind power can be obtained. The propulsive power of wind is used to drive multi-bladed turbine. When the blades start to rotate, it produces an electrical energy. With the help of this electrical energy the batteries are charged. When wind mill stop the batteries supply the energy. It is cheapest source of energy & government of India is planned to make use of this in certain parts of the country.
3. **Tidal Power:**

In ocean tides & wave there is tremendous amount of energy. A small dam with larger gates can be made across the mouth of the bay & low head turbines are used to run the generators for generation of electrical power. At the time of tides the gates are opened & then they are closed & the water so trapped is made to pass through the water turbines connected to generator.

4. **Bio-Gas:**

Biomass refers to all plant material and animal excreta when considered as an energy source. Some important kinds of biomass are inferior wood, urban waste, biogases, farm animal and human waste.

5. **Geo-Thermal Energy:**

We live between two great sources of energy, the hot rocks beneath the surface of the earth and the sun in the sky. Our ancestors knew the value of geothermal energy; they bathed and cooked in hot springs. Today we have recognized that this resource has potential for much broader application. The core of the earth is very hot and it is possible to make use of this geothermal energy (in Greek it means heat from the earth). These are areas where there are volcanoes, hot springs, and geysers, and methane under the water in the oceans and seas. In some countries, such as in the USA water is pumped from underground hot water deposits and used to heat people’s houses.
4. Overview of Electrical Power Generation in India & future perspectives:

A power plant or a power generating station is basically an industrial location that is utilized for the generation and distribution of electric power in mass scale, usually in the order of several 1000 Watts. These are generally located at the sub-urban regions or several kilometers away from the cities or the load centers, because of its requisites like huge land and water demand, along with several operating constraints like the waste disposal etc. For this reason, a power generating station has to not only take care of efficient generation but also the fact that the power is transmitted efficiently over the entire distance. And that’s why; the transformer switch yard to regulate transmission voltage also becomes an integral part of the power plant.

a. Hydro-Electric Power Station:

In hydro-electric power station, a dam is constructed across river or lake to store the water. Stored water posses potential energy, when water flows towards turbine the potential energy is converted into kinetic energy. The turbine & generator are mechanically coupled with each other, when water flows towards turbine it start to rotate at this time the mechanical energy is converted into electrical energy, and with the help of generator electrical energy produced.
b. Thermal Power Station:

A thermal power station or a coal fired thermal power plant is by far, the most conventional method of generating electric power with reasonably high efficiency. It uses coal as the primary fuel to boil the water available to superheated steam for driving the steam turbine. The steam turbine is then mechanically coupled to an alternator rotor, the rotation of which results in the generation of electric power.

c. Nuclear Power Station:
The nuclear power generating stations are similar to the thermal stations in more ways than one. However, the exception here is that, radioactive elements like Uranium and thorium are used as the primary fuel in place of coal. Also in a nuclear station the furnace and the boiler are replaced by the nuclear reactor and the heat exchanger tubes. For the process of nuclear power generation, the radioactive fuels are made to undergo fission reaction within the nuclear reactors. The fission reaction, propagates like a controlled chain reaction and is accompanied by unprecedented amount of energy produced, which is manifested in the form of heat. This heat is then transferred to the water present in the heat exchanger tubes. As a result, super heated steam at very high temperature is produced. Once the process of steam formation is accomplished, the remaining process is exactly similar to a thermal power plant, as this steam will further drive the turbine blades to generate electricity.

d. Diesel Power Station:

A generating station in which diesel engine is used as the prime mover for the generation of electrical energy is known as diesel power station. In a diesel power station, diesel engine is used as the prime mover. The diesel burns inside the engine and the products of this combustion act as the working fluid to produce mechanical energy. The diesel engine drives alternator which converts mechanical energy into electrical energy. As the generation cost is considerable due to high price of diesel, therefore, such power stations are only used to produce small power.
e. Solar Power Station:

There are two methods to produce an electrical energy by using sun. In one method sun rays are concentrated over a water tank placed at the focal length of lens & water is made to boil, to produce steam, which is used to run steam turbines, which are used to run generators. In another method; reflectors are used to concentrate sun rays to focal point & they turn along with the sun so that sun energy can be utilized to produce steam, which is used to run steam turbines connected to generators.

f. Wind Power Station:

By using wind mills the wind power can be obtained. The propulsive power of wind is used to drive multi-bladed turbine. When the blades start to rotate, it produces an electrical energy. With the help of this electrical energy the batteries are charged. When wind mill stop the batteries supply the energy.
g. Tidal Power Station:

In ocean tides & wave there is tremendous amount of energy. A small dam with larger gates can be made across the mouth of the bay & low head turbines are used to run the generators for generation of electrical power. At the time of tides the gates are opened & then they are closed & the water so trapped is made to pass through the water turbines connected to generator.

h. Cogeneration:

Cogeneration is also called as combined heat and power or combine heat and power. As it name indicates cogeneration works on concept of producing two different form of energy by using one single source of fuel. Out of these two forms one must be heat or thermal energy and other one is either electrical or mechanical energy. Cogeneration is the most optimum, reliable, clean and efficient way of utilizing fuel. The fuel used may be natural gas, oil,
diesel, propane, wood, bassage, coal etc. It works on very simple principle i.e. the fuel is used to generate electricity and this electricity produces heat and this heat is used to boil water to produce steam, for space heating and even in cooling buildings. In conventional power plant, the fuel is burnt in a boiler, which in turn produces high pressure steam. This high pressure steam is used to drive a tribune, which is in turn is connected to an alternator and hence drive an alternator to produce electric energy. The exhaust steam is then sent to the condenser, where it gets cool down and gets converted to water and hence return back to boiler for producing more electrical energy.

**i. Magneto Hydro Dynamic Power Generation (MHD)**

The MHD generation or, also known as magneto hydrodynamic power generation is a direct energy conversion system which converts the heat energy directly into electrical energy, without any intermediate mechanical energy conversion, as opposed to the case in all other power generating plants. Therefore, in this process, substantial fuel economy can be achieved due to the elimination of the link process of producing mechanical energy and then again converting it to electrical energy.