

M. Sc. Semester-III, Paper: CC-12 (Environmental & Green Chemistry)

Unit: 1 Environment/Atmosphere [By Dr. Birendra Kumar, Maharaja College]

⇒ Environment? Environment is defined in a number of ways:

* Environment is the sum of all social, economical, biological, physical and chemical factors which constitutes the surroundings of man.

* In other words, Environment is the representation of physical components of the earth where in man is the important factor influences his environment.

* Environment is the circumstances, objects or conditions by which one is surrounded.

* Environment is the complex of physical, chemical and biotic factors (such as climate, soils, living things) that act upon an organism or an ecological community and ultimately determine its form and survival.

⇒ Components of Environment:

Environment consists of following three important components:

1. Abiotic or Non-living components

2. Biotic or living component

3. Energy component

Component

1. Abiotic/Non-living/Physical environment/ includes medium (soil, water, air and bodies of other organism in case of parasites) and climate (temperature, light, wind, rainfall, snow, humidity etc.). It is divided into three categories:

(a) Lithosphere (Solid earth), (b) Hydrosphere (water components), (c) Atmosphere (Gaseous component)

2. Biotic or living component/environment consists of flora and fauna including man as an important factor.

3. Energy component includes solar energy, geochemical energy, thermo-electrical energy, hydro-electrical energy, nuclear atomic energy etc. Energy due to radiation and other sources also play an important role.

⇒ Types of Environment: Environment can be divided into two categories:

1. Natural environment: The natural environment system operates through self regulating mechanism, i.e. any change in natural ecosystem brought about by natural process is counter-balanced by changes in other component of the environment. There exists a reciprocal relationship among various components of environment. These components are air, water, soil, radiation, land, forest, wild-life, noise, space etc.

2. Man made environment: Man is the most powerful environmental agent due to modern technologies capable of modifying the environment according to his needs to great extent. It includes technology, transportation, housing, agricultural implements, industrial revolution, space laboratories, channeling of energy sources etc.

⇒ Bio-geochemical cycles in Environment:

Biospace is that part of the earth which has living organism. It is divided into Hydrospace, Lithospace & Atmosphere. Hydrospace includes bodies containing water (e.g. Ponds, lakes, Rivers etc.). Lithospace includes the solid part of the earth (Rock, mountain etc.). The atmosphere includes gaseous envelopes around hydrospace and Lithospace.

There is a profound effect of biospace, Lithosphere and atmosphere on living organism. The hydrosphere supplies water to the organism. Lithosphere supplies minerals and atmosphere supplies gases. Biosphere as a whole supplies food to us. The organism grow and finally return to material to the biosphere through expiration and death. Thus, there is a cycling of material in the atmosphere. Energy does not circulate in the nature. It is used only once by an organism and then converted into heat which is lost to the ecosystem.

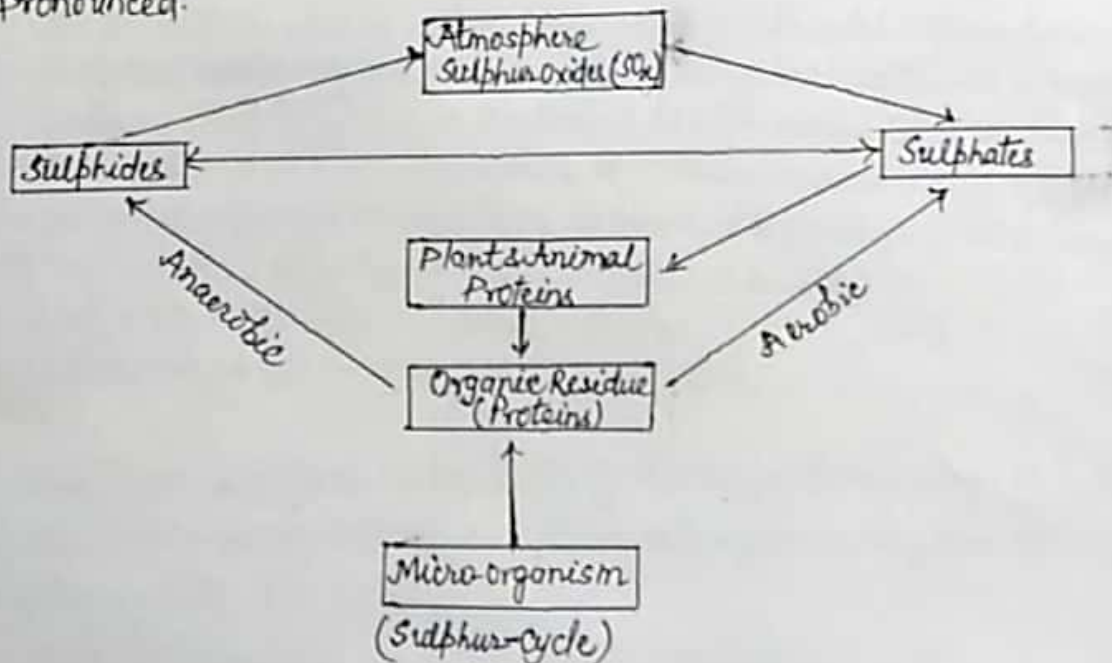
Thus, there is nothing like energy cycle. Biochemical cycles are generally of two types:

