

Biological N-Fixation:-

Bio - Life
logy - study

Nitrogen is very essential for all organisms. Animals and plants also need nitrogen in amino acids. Protein is made up of amino acids and amino acids are made up of nitrogen. e.g. Meat

Fixation:-

Capture the N which is not available to plants to make it available. N_2 in atmosphere is in inert form. (78%). Plant need N for their different process but atmosphere N_2 is available to plants. N is essential part of plants b/c plants need it for carrying their functions. There are two process by which we fix N_2 .

1. Industrial Fixation
2. Biological Fixation.

By the use of chemical reactions we change inert N_2 to use in industrial fixation. But it is costly method. In biological micro organisms fix it in unstable form.

A majority of organisms can only use N_2 in combine form such as Nitrogen that is combine with other atoms. e.g.

Ammonium (NH_4^+) or Nitrates (NO_3^-)

Definition:-

The process of N-fixation is the reduction of the N_2 to a biologically useful combined form. Its overall reaction is like this



This process is done by industrial fixation.

The symbol of Nitrogen is N. It liquifies at $-195.8^\circ C$. Its freezing point is $-210^\circ C$. Its atomic number is 7. It is a colourless, odourless, tasteless and diatomic gas at standard conditions.

Liquid nitrogen is used to preserve freshly harvested leafy vegetables. It is constituent element of all proteins and amino acids.

Many industrially important compounds such as ammonium (NH_4^+), Nitric acid (HNO_3) and cyanides contain N.

Basically Nitrogen is a French word and it was first discovered by Daniel Rutherford in 1772 and he given it the name of noxious air or fixed air.

It is also used in the production of electronic parts such as Transistors, Diodes and integrated Circuit.

It is used a dielectric gas for high voltage equipments.

It is also used for manufacturing of stainless steel.

It is also used in military aircraft fuel system to reduce fire hazards.

Filling of automotive and aircraft tires due to its inertness and lack of moisture or oxidative qualities.

Nitrogen (N) Uses for Plant Growth:

- i, Elemental Nitrogen makes up about 8% of plant dry weight.
- ii, N_2 is approximately 80% by volume of atmosphere but plants can not absorb or take in this form of nitrogen.
- iii, Only bacteria are able to fix and convert this atmospheric nitrogen into forms that plants can use. i.e Nitrate (NO_3^-), Ammonium (NH_4^+)
- iv, Deficiency of nitrogen mostly limits plants growth and yield.
- v, Nitrogen is the key constituents of following i.e
 - a) Amino acids
 - b) Protein (cell membrane, enzymes are made up of proteins) (Required for haemoglobin, part of leghaemoglobin)
 - c) Nucleic acids (DNA, RNA)
 - d) Growth Regulators
 - e) Chlorophyll

Sources of Nitrogen:-

- In atmosphere nitrogen is present in gaseous form.
- In oceans it is present in dissolved form.
- In soil it is present in organic form and inorganic form (Mineral form)

Organic Forms:-

- 1) Plant and animal residues.
- 2) Microbial biomass
- 3) Humus (Highly decomposed organic matter is called humus)

d) Newly formed humic substances.

Mineral Forms:

a) Nitrate (NO_3^-)

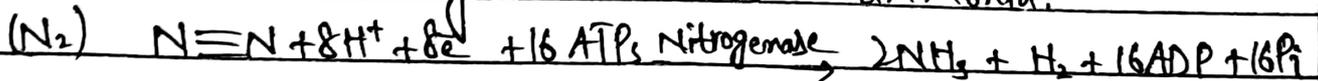
b) Ammonium (NH_4^+)

Nitrogen (N_2) Fixation:

Nitrogen is the process by which nitrogen is taken by its natural molecular form (N_2) in the atmosphere and converted into nitrogen compounds such as Ammonia (NH_3), Nitrate (NO_3^-) and Nitrogen dioxide (NO_2) useful for other chemical process.

OR

The process of N_2 -fixation is the reduction of nitrogen (N_2) to a biologically useful combined form of nitrogen such as ammonia.



Because N_2 is a very stable and so this reaction is very costly energetically. Due to high input of energy is required. (16 ATPs)

This is the reason that N_2 -fixation capability is not universal among organisms.

Facts of Nitrogen Fixation:-

There are some facts of Nitrogen Fixation, i.e.

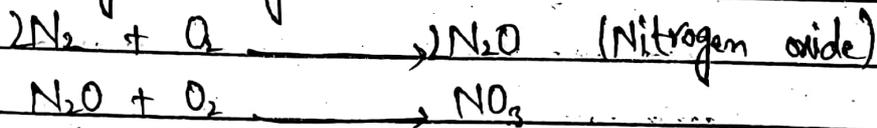
- 1, Chemical + Biological Processes fix $\text{N} = 260$ million tons per year globally
- 2, Industrial production of N Fertilizer = 85 million tons per year

- 3, Spontaneous / Atmosphere processes such as lightning ultraviolet radiation and combustion fixation = 46 million tons per year globally.
- 4, Remaining approximately half of the nitrogen is fixed by biological processes.

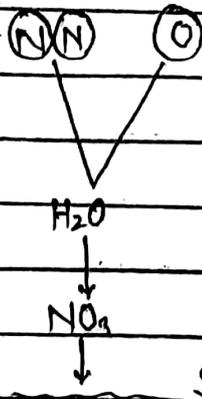
There are three ways by which N get fixed i.e.

1, Spontaneous N-Fixation:

The enormous energy of lightning breaks nitrogen molecule apart and enables the nitrogen atoms to combine with oxygen forming nitrogen oxides.



Nitrogen oxide dissolved in rain water forming nitrates. Nitrates are carry to the ground with the rain. It is called as acid rain. It can also be explained like this



During this process another reaction may occur.

$$H_2O \xrightarrow{\text{lightning}} H^+ + OH^- \rightarrow \text{unstable form}$$

$$N_2 + H^+ \rightarrow NH_3 \text{ or } NH_4^+ \rightarrow \text{stable form}$$

By this process only 5-8% of total Nitrogen fixation occurs.