UNIT 9 COST OF COAL COMBUSTION BY K.C. SAHU

Structure

9.0 OBJECTIVES

After completing the unit you should be able to

- read and understand scientific text of description and explanation,
- form statements of comparison and contrast,
- use appropriate diagrams to show cause and effect relationships,
- make sentences showing cause and effect relationships,
- organize phrases into logical statements,
- use appropriate connecting words to indicate correct logical relationship between two statements or two sections of a text, and
- understand how various statements are logically related to each other in scientific descriptions and explanations.

9.1 INTRODUCTION

In this unit we have given you another type of passage, i.e. which deal with explanatory–descriptive writing. The passage is entitled "Cost of Coal Combustion" by K.C. Sahu. The exercises we have set will further develop your reading skills

The section on 'Language use' and 'Organisation' deal with description of processes and statements of cause and effect.

9.2 PASSAGE FOR READING

9.2.1 Study Guide

Here is an article "Cost of Coal Combustion" by K.C. Sahu. Some of the words and phrases have been explained for you in the glossary given at the end of the article.

Try to understand the article and answer the comprehension question set on it. Check your answers with those given by us at the end of the unit.

9.2.2 Pre-reading

Exercise 1

Examine the heading of the article, the sub-headings and diagrams, and the first sentence of each paragraph. Then tick (✔) which of the following questions will be answered in the article :

(a) What are chemical pollutants ?
(b) What is the current annual coal production of India ?
(c) What is the problem with Indian Coal ?
(d) How does a coal–based thermal plant pollute the atmosphere ?
(e) What is thermal pollution ?
(f) What causes acid rain ?
(g) Why is sulphur in Coal undesirable ?
(h) What are the major sources of thermal pollution ?
(i) How much ash is generated in a day by the Talcher thermal plant in Orissa ?
(j) How much sulphur dioxide will be emitted everyday by a super thermal plant using normal or low sulphur Coal ?
(k) What is radiation pollution ?
(l) What is the most common and convenient method of solid-waste disposal ?
(m) What are the hazardous effects of a coal-based thermal plant ?
(n) What is the long-term global impact of hydrocarbon burning ?

9.2.3 Text

Man needs energy in various forms and for various purposes. Prior to the discovery of the use of coal, wood provided a major source of energy as fuel. Substitution of coal in place of wood burning has perhaps protected at least the remaining forest cover on the earth's surface. As a matter of fact coal is fossilised solar energy, stored in fossil plants which grew extensively in the geologic past.

2. Energy in the form of electricity is a basic requirement for all modern developmental activities and can be generated by a variety of methods, materials and mechanisms. There continues to be a controversy about the long-term impact of generation of large amounts of energy by various methods. However, the vagaries of the monsoon and the uncertainty of hydel power, the meagre oil reserves, the problems associated with safety and disposal of nuclear waste and the high technology needed for tapping non-conventional energy resources, single out coal as the primary and principal source of electricity in India.

India's coal reserves

3. India has a coal reserve of 200 billion tonnes and a current annual production of 250 million tonnes. Seventy per cent of coal production and virtually the entire lignite goes into power generation. By early next century India will be producing 400 million tonnes of coal and lignite of which about 330 million tonnes will be needed for power generation.

4. The problem with Indian coal is that all major deposits of the mineral are geographically concentrated and, except the lignite which has relatively lower calorific value, the Indian bituminous coal is high in ash content. The European coal formed by *in situ* accumulation of plant materials contains 3 to 5 per cent of ash as against the Gondwana coals of India, South Africa, Australia and Brazil formed by drifted plants which contain 15 to 45 per cent of ash. Some of the thermal plant authorities in India have complained of receiving coal with as much as 52 per cent of ash which during the

For every megawatt of a thermal plant, about one acre of land is required for disposal of the ash generated, the material generated accumulating to a height of eight to ten metres.

