Lesson2 - Section1

Power Stations

There are five sources of energy which together account for nearly all the world's electricity. They are coal, oil, natural gas, hydroelectric power and nuclear energy. Coal, oil and nuclear plants use the steam cycle to turn heat into electrical energy, in the following way. The steam power station uses very pure water in a closed cycle. First it is heated in the boilers to produce steam at high pressure and high temperature, typically 150 atmospheres and 550°C in a modern station. This high-pressure steam drives the turbines which in turn drive the electric generators, to which they are directly coupled. The maximum amount of energy will be transferred from the steam to the turbines only if the latter are allowed to exhaust at a very low pressure, ideally a vacuum. This can be achieved by condensing the outlet steam into water. The water is then pumped back into the boilers and the cycle begins again. At the condensing stage a large quantity of heat has to be extracted from the system. This heat is removed in the condenser which is a form of heat exchanger. A much larger quantity of cold impure water enters one side of the condenser and leaves as warm water, having extracted enough heat from the exhaust steam to condense it back into water. At no point must the two water systems mix. At a coastal site the warmed impure water is simply returned to the sea at a point a short distance away. A 2 GW station needs about 60 tons of sea water each second. This is no problem on the coast, but inland very few sites could supply so much water all the year round. The alternative is to recirculate the impure water. Cooling towers are used to cool the impure water so that it can be returned to the condensers, the same water being cycled continuously. A cooling tower is the familiar concrete structure like a very broad chimney and acts in a similar way, in that it induces a natural draught. A large volume of air is drawn in round the base and leaves through the open top. The warm, impure water is sprayed into the interior of the tower from a large number of fine jets, and as it falls it is cooled by the rising air, finally being collected in a pond under the tower. The cooling tower is really a second heat exchanger where the heat in the impure water is passed to the atmospheric air; but unlike the first heat exchanger, the two fluids are

allowed to come into contact and as a consequence some of the water is lost by evaporation.

The cooling towers are never able to reduce the impure water temperature right down to the ambient air temperature, so that the efficiency of the condenser and hence the efficiency of the whole station is reduced slightly compared with a coastal site. The construction of the cooling towers also increases the capital cost of building the power station. The need for cooling water is an important factor in the choice of sites for coal, oil and nuclear plants. A site which is suitable for a power station using one type of fuel is not necessarily suitable for a station using another fuel.

Coal-Fired Power Stations

Early coal-burning stations were built near the load they supplied. A station of 2 GW output, consumes about 5 million tons of coal in a year. In Britain where most power station coal is carried by rail, this represents an average of about 13 trains a day each carrying 1000 tons. This means that large coal-fired stations need a rail link unless the station is built right at the pit head.

Oil-Fired Power Stations

Power station oil can be divided into crude oil which is oil as it comes from the well, and residual oil which remains when the more valuable fractions have been extracted in the oil refinery. The cost of moving oil by pipeline is less than that of moving coal by rail, but even so stations burning crude oil are often sited near deep-water berths suitable for unloading medium-sized tankers. Stations burning residual oil need to be sited near to the refinery which supplies them. This is because residual oil is very viscous and can only be moved through pipelines economically if it is kept warm.

Nuclear Power Stations

In contrast to coal and oil the cost of transporting nuclear fuel is negligible Because of the very small amount used . A 1 GW station needs about 4½ tons of uranium each week. This compares very favourably with the 50,000 tons of fuel which would be burnt each week in a comparable coal-fired power station. Present nuclear stations use rather more cooling water than comparable coal-fired or oil-fired plants due to their lower efficiency. All nuclear stations in Britain, with one exception, are situated on the coast and use sea water for cooling.

Hydroelectric Power Stations

Hydroelectric power stations must be sited where the head of water is available, and as this is often in mountainous areas, they may need long transmission lines to carry the power to the nearest load center or link up with the grid. All hydroelectric schemes depend on two fundamental factors: a flow of water and a difference in level or head. The necessary head may be obtained between a lake and a nearby valley, or by building a small dam in a river which diverts the flow through the power station, or by building a high dam across a valley to create an artificial lake.

Part I. Comprehension Exercises

A. Put "T" for true and "F" for false statements. Justify your answers.

..... 1. Gas and nuclear plants use the steam cycle to turn heat into electricity.
..... 2. Condensers remove the heat from the outlet steam.
..... 3. The steam power station uses pure water in an open cycle.
..... 4. Steam pressure affects the generators directly.
..... 5. Having cooled off the exhaust steam, the warmed impure water may be recirculated.
..... 6. Natural air is forced through the cooling tower.
..... 7. Large coal-fired stations situated far from the pit head need a rail link.
..... 8. Oil-fired power stations consume certain constituents of crude oil.
..... 9. Nuclear power stations use less cooling water than comparable coal-fired or oil-fired plants.
..... 10. Hydroelectric power stations have to be built where there is enough water pressure.

