LECTURE NOTES

On

RE(6^{TH} SEM)

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CHAPTER – 1
ENERGY SOURCES

1.1. Introduction to energy

The energy of a body is its capacity to do work. It is measured the total amount of work that the body can do.

Energy is the primary and most universal measure of all kinds work by human beings and nature. Every thing what happens the world is the expression of flow of energy in one of its forms.

1.2. Different forms of energy

The different forms of energy are:

1. Mechanical energy (kinetic and potential)
2. Thermal (or) Heat energy
3. Chemical energy
4. Electrical energy
5. Nuclear energy
6. Electromagnetic energy
7. Gravitational energy

The S.I unit of energy is Joule or KJ or Watt.h.

Primary Energy Sources

Primary energy sources can be defined as sources which provide a net supply of energy Coal, Oil, Uranium etc., are examples of this type. The energy required to obtain these fuels is much use than what they can produce by combustion or nuclear reaction. The supply of primary fuels is limited. It becomes very essential to use these fuels sparingly.

Examples

Coal, natural gas, oil and nuclear energy.

Secondary Energy sources

Secondary fuels produce no net energy. Though it may by necessary for the economy, these may not yield net energy.

Secondary sources are like sun, wind, water (tides), etc. Solar energy can by used through plants, solar cells, solar heaters and solar collectors.

1.3. Energy sources and their availability

Introduction

Today every country draws its energy needs from a variety of sources. We can broadly categorize these sources as commercial and non-commercial. The commercial sources include the fossil fuels (coal, oil and natural gas), hydro-electric power and nuclear power, while the non-commercial sources include wood, animal waste and agricultural wastes. In an Industrialized country like U.S.A. most of the energy requirements are met from commercial sources, while in an Industrially less developed country like India, the use of commercial and non-commercial sources are about equal.

1.4. Conventional and non-conventional sources energy

1.4.1. Conventional energy sources

Conventional energy sources are:

(a) Fossil fuel energy

(b) Hydraulic energy

(c) Nuclear energy

(a) Fossil fuel energy

Coal, petroleum, and natural gas are called Fossil fuel as these are formed by the decomposition of the remains of dead plants and animals buried under the earth for a long time. These are non-renewable sources of energy, which, if exhausted, can not be replenished in a short time. Their reserves are limited and are considered very precious. These should be used with care and caution to let them last long. These are also contributing to the global environmental pollution.

(i) Coal

Since the advent of industrialization coal has been most common source of energy. In the last three decades, the world switched over from

coal to oil as a Major source of energy because it is simpler and cleaner to obtain useful energy from oil.

Coal is a complex mixture of compounds of carbon, hydrogen and oxygen. Small amounts of nitrogen and Sulphur compounds are also present in coal. It is mainly available in Bihar, West Bengal, Orissa and Madhya Pradesh. The big coal mines in our country are at Jharia and Bokaro in Bihar and at Raniganj in West Bengal. It is considered as the backbone of the energy sector for its use in industry, transportation and electric power generation.

Depending upon the carbon contents of coal, it is classified as follows:

Type of coal	**Carbon content (%)**
1. Peat	60
2. Lignite (soft coal)	70
3. Bituminous (house hold coal)	80
4. Anthracite (hard coal)	90

It is clear that peat is the most inferior quality of coal. Whereas anthracite is the most superior quality of coal. Bituminous is most commonly used in households and industry.

On strong heating, coal breaks up to produce coal gas, ammonia, coaltar and coke. Coke is 98% carbon, obtained after lossing all its volatile constituents during destructive distillation of coal. It can be used as smoke free fuel.

(ii). Petroleum

It is a dark coloured, viscous and foul smelling crude oil. The petroleum means rock oil. It is normally found under the crust of earth trapped in rocks. The crude oil is a complex mixture of several solid liquid gaseous hydrocarbons mixed with water, salt and earth particles. It is a natural product obtained from oil wells.

Some of the crude oil producing locations in our country are:

(i) Ankleshwar and Kalol in Gujarat

(ii) Rudrasagar and Lakwa in Assam; and

(iii) Bombay high (off-shore area)

The oil wells of Bombay high are producing about 22 million tons of crude petroleum oil per year, which is little less than half of the total requirement of the country. The efforts are also being made to search oil well in off-shore deltas to Godavari, Kaveri, and Rajasthan.