rainy season becomes slimy and adversely affects feeding of the furnaces. High ash coal means more wear and tear of plant and machinery, low thermal efficiency of the boiler, slugging, choking and scaling of furnaces and tubings and most serious of all generation of a large amount of slag and fly ash. As a thumb rule, for every MW of installed capacity, approximately one acre of land is required for disposal of the ash generated, the material accumulating to a height of 8 to 10 metres. Normally all new thermal plants make their own ash ponds for solid waste disposal, but quite a few, especially the older ones having little land space or being in cities, cannot afford an ash pond and simply let the solid waste run into the nearby river or stream, choking the natural drainage system and despoiling the land down stream. Ultimately the fly ash finds its way onto the coastal plains, producing siltation and increasing flood hazards. Between 85 to 90 per cent of the solid waste generated in the form of bottom ash and fly ash is normally collected in the nearby ash ponds, but around 10 per cent is lost as fall-out from the chimneys. The fall-out increases the suspended particulate matter in the air and in many instances adversely affects the agricultural land, flora and vegetation around.

Sulphur content in coal

5. A coal-based thermal plant pollutes the atmosphere by gaseous emissions as sulphur dioxide, nitrogen oxide, etc. causing acid rain, which is known to damage soil, vegetation and aquatic life of the region and also produces a tremendous amount of solid wastes, flyash and bottom ash. A super thermal plant using even normal or low sulphur coal will emit about 100 tonnes of sulphur dioxide a day. The acidic gases of course can be effectively neutralised in a scrubber using lime but the lime sludge generated is two tonnes for every 100 tonnes of coal burnt. This again poses disposal problems and has not been found economical.

6. Fortunately, except the tertiary coal of Assam, Indian coal is reasonably low in sulphur (average 0.5 per cent). Sulphur in coal is undesirable because it produces sulphur dioxide gas (with consequent acid rain) and corrodes plant and machinery. The Assam coal contains 1 to 3 per cent of sulphur and needs cleaning prior to its burning. One rarely misses the sight of heaps of marcasite boulders sorted out of the lignite mass in Neyveli during mining. The sulphur content of the lignites of Neyveli varies from 1.5 to 2 percent.

7. The geographical concentration of coal in the Gondwana coal fields of the Damodar-Sone-Narmada valley, Mahanadi valley and Godavari valley is a natural disadvantage from the point of view of transport. The Neyveli lignite deposits therefore came as a blessing to the South. Besides, with 30 to 45 per cent ash in the coal, one has to haul one wagon of non-carbonaceous material (stone) for transport of every three wagons of coal to the consuming centres. Therefore it is more economical to generate power at the minehead and transfer the energy produced to even the most far off places than to transport an equivalent amount of coal. Thus, most of the coal-based thermal power plants are either located or planned to be sited in some of the large coal fields.

Repository of toxic metals

8. Looking back into geological time of about 150 million years, one finds formation of coal by accumulation of plant materials in Gondwana trough lakes accompanied by large-scale mobilisation, transport and deposition of many toxic metals from a mineralised Indian shield into the lake either in solution or in particulate. These ultimately form the coal ash and account for 30 to 50 per cent of inorganic matter in Indian coal. The coal forming conifers can even uptake many toxic elements from the soil, it grows over and retains them by carbon filtration and contribute to the inorganic content of the coal. Thus coal becomes a repository of many toxic metals. A cursory examination of these metals in coal and their enrichment in ash after combustion, points out that the centres of large-scale combustion of coal are likely to be receptacles of a huge amount of such toxic metals. For example, a super thermal power plant consuming 8 million tonnes of coal containing x grams per tonne of any toxic metal will pump into the surrounding eco-system 8 x million grams of the metal.

9. The Talcher thermal plant in Orissa generates 3,000 tonnes of ash a day. When exposed to natural leaching and if only 15 per cent of the toxic metals are leached out, the adjacent Narnira river will receive 208 kg of iron, 56 kg of zinc, 45 kg of copper, 5 kg of cadmium, 56 kg of nickel, 4.6 kg of uranium, 16.5 kg of thorium, 60.6 kg of chromium and 11.2 kg of cobalt, all in a mobile state. The long term impact of such an addition is little understood.