B. Choose a, b, c, or d which best completes each item.

1. In steam power stations, the turbine efficiency will increase if ..... .
   a. the steam pressure is kept constant
   b. the outlet steam is condensed into water
   c. the steam temperature is not varied
   d. the outlet water is pumped back into the boilers
2. The steam power station uses pure water ..... .
   a. to produce the steam required to drive the turbines
   b. to produce the steam required to activate the generators

c. to create the vacuum space necessary for the system
d. to create the pressure and temperature needed

3. The heat of the steam is removed by ..... the condenser.
   a. the recirculation of cold pure water in
   b. the flow of natural air in one side of
   c. the recirculation of the steam in
   d. the flow of cold water through one side of
4. Prior to recirculation, impure water must be cooled ..... .
   a. in broad concrete structures
   b. in broad metal chimneys
   c. at the bottom of the tower
   d. at the top of the tower
5. The cooling factor in a cooling tower is ..... the tower.
   a. the pond under
   b. the interior of
   c. the water inside
   d. the air passing through
6. Systems recirculating impure water, compared with those on the coast, …… .
   a. decrease the efficiency of the station
   b. increase the capital cost of building the station
   c. reduce the impure water temperature to the required level
   d. both a and b
7. The first paragraph mainly discusses ..... .
   a. the structure of a condenser compared with that of a cooling tower
   b. the mechanism of the steam power station
   c. the main sources of energy which account for electricity
   d. the cooling water as a deciding factor in the choice of sites for coal, oil, and nuclear plants

C. Answer the following questions orally.

1. What are the five sources of energy used for the generation of electrical energy?
2. What are the two water systems used in the condenser?
3. What is the water resulted from steam condensation used for?
4. How much sea water does a 2 GW station need each second?
5. How is the mechanism of a cooling tower similar to that of a chimney?
6. How do you describe the mechanism of a cooling tower?
7. What are the two heat exchangers used in the system?
8. How much coal does a 2 GW station consume every year?
9. Why should stations burning residual oil be sited near to the refinery which supplies them?

10. Why is the cost of transporting nuclear fuel negligible compared with coal and oil?

Part II. Language Practice

A. Choose a, b, c, or d which best completes each item.

1. The energy of water may be converted to work by hydraulic ..... .
   a. turbines b. generator
   c. boilers d. towers
2. Gas oil must be ..... and then used.
   a. isolated b. heated
   c. refined d. vapourized
3. In the condenser, the outlet steam is ..... and recirculated.
   a. exchanged b. condensed
   c. depressurized d. purified
4. Cooling towers cause water to be ..... .
   a. condensed b. exhausted
   c. evaporated d. recycled
5. Air pump suction must be applied to the lowest pressure point or points within a condenser which are normally at the inlet tube plate where ..... rate and hence steam side pressure drop are greatest.
   a. the condensation b. the temperature
   c. the cooling d. the evaporation

B. Fill in the blanks with the appropriate form of the words given.

1. Exchange

a. The atomic movements of materials are said to be held in parallel or antiparallel by exchange forces, thought to be due to the sharing or ..... of electrons between neighbouring atoms in the crystal structure of the material.

b. Coupling forces, similar to the ..... forces of the atom, exist between the molecules of a compound.

c. Cooling towers and condensers are two kinds of heat ..... .

2. Circulate

a. A ..... register retains data by inserting it into a delaying means and regenerating and reinserting the data into the register.

b. A constant flow of electrolyte through a cell to facilitate the maintenance of uniform conditions of electrolysis is known as ..... of electrolyte.

C. A.....magnetic wave is a traverse magnetic wave for which the lines of magnetic force form concentric circles.

3. Couple

a. Water heated in the boilers of the steam power station produces steam at high pressure which drives the turbines ..... to generators.

b. Typical oscillators are in practice amplifiers in which power is fed into the grid circuit from the plate circuit by means of either electrostatic or electromagnetic ..... between these circuits.

4. Condense

a. Condensed-mercury temperature is the temperature measured on the outside of the tube envelope in the region where the mercury is ..... in a glass tube or at a designated point on a metal tube.

b. Steam can be ..... into water.

c. A ..... is a form of heat exchanger.

5. Drive

a. A ..... is an electronic circuit that supplies input to another electronic circuit.

b. Grid ..... power is the average of the product of the instantaneous values of the alternating components of the grid current and the grid voltage over a complete cycle .

b. A system consisting of one or several electric motors and of the entire electric control equipment designed to govern the performance of these motors is called the electric ..... .

C. Fill in the blanks with the following words.

generally	quality	same	oil
produce	natural	feed	used
situated	heat		

Any steam power station burning coal or ..... could fairly easily be converted to burn ..... gas. Such stations must, of course, be ..... near a large gas main. However, it is ..... felt that natural gas is too high a/an ..... fuel and too valuable as an industrial .....stock and home heating fuel, to be..... in power stations. The point is that gas burnt to produce electricity

which might then be used for home heating, would produce ..... at about 33 percent efficiency, whereas the ..... gas burnt in a domestic boiler would ..... heat at up to 80 percent efficiency.

D. Put the following sentences in the right order to form a paragraph. Write the corresponding letters in the boxes provided.

a. The flame temperature is clearly much higher than the steam temperature, but the thermodynamic efficiency of a conventional station depends on the steam temperature not the flame temperature.
b. Firstly, work associated with existing coal- and oil-burning power stations where efforts are being made to utilize the inherent thermodynamic efficiency of the very high flame temperatures of burning oil or pulverised coal.
c. Generators have been constructed to convert some of the energy in the flame, which is a moving ionised gas, directly into electricity.
d. Experiments and design studies are being carried out to develop new ways of generating electricity.
e. Secondly, work is being done to try to convert solar energy into electricity.
f. These fall broadly into three groups.
g. Thirdly, we have what is sometimes called the nuclear alternative,
h. These are known as magnetohydrodynamic generators.

1	2	3	4	5	6	7	8