The crude petroleum is refined by the process of fractional distillation to obtain more useful petroleum products. The crude petroleum is heated to a temperature of about 400^{o}C in a furnace and vapors thus formed are passed into a tall fractioning column from near its bottom. As the mixture of hot vapours rises in the column, it starts getting cooled gradually.

The products obtained from crude petroleum as follows:

(i) Petroleum gas (below 40^{o}C) used as LPG.

(ii) Petrol (40^{o}C to 170^{o}C) for light vehicles.

(iii) Kerosene (170 to 250^{o}C) for household and industrial use.

(iv) Diesel oil (250 to 350^{o}C) for heavy vehicles.

(v) Residual oil ; (a) Lubrication oils (b) paraffin wax and (c) asphalt

(vi) Fuel oil (350 to 400^{o}C) for boilers and furnaces.

(iii) Natural gas

It consists about 95% Methane and rest ethane and propane. It occurs deep under the crust of the earth either alone or a long with oil above the petroleum deposits. It is a product of petroleum mining.

The gas is available in Tripura, Jaisalmer, off-shore areas of Bombay High and in the Krishna – Godavari delta. It is used as a domestic and industrial fuel. The natural gas is now also available as CNG (Compressed Natural Gas) a substitution of petrol in automobiles.

(b) Hydraulic energy (or) Water power

Water power is developed by allowing water to fall under the force of gravity. It is used almost exclusively for electric power generation, in fact, the generation of water power on a large scale became possible around the beginning of the twentieth century only with the development of electrical power plants or Hydro electric plants were usually of small capacities usually less than 100 KW.

Potential energy of water is converted into Mechanical energy by using prime moves known as hydraulic turbines. Water power is quite cheap where water is available in abundance. Although capital cost of hydro electric power plants is higher as compared to other types of power plants but their operating Costs are quite low, as no fuel is required in this case. The development rate of hydropower is still low, due to the following problems:

1. In developing a project, it will take about 6-10 years time for planning, investigation and construction.
2. High capital investment is needed, and some parts of the investment have to be designed from foreign sources.
3. There are growing problems on relocation of villages, involved, compensation for damage, selecting the suitable resettlement area and environmental impact.

Because of long transmission line to the villages with low load factor, the electric power will be available to the people in rural areas may not be economical. This leads to the development of Mini or Micro hydroelectric projects to supply the electric power to remote areas. The Importance of Micro hydroelectric projects have been observed in some parts of the country with availability of river flow through out the year.

In order to reduce the cost of development several Measures have been considered as follows:

(a) Development of low cost turbines and generators.
(b) Participation of villages in the development and operation of the project.
(c) Using the appropriate technology and tolerable substandard requirement and project civil work component at the beginning stage.

(c) Nuclear energy

According to modern theories of atomic structure, matter consists of minute particles known as atoms. Heavier unstable atoms such as U^{235}, Th^{239}, liberate large amount of heat energy. The energy released by the complete fission of one Kg of Uranium (U^{235}), is equal to the heat energy obtained by burning 4500 tonnes of coal (or) 220 tons of oil. The heat produced by nuclear fission of the atoms of fissionable material is utilized in special heat exchangers for the production of steam which is then used to drive turbogenerators as in the conventional power plants.

However there are some limitations in the use of nuclear energy namely high capital cost of nuclear power plants, limited availability of raw materials, difficulties associated with disposal of radio active waste and shortage of well trained personnel to handle the nuclear power plants.

The Uranium reserves in the world at present are small. These reserves are recoverable but are expensive. The presently working power plants are:

1. Tarapur atomic power station in Maharashtra
2. Ranapratap sagar atomic power station near Tota, Rajasthan
3. Kalpakkam atomic power station near Madras, Tamilnadu.
4. Narora atomic power station in U.P.

About 3% of the energy produced in India is obtained from nuclear power plants.

1.4.2. Non-Conventional Energy Sources

The sources of energy which are being produced continuously in nature and are in exhaustible are called renewable sources of energy (or) non-conventional energy.

Some of these sources are:

(a) Wind energy

(b) Tidal energy

(c) Solar energy