10. Combustion of coal in the furnace of a thermal plant at 1200 to 1500° Celsius under a jet of air partially melts the inorganic constituents. The result is formation of a mass of spherical and cryptocrystalline particulate, silicious in composition and dominantly of high temperature quartz. The trace metals are redistributed, the volatile ones like cadmium , iron, mercury, etc. leave the original matrices and later, along the ash ducts, condense over the cooling particulate. The crytocrystaltine grains and the hollow spherical ones known as cenosphere and plerosphere have large specific and internal surfaces and provide ideal sites for condensation of the volatilised metals. High temperature silica, the dominant mineral of the ash, has no lattice site to accommodate any of the toxic metals. Thus the entire mass of toxic metals is confined to the surface

A super thermal plant using even normal or low sulphur coal will emit about 100 tonnes of sulphur dioxide every day.

of the newly formed ash particulate, and is easily released into the environment.

Hazardous effects

11. Leaching experiments have been carried out on fly ash and most of the toxic metals are found to be confined to a few angstrom depth from the surface of the particulate. Even mild acidic rainfall, characteristic of the thermal plant region due to emitted sulphurous gases, can mobilise these metals from the particle surface and pollute the aquatic regime. A noteworthy feature of the fly ash is the increased concentration of the metals with a decrease in the particle size. When inhaled the 10 to 1 micron size particles are caught in the nasal mucus, 75 per cent of which are swallowed. On reaching the stomach most of the metals are extracted by gastric juices and could easily enter the body fluid. The submicron particles enter deeper into the lungs and are deposited on the alveolar walls where the metals could be transferred to blood plasma across the cell membrane. The residual particles being silica or mullite are refractory and inert and cause silicosis.

12. The first order impact of a coal-based thermal plant, manifested by acid rains, increased suspended particle matter in air, despoiling of land, choking of the drainage system, etc. are amenable to technological solution by way of installation of precipitators and scrubbers and provision of tall stacks, ash ponds, etc. However, experience shows that many of the primary aims of technological efforts become secondary with the passage of time and with 'other factors' taking over the primary aims, the end result is back to square one. For example, the problem of disposal of the lime sludge of the gas scrubber, the decreased efficiency of the precipitator with continuous accumulation of the less conductive ash particles on the precipitator blades (an imported precipitator designed for low ash coal of the West will fail with high ash Indian coal) and leakage or overflow of the ash ponds due to local aquifer conditions and monsoon cloud bursts are some of the hazards associated with the curative measures in thermal plant projects.

13. The higher order effects of a large-scale entry of toxic metals into the ecosystem around a coal-based thermal plant go unnoticed. Metal toxicity arising out of ingestion through water, the food chain or inhalation, has been documented in great detail. Damages like silicosis or carcinogenesis arising out of metal toxicity are restricted to individuals. But genotoxic damage like teratogenic and mutagenic changes, often known to be caused by metal toxicity, has grave implications for the survival of mankind.

14. Besides toxic heavy metals, coal carries 0.3 to 0.5 per cent of halogens, chlorine, fluorine, etc. One of the resistant minerals that easily accumulates in coal forming basins are the light micas, obviously derived from granites and pegmatites of Nellore,

Bihar, Bastar and even Khondalites of the Eastern ghats. Micas and clay minerals are known to be storehouses of halogens. The bright yellow flame indicates that coal was once soaked in saline water or has a significant amount of sodium salts. With a temperature range of 1500°C in the boiler furnace and 150°C in the stack outlet and in the presence of a variety of catalytic heavy metals in the matrix, one cannot totally exclude the possibility of a combination of these halogens, chlorine and fluorine, with carbon atoms to generate chloro-flurocarbons. Considering the massive scale of coal consumption in thermal plants, even if a small fraction of the halogens present enter into such a reaction, the generation of CFCs will be so large that the present world consumption of industrial CFCs would be very small. We must start looking into the deozonization capacity of coal combustion.

