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Methanol FACTS

Methanol Institute

Methanol Use in Denitrification

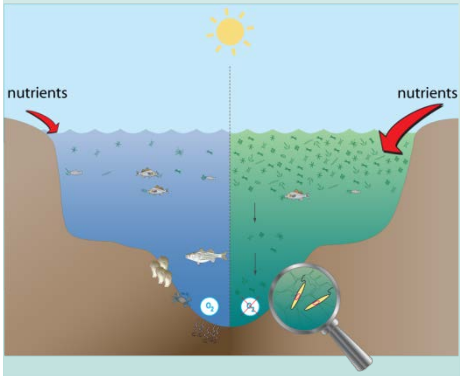
Importance of Denitrification

The U.S. Environmental Protection Agency along with numerous state agencies determined that the Gulf of Mexico “Dead Zone,” an area of eutrophication (excessive plant/algae growth) and hypoxia (oxygen depletion), spans some 6,700 square miles (17,300 square kilometers) from the mouth of the Mississippi River. Marine dead zones or areas of significant hypoxic conditions can be found in more than 400 estuaries worldwide including the Chesapeake Bay, Long Island Sound, Baltic Sea, Black Sea, Caspian Sea, Mediterranean Sea, East China Sea, and the South China Sea. These hypoxic zones are caused by nutrient enrichment, particularly nitrogen and phosphorous, that comes from agricultural run-off and major point sources such as wastewater treatment plants.

Facing regulatory pressure, municipal wastewater treatment facilities around the globe are increasingly turning to a process of biological nutrient removal or “denitrification” that is based on the addition of methanol as a carbon source to accelerate the biodegradation of nitrogen. The Methanol Institute has prepared a white paper titled “Methanol in Wastewater Denitrification,” providing a comprehensive overview of the use of methanol in the removal of nitrogen from wastewater.

Denitrification around the World

The last several decades have seen a worldwide increase in the regulatory control of nitrogen from municipal and industrial wastewater treatment plants. In the United States, the Clean Water Act implements water regulation by incorporating both technology-based and water-quality-based levels of treatment. Historically, most WWTPs have treated to standards based on the ability of secondary treatment to meet effluent standards, such as 30 mg/L for both biological oxygen demands (BOD) and total suspended solids.



As the impact of the macronutrients, nitrogen and phosphorus, on eutrophication – a term used to describe when aquifers and waterways gain too much nutrient from sewage and wastewater - has become more apparent, the U.S. Environmental Protection Agency began to put more

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emphasis on meeting water-quality-based standards through the development of total maximum daily load analysis or TMDLs for nutrients.

Given the regional nature of sources for impacted estuaries, the most effective way to control the amount of nitrogen effluents is through collaborative efforts of multiple jurisdictions. The Chesapeake Bay and Long Island Sound programs are examples of coordination by state and local agencies to reduce the total load of reactive nitrogen to regional water bodies, which includes the upgrading of WWTPs to remove nitrogen from their effluents.

The Blue Plains Wastewater Treatment Facility serving Washington D.C. is an example of one of the largest advanced wastewater treatment plants in the United States which continually meets the waste load allocation for nitrogen loading into Chesapeake Bay each year. The addition of methanol to the denitrification process has enabled the Blue Plains facility and many plants like it to save millions of dollars over the long-term in supplemental carbon chemical costs.

In Europe, the European Water Framework Directive (EU WFD) marked a shift in focus from point-source control to an integrated prevention and control approach at the water-body level. As a result, tertiary wastewater treatment has increased since 1990 although the percentage of wastewater treatment plants with tertiary treatment varies by region. The EU WFD caused the discharge standard for nitrogen in water to decrease from 10 mg/L to 2.2 mg/L. The goal of this action is to “promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems, mitigate the effects of floods and droughts, and reduce pollution.” The two- step strategy to achieve the directive’s goals includes the adoption of new wastewater treatment technologies which includes biological denitrification.

In China, expanding industrialization has resulted in a rising need for discharge standards and more effective wastewater treatment. As of 2002, 36% of rivers in China were not suitable for drinking-water use due to pollution issues which has led to water shortages. Environmental legislation put in place in 2003 sets Class 1A effluent discharge standards at <5 mg/L ammonia nitrogen and <15 mg/L total nitrogen. In the last several years, numerous existing WWTPs have been upgraded to biologically remove nitrogen using denitrification filter technology with methanol as the preferred supplemental carbon source.

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Denitrification Process

In order to meet mandated ammonia discharge requirements most municipal systems in the United States practice nitrification which adds additional nitrogen in the form of nitrate nitrogen to the water. However, only a small amount of nitrate nitrogen is removed in wastewater treatment systems designed for nitrification only. A tertiary nitrogen removal process provides a method for removing a large portion of the nitrogen in the form of nitrate from wastewater effluent before it is discharged into sensitive waterways. Through a process known as "denitrification," water treatment facilities convert the excess nitrate into nitrogen gas which is then released into the atmosphere.

The removal of nitrogen in biological treatment systems consists of four basic steps. The first step is the conversion of organic nitrogen to ammonia in a process called ammonification. Ammonia is then converted to nitrate in a two-step aerobic process called nitrification (the conversion of ammonia to nitrite followed by the conversion of nitrite to nitrate). Finally, conversion and removal of nitrate can be carried out using various treatment configurations. All treatment systems, however, require an aerobic zone for converting ammonia to nitrate and an anoxic zone for converting the nitrate to nitrogen gas. One of the more common approaches to retrofitting existing facilities is to extend the aeration period to allow for nitrification followed by a fixed film filtration system for denitrification. Because organic carbon is consumed mostly in the extended aeration process it is often necessary to add a carbon source such as methanol, especially when the discharge requirements for total nitrogen are low.

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Role of Methanol in Wastewater Treatment

As part of the denitrification process methanol plays a crucial role in reducing environmentally damaging effluent high in nitrogen that is discharged by wastewater treatment facilities across the globe. Methanol is a naturally occurring, biodegradable molecule and is employed in these operations because of its favorable chemical properties. Over 200 major wastewater treatment facilities across the United States are currently using methanol in their denitrification process. Methanol is the most common organic compound used in denitrification, accelerating the activity of anaerobic bacteria that break down harmful nitrate. In an anoxic tertiary nitrogen removal system, an external carbon source such as methanol is often required to ensure that denitrification is maximized.

Additional Information on the use of Methanol for Wastewater Treatment

The Methanol Institute (MI) serves as the trade organization for the global methanol industry. Utility Managers, wastewater treatment plant operators, engineering firms and process equipment manufacturers interested in obtaining information on the use of methanol for denitrification can visit our web site at www.methanol.org

The Methanol Institute provides technical and safety information on the use of methanol in wastewater treatment applications including a safe handling manual.

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