

Answer on the question #54602 – Chemistry – General chemistry

Question:

Discuss biological and artificial modes of fixation of nitrogen

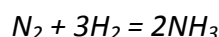
Answer:

Nitrogen fixation is the process of conversion of atmospheric nitrogen into the chemical compounds. Nitrogen compounds are vital for the living organisms: plants, animals and human race.

There are two modes of nitrogen fixation: industrial and biological one.

I. Industrial mode is closely connected with two processes:

- a) Haber-Bosch process of conversion of nitrogen into ammonia with the use of hydrogen, high temperature and pressure in the presence of catalyst:



This process is the one of unique industrial importance, providing the humanity with the vast amount of fertilizers as well as pesticides.

- b) The other way of nitrogen capture is ambient nitrogen reduction that represents the idea of fixation of dinitrogen by the transition metals and their salts with subsequent hydrolysis and ammonia release.

II. Biological mode: by certain microbes — alone or in a symbiotic relationship with some plants and animals:-Biological nitrogen fixation was discovered by the Dutch microbiologist Martinus Beijerinck. It contributes 60% of total nitrogen fixation. But the major conversion of atmospheric N_2 into salts of nitrogen, and then into proteins, is achieved by microorganisms (prokaryotes) such as bacteria, fungi and algae in the process called biological nitrogen fixation (or dinitrogen fixation). Microorganisms that fix nitrogen are called diazotrophs. Biological nitrogen fixation are of two types :

-free-living nitrogen fixation;

-symbiotic nitrogen fixation;

-the fixation of free nitrogen of the soil by N_2 -fixing organisms living symbiotically inside plants is known as symbiotic biological nitrogen fixation.

III. Other interesting mode of nitrogen fixation is one through the lightning:

$N_2 + O_2 = 2NO$ – combination of oxygen and nitrogen with the lightning

$2NO + O_2 = 2NO_2$ – presence of the excess oxygen oxidizes NO to nitrogen dioxide

$2NO_2 + H_2O = HNO_3 + HNO_2$ – reaction with water, products are nitric and nitrous acids

$4NO_2 + 2H_2O + O_2 = 4HNO_3$ – reaction with water and oxygen

HNO_3 (HNO_2) = H^+ + NO_3^- (NO_2^-) – nitrate and nitrite ions formation in the soil and water.