Long-term impact

15. A holistic analysis of the long-term global impact of hydrocarbon burning is in the consumption of atmospheric oxygen and production of carbon dioxide in the process. It is beyond doubt that the evolution of life on earth and oxygen in atmosphere was a parallel process. That is, primeval earth had little oxygen in the atmosphere and over a period of 3 eons has collected the life sustaining element to a level of 21 per cent in the atmosphere. In contrast, the anoxic carbon dioxide, rich atmosphere of early earth had gradually consumed its carbon dioxide, most of which is now locked up in the vast amount of carbonates in the crust. Although the primary mechanism of oxygen generation from the Precambrian to the present time has been by the process known as photosynthesis, aided by photochemical dissociation of water molecules, the oxygen reservoir of atmosphere could not have been built up either by the photosynthesis – respiration cycle or by the photosynthesis – decay cycle. Either way the organic materials (glucose) eventually capture and recombine with all the released oxygen. A small fraction of the organic plant material estimated at 1 in 10,000 parts settles without decay and forms organic sediments without recombining with the oxygen released in the process.

16. For each bit of organic matter buried in geologic time, a corresponding quantity of oxygen has been released and stored in the atmosphere. This is the real source of oxygen in the present atmosphere. It would not exist if the organic carbon had not become encapsulated in the crustal sediments, a major amount in the form of fossil fuels, and it would disappear if these buried organic materials were brought to the surface to be oxidised. Thus whatever be the mechanism or efficiency of the fossil fuel burning process, every three tonnes of carbon burnt will consume eight tonnes of oxygen. That is, we are borrowing from the present oxygen reserve of the atmosphere. With an estimated known workable fossil fuel reserve of 8.6 trillion tonnes, man can deplete about 17×10^{12} tonnes of atmospheric oxygen.

17. This oxygen budgeting again does not take into consideration the global consumption of oxygen due to ferrous-ferric conversion, sulphur-sulphate formation or oxidation of volcanic gases including formation of water from hydrogen, etc. However, though the consumption (withdrawal) is small with respect to a large atmosphere reserve, other side effects and emissions harmful to the life system present the real problem in fossil fuel combustion.

18. There has been a controversy on the harmful effects of power plants using fossil fuel or fissile fuel, especially on issues like radioactivity. Although accidents like Three Mile Island and Chernobyl are often quoted, supporters of nuclear power plants point to the cumulative deaths in various coal mines as well as the total population and environmental degradation caused by coal-based thermal power plants and even the unknown extent of radioactive fallout from the burning of coal. In the radioactive fallout from either type of plants, the damage cannot be compared directly because various radio nuclides are involved and their pathways for public exposure are different.

Every three tonnes of carbon burnt consumes eight tonnes of oxygen. That is, we are borrowing from the present oxygen reserve of the atmosphere.

In nuclear plants, the exposure is mostly to the skin or the whole body probably to the thyroid while, in the case of fly ash the exposure is primarily to bones from soluble nuclides and to lungs from insoluble nuciides.

19. It is true that use of electricity has come to stay and we can neither reverse or halt the generation of power in any of the plants. The purpose of this article is not to suggest that power plants, thermal or nuclear, are undesirable and should be abandoned, but to bring home the cost of a unit of electricity which we casually pay at the bill counter. The cost is not just a few rupees, but is survival in the long run. Therefore the next time we switch on any electrical appliance let us remember its environmental impact.

9.2.4 Glossary

1. **combustion** : burning

   fossil : trace of a former living thing preserved in the rocks dug from the earth

3. **accumulation** : the act of piling up

   slimy : covered with slime

   slagging : forming into slag

   slage : solid scum or melted metal

   siltation : act of sediment deposition

6. **marcasite** : sulphide of iron into crystals
7. **transport** : carry
8. **toxic** : poisonous
11. **residual** : remaining
13. **mutagenic changes** : changes related to mutation
15. **photosynthesis** : the building up of complex compounds by the chlorophyll apparatus of plants by means of the energy of the light

9.2.5 Exercises in Comprehension

Exercise 2

Answer the following questions by selecting the best alternative under each :

1. What is the article about?
   (a) Use of Coal to generate electricity
   (b) India's Coal reserves
   (c) Power plant pollution

2. Why is Coal singled out as the primary and principal source of electricity in India ? Because
   (a) Coal is fossilized solar energy.
   (b) The technology needed for tapping other conventional energy sources is not available.
   (c) There are many problems associated with the high technology needed for tapping non-conventional energy sources.

