Aerobic – Anaerobic Treatment of Ammonia and Nitrate with the iSOC® System

A two step sequential aerobic – anaerobic process can be used for in situ treatment of ammonia in groundwater. In the first step the nitrification process converts ammonia to nitrate, followed by de-nitrification, the conversion of nitrate to nitrogen gas.

Nitrification

Ammonia + Oxygen + Bacteria → Nitrite
Nitrite + Oxygen + Bacteria → Nitrate

De-nitrification

Nitrate + Electron Donor (Hydrogen) + Bacteria → Nitrogen Gas

iSOC® units placed in treatment wells are used to deliver oxygen to stimulate conversion of ammonia to nitrate under aerobic conditions in the first step (Table 1).

Table 1

Contaminant	Gas Delivered	Electron Donor	Carbon Source	Process	Product
Ammonia	O_2	Ammonia	In-Situ Organics	Nitrification (Aerobic)	Nitrate

To switch to anaerobic conditions, hydrogen is delivered through iSOC® units. In the anaerobic environment, denitrifying bacteria are able to use NO_2 and NO_3 instead of O_2 as their terminal electron acceptor. In the presence of an electron donor such as hydrogen, the net effect is conversion of nitrate to inert nitrogen gas (Table 2). Bacteria that utilize hydrogen as an electron donor include heterotrophic bacteria that also require an organic carbon source and autotrophic bacteria that utilize an inorganic carbon source (CO_2). These bacteria have been identified as fairly ubiquitous in the environment.

Table 2

Contaminant	Gas Delivered	Electron Donor	Carbon Source	Process	Product
Nitrate	H_2 +/- CO_2	H_2	In-Situ or Added Organics or CO_2	Denitrification (Anaerobic)	N_2

The following link connects to a journal article published by the USGS that provides background information for the nitrification process and the results of related laboratory studies.
(http://www.pubmedcentral.nih.gov/pagerender.fcgi?artid=201585&pageindex=1)

The USGS Home page for nitrate remediation includes more information regarding the in situ process, field studies and a bibliography, see

(http://wwwbrr.cr.usgs.gov/projects/EC_biogeochemistry/BioReac2.htm)

An iSOC® ammonia-nitrate treatment system design could include the placement of iSOC® treatment wells delivering oxygen and hydrogen in sequential downgradient treatment biobarriers or by converting from aerobic to anaerobic conditions in the same treatment area. If necessary, carbon dioxide can be added with hydrogen to stimulate autotrophic bacteria.

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