(A) Sedimentary Cycles: In these cycles, the main reservoir is the soil and the sedimentary and other rocks of the earth's crust. Example: Sulphur & Phosphorus Cycles.

(B) Gaseous Cycles: In these cycles, the main reservoir of nutrients is atmosphere and the oceans. Example: Oxygen, Carbon & Nitrogen Cycles.

⇒ Sulphur Cycle:

Sulphur is an essential constituent of proteins and amino acids. It exists as elemental sulphur, sulphides, sulphites, sulphates, sulphur mono-oxide etc. Sulphur cycle may be gaseous and sedimentary phase. In sedimentary phase of S-cycle, Sulphur is tied up in organic and inorganic deposits. Sulphur is released from these deposits by decomposition. The gaseous/atmosphere phase of S-cycle is less pronounced.

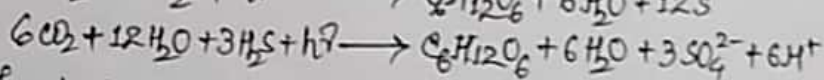
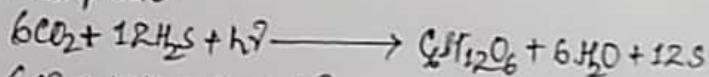


(3)

The combustion of fossil fuels, volcanic eruptions, the surface of oceans and gases released by decomposition are various main sources of sulphur in atmosphere. In the beginning, sulphur comes in the atmosphere as H_2S which undergoes oxidation and gets converted into SO_2 . SO_2 present in atmosphere is carried to earth in the form of dilute H_2SO_4 (Acid rain). Sulphur as SO_4^{2-} ion is absorbed through plant roots, where it is incorporated into amino acids and proteins. The sulphur in amino acid is transferred to animals. Excretion and death carry sulphur in living materials back to the soil and also to the bottom of ponds, lakes, seas, where the organic matter interacts with bacteria of detritious food chain. In the later to $-SH$ group of amino acid gets separated from the rest of the molecules as H_2S . H_2S is oxidised in an aerobic environment to SO_4^{2-} ion by bacteria.



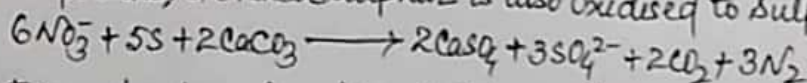
In the bottom of certain lakes and ponds, where there exists an anaerobic environment, it is not easily possible to oxidise sulphide by above process, because of absence of oxygen. But if UV-radiation is present in these environment, photosynthetic bacteria are capable of using sulphide (H_2S) in the manufacture of carbohydrate and oxidise H_2S to sulphur or sulphate.



Other bacteria may also convert elemental sulphur to sulphate.

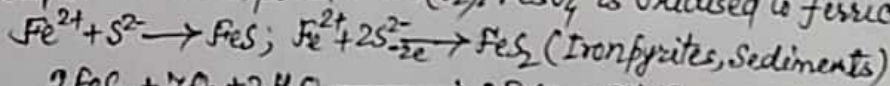


If nitrate is present, elemental sulphur is also oxidised to sulphate by certain bacteria



The sulphate can also be reduced to sulphite or elemental sulphur by some bacteria under certain conditions. All these reactions taking place within the organic phase.

Under neutral and alkaline conditions, FeS_2 (in sediments) is insoluble and firmly held in mud and wet soil. Some $FeSO_4$ is contained in sedimentary rocks overlying coal deposits when exposed to air (O_2), $FeSO_4$ is oxidised to ferric sulphate in presence of water.



Thus, sulphur in pyrite rocks, suddenly discharges heavy slugs of sulphur, sulphuric acid (H_2SO_4), ferric sulphate and $Fe(OH)_2$ into aqueous ecosystem which destroy life and causes water to be acidic.