3. What is the problem with Indian Coal ?
   (a) It is high in ash content.
   (b) It contains 3 to 5 % of ash.
   (c) It is low in sulphur.

4. What is the result of using high ash Coal ?
   (a) There is more wear and tear of plant and machinery.
   (b) Thermal efficiency of the boiler increases.
   (c) Both of these.

5. How does a Coal-based thermal plant pollute the atmosphere ?
   (a) by gaseous emissions of CO_2
   (b) by gaseous emissions of sulphur dioxide, nitrogen oxide, etc.
   (c) both of these

6. What is the average content of sulphur in Indian Coal ?
   (a) 5 per cent
   (b) 0.05 per cent
   (c) 0.5 per cent

7. Why is sulphur undesirable in Coal ? Because
   (a) it corrodes plant and machinery
   (b) it leads to acid rain.
   (c) both of these

8. What is silicosis ?
   (a) a process of silicon deposition
   (b) a disease caused by swallowing toxic metals
   (c) a disease caused by inhaling silica dust

9. The solid waste run into the nearby river or steam, choking the natural drainage system and despoiling the land downstream (Para. 4) : What is the technical solution of this problem ?
   (a) installation of scrubbers
   (b) provision for ash ponds
   (c) both of these

10. "We must start looking into the deozonization capacity of Coal Combustion" (Para. 13). What is the implication of this statement ?
   (a) Scientists do not know that CFCs generated as a result of Coal Combustion may lead to ozone layer depletion.
   (b) Scientists are mainly concerned about industrial CFCs and have largely ignored a more potential source of CFCs, i.e. Coal Combustion.
   (c) Scientists should be aware of the enormous environmental damage caused by Coal Combustion.

Exercise 3

Complete the following sentences by choosing the best alternative under each.

1. The long-term global impact of hydrocarbon burning is in
   (a) the depletion of ozone layer.
   (b) the depletion of atmospheric oxygen.
   (c) the generation of CFCs.

2. The purpose of the article is to
   (a) suggest that Coal-based thermal power plants should be abandoned.
   (b) highlight the environmental damage caused by Coal Combustion.
   (c) discuss the long terms impact of Coal Combustion.

3. A Coal-based thermal plant emits sulphurous gases which
   (a) pollute the aquatic region.
   (b) mobilise toxic metals from the particle surface.
   (c) causes acid rain.

4. Compared to Indian Coal, European Coal is
   (a) high in sulphur.
   (b) high in ash content.
   (c) low in ash content.

5. High ash Coal means
   (a) generation of a large amount of slag and fly ash.
   (b) less wear and tear of plant and machinery.
   (c) increased thermal efficiency of boiler.

6. Fly ash is characterized by
   (a) the increased concentration of metals with a decrease in the particle size.
   (b) decrease of toxic metals and increase of particle size.
   (c) 1 micron size particles.

7. Coal-based thermal plants cause, in the long run
   (a) depletion of atmospheric oxygen.
   (b) increase in suspended particle matter in the air.
   (c) despoiling of the land down stream.

8. Most of the Coal-based thermal power plants are either located or planned to be sited in some of the large coalfields because
   (a) facilities for transportation of Coal are not available.
   (b) Coal transportation is not economically viable.
   (c) Coal is readily available.

9. The article does not elaborate
   (a) the long term global impact of Coal Combustion
   (b) the methods to tap non-conventional energy sources
   (c) the first order impact of a Coal-based thermal plant

10. Metal toxicity may lead to
   (a) heart attack
   (b) mutagenic changes
   (c) kidney failure

Exercise 4

There are twelve statements below. Read the statements carefully and write down whether they are true (T) or false (F), according to the information expressed in the articles.

1. The article highlights the significance of electricity as a basic requirement for all modern developmental activities.
2. Many thermal plants cannot afford an ash pond.
3. Fly ash may produce siltation and increase flood hazards.
4. Acid rain may damage soil, vegetation and aquatic life.
5. The use of scrubber to neutralise acidic gases is both effective and economical.
6. The tertiary coal of Assam is reasonably low in sulphur.
7. As support for the contention that the centres of large-scale combustion of coal are likely to be receptacles of a huge amount of toxic metals, the author cites example of toxic metal dispersion around Talchar Thermal Power plant in Orissa.
8. Combustion of coal in the furnace of a thermal plant at 1200 to 1500° Celsius under a jet of air leads to cenosphere and plerosphere.
9. Acid rain can mobilise toxic metals from the particle surface.
10. According to the author, there is a need to analyse Coal Combustion in terms of its environmental impact.
11. The author has not discussed the impact of radioactive fallout from the burning of coal.
12. Metal toxicity always lead to genotoxic damage.

9.2.6 Use of Language

Exercise 5 : Describing a process and the results

Sometimes when we describe a process, we also mention what the results or effects of the process are. For example.

(a) Combustion of coal in the furnace of a thermal plant at 1200 to 1500° celsius under a jet of air partially melts the inorganic constituents resulting in the formation of a mass of spherical and cryptocrystalline particulate.
(b) Coal combustion emits sulphurous gases causing acid rain.

Now, complete the descriptions below. Use information from the article.

1. Acid rain mobilises toxic metals from particle surface
.....
.....

2. The fall-out from the chimneys increases the suspended particulate matter in the air causing
.....
.....

3. The solid waste runs into the nearby river or stream
.....
.....

4. A Coal-based thermal plant emits sulphurous gases causing acid rain which
.....
.....

5. Coal Combustion generates a large amount of fly ash which finds its way into coastal plains,.....
.....

Exercise 6 : Cause and Effect Relationships

In Science and technology, as you may know, we often give details that explain something. Scientific explanations of forms, functions, phenomena, properties, behaviour, etc. involve a discussion of why things happen. Sometimes an explanation may consist of a series or chain of causes and results.

Expiations generally follow any one of the following patterns.

CAUSE (C) – EFFECT (E)

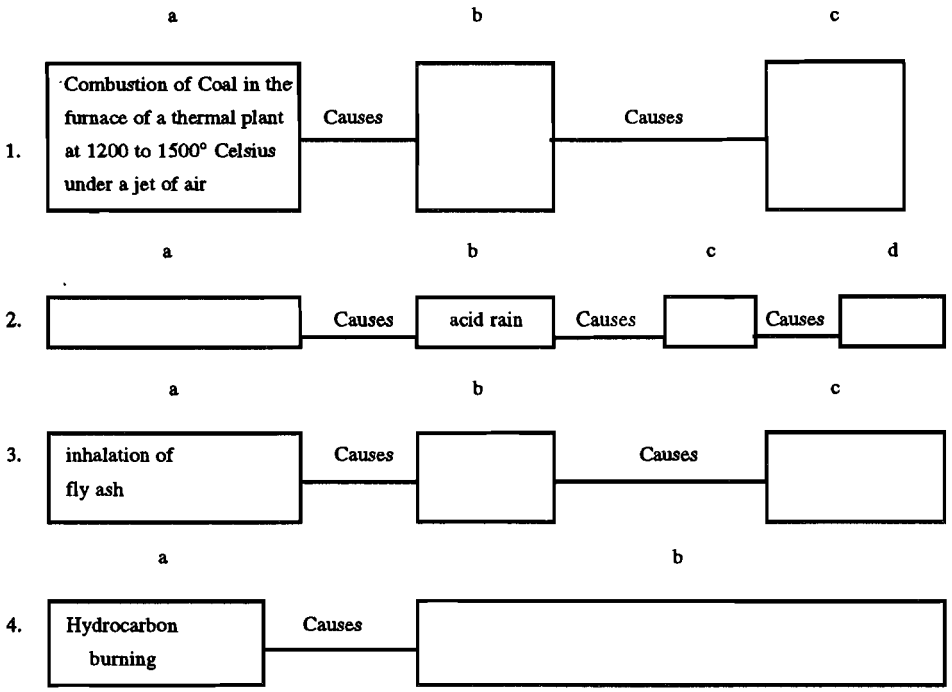
(a) C ..... cause/lead to/account for/give rise to ..... E
(b) C ..... therefore/thus/hence/as a results/ ..... E
(c) E ..... because/since C
(d) E ..... caused by/result from C

Now look at the following sentences showing cause and effect relationships.

(a) Sulphurous gases emitted by coal-based thermal plants cause acid rain.
(b) It is more economical to generate power at the minehead and transfer the energy produced to far off places than to transport an equivalent amount of coal. Thus, most of the coal-based thermal power plants are located in some of the large coalfields.
(c) Most of the Coal-based thermal power plants are located in some of the large coalfields, because it is more economical to generate power at the minehead and transfer the energy produced to far off places than to transport an equivalent amount of Coal.

(d) Acid rain is caused by sulphurous gases emitted by Coal-based thermal power plants.

I. Complete the following diagrams to show cause and effect relationships.



II. Make sentences showing cause/effect relationships by using all the phrases given. The phrases are not in the right order.

1. primary damage, pollutants, direct identifiable impact on the environment
2. anorexia, permanent brain damage, lead poisoning
3. chlore-flurocarbons, increase in the ultraviolet ray intensity at the surface of the Earth, depletion of the ozone layer
4. inhaling silica dust, Silicosis
5. poor agricultural practices, stripping the land of valuable nutrients for crop growth, soil erosion

9.2.7 Organization

Exercise 7

Here are some sentences connected with the text.

1. About 10 percent of the solid waste generated in the form of bottom ash and fly ash is lost as fall-out from the chimneys.
2. A coal-based thermal plant, emits sulphurous gases causing acid rain.
3. The Indian bituminous coal is high in ash content.
4. High ash coal results in the generation of a large amount of slag and fly ash.

Now here are some sentences from the text which follow on from each of the sentences above, but the parts of these sentences are in the wrong order. Look at the sentences above and make a sentence to follow on from each.

as against the Gondwana Coals of India
accumulation of plant materials
the European Coal formed by 'in situ'
Contains 3 to 5 per cent of ash
which contains 15 to 45 per cent of ash

the suspended particulate matter in the air
the agricultural land, flora and vegetation around and
the fall-out increases
in many instances adversely affects

for disposal of the ash generated
as a thumb rule
approximately one acre of land is required
for every MW of installed capacity

using even normal or low sulphur coal
about 100 tonnes of sulphur dioxide a day
will emit
a super thermal plant

Exercise 8

The following sentences form a paragraph, but they are not in the right sequence. Put them in the correct order.

(a) Certain pollutants decrease the concentration of OZONE occurring naturally in the stratosphere, which in turn increases the amount of ultraviolet radiation reaching the Earth's surface.

(b) The effect of this increase may be to alter the Earth's climate by increasing the average global temperature.

(c) Although the cause is still uncertain these chemicals may be responsible for the noticeable loss of OZONE over the solar regions during the 1980s.

(d) Humans pollute the atmosphere on a global scale, although until the early 1970s little attention was paid to the possible deleterious effects of such pollution.

(e) Such radiation may damage vegetation and increase the incidence of skin cancer.

(f) Nitrogen oxides emitted by supersonic aircraft and chlorofluorocarbons used as refrigerants and aerosol can propellants are the major stratospheric contaminates.

(g) Measurements in Hawaii suggest that the concentration of carbon dioxide in the atmosphere is increasing at a rate of about 0.2% every year.

Exercise 9

1. Look at the first two paragraphs of the article. What seems to you to be the function of these paragraphs ?

   (a) paragraph 1 states the topic to be discussed in the article and paragraph 2 provides the context.

   (b) paragraph 1 provides the context and paragraph 2 states the topic to be discussed in the article.

   (c) paragraph 1 introduces the topic to be discussed and paragraph 2 puts forward the author's views about the topic.

2. Now look at paragraph 4 of the article. What is the function of this in the context of the whole article ?

   (a) It contrasts Indian Coal with European Coal.

(b) It discusses the factors responsible for the high ash content in Indian Coal.

(c) It discusses the impact of Coal-based thermal plants consuming high ash Indian Coal.

3. Look at paragraph 9. How is it related to the paragraph which precedes it ?

(a) It discusses the deposition of toxic metals.

(b) It is a concrete example of how thermal power plants pump toxic metals into the surrounding ecosystem.

(c) It discusses the effects of a large-scale entry of toxic metals into the ecosystem around a Coal-based thermal plan.

9.3 LET US SUM UP

In this unit we have given you practice in

(i) reading a descriptive passage – explanatory passage,

(ii) forming statements of comparison and contrast,

(iii) describing objects in terms of their various elements/parts,

(iv) describing process and their results,

(v) using appropriate diagrams to show cause and effect relationships,

(vi) making sentences showing cause/effect relationships,

(vii) organizing phrases into logical statements,

(viii) using appropriate connecting words to indicate correct logical relationship between two statements or two sections in a text, and

(ix) organizing statements to form a coherent paragraph.

9.4 KEY WORDS

cause : that which produces an effect
effect : result of an action
explanation : act of explaining
phenomenon : anything directly apprehended by the senses or an event that may be observed

9.5 ANSWERS TO EXERCISES

Exercise 1

(b), (b), (d), (f), (g), (i), (j), (m), (n)

Exercise 2

1. c 2. c 3. a 4. a 5. c 6. c 7. c 8. c 9. c 10. b

Exercise 3

1. b 2. b 3. c 4. c 5. a 6. a 7. a 8. b 9. b 10. b

Exercise 4

1. F 2. T 3. T 4. T 5. F 6. F 7. T 8. T 9. T 10. T 11. T 12.F

Exercise 5

1. and pullute the aquatic region
2. air pollution
3. choking the natural drainage system and despoiling the land down stream
4. may damage soil, vegetation and aquatic life of the region
5. producing siltation and increasing flood hazards

Exercise 6

1. b (melting of the inorganic constituents)
   c (formation of a mass of spherical and cryptocrystalline particulate)
2. a (gaseous emissions of sulphur dioxide)
   c (fly ash)
   d (air and water pollution)
3. b (metal toxicity)
   c (silicosis)
4. b (depletion of atmospheric oxygen)

II

1. Pollutants cause primary damage with direct identifiable impact on the environment.
2. Lead poisoning cause anorexia which may lead to permanent brain damage
3. chloro-flurocarbons cause depletion of the ozone layer which may lead to the increase in the ultraviolet ray intensity at the surface of the Earth.
4. Silicosis is caused by the inhaling of the silica dust
5. Soil erosion caused by poor agricultural practices may result in stripping the land of valuable nutrients for crop growth.

Exercise 7

1. About 10 per cent of the solid waste generated in the form of bottom ash and fly ash is lost as fall-out from the chimneys. The fall-out increases the suspended particulate matter in the air and in many instances adversely affects the agricultural land, flora and vegetation around.
2. A Coal-based thermal plant emits sulphurous gases causing acid rain. A super thermal plant using even normal or low sulphur coal will emit about 100 tonnes of sulphur dioxide a day.
3. The Indian bituminous coal is high in ash content. The European coal formed by 'in situ' accumulation of plant materials contains 3 to 5 per cent of ash as against the Gondwana Coals of India which contains 15 to 45 per cent of ash.
4. High ash coal results in the generation of a large amount of slag and fly ash. As a thumb rule, for every MW of installed capacity, approximately one acre of land is required for disposal of the ash generated.

Exercise 8

Correct logical order :

Exercise 9

1. b 2. c 3. b