

# Nitrogen Removal from Wastewater

## NITROGEN FORMS

Nitrogen exists in several forms. The principal nitrogen types of concern to wastewater treatment are: total Nitrogen (t-N), Total Kjeldahl Nitrogen (TKN), Ammonia (NH<sub>3</sub>), Organic Nitrogen (org-N), Nitrate (NO<sub>3</sub>), and Nitrite (NO<sub>2</sub>). Concentrations are reported in mg/L, as Nitrogen.

The relationships of the various forms are confusing, but important to understand.

**total-Nitrogen** (total-N). In order to determine the total-Nitrogen concentration, laboratory testing of TKN, Nitrate and Nitrite is required. The results of the three tests are added together. Many labs perform a cost saving nitrite+nitrate test. If regulations allow, total-N may be determined by performing TKN and nitrite+nitrate testing.

$$\text{total-N} = \text{TKN} + \text{NO}_3 + \text{NO}_2$$

**Total Kjeldahl Nitrogen** (TKN). TKN is made up of Ammonia and organic-Nitrogen. A municipal wastewater treatment plant with an effluent containing more than 5 mg/L TKN is not fully nitrifying.

$$\text{TKN} = \text{NH}_3 + \text{org-N}$$

**Ammonia** (NH<sub>3</sub> or NH<sub>4</sub>). When the pH of the wastewater is acidic or neutral, the majority of the nitrogen is ammonium (NH<sub>4</sub><sup>+</sup>). When the pH increases over 8.0, the nitrogen is mostly ammonia (NH<sub>3</sub>). A municipal wastewater treatment plant with an effluent containing more than 2 or 3 mg/L NH<sub>3</sub> is not fully nitrifying.

**organic-Nitrogen** (org-N). A small fraction, typically one or two milligrams per liter, of the organic-Nitrogen is not amenable to biological treatment and passes through the treatment facility unchanged. A municipal wastewater treatment plant that is effectively nitrifying generally contains less than 3 mg/L organic-Nitrogen.

**Nitrate** (NO<sub>3</sub>). Without additional information, the NO<sub>3</sub> concentration in municipal effluent is of little value. An effluent NO<sub>3</sub> concentration of less than 3 mg/L exists in wastewaters that are fully nitrified and denitrified as well as in effluent with no nitrogen removal at all. An effluent that is fully nitrified but has not been denitrified will generally contain an NO<sub>3</sub> concentration of approximately 20 mg/L.

**Nitrite** (NO<sub>2</sub>). Municipal wastewater effluents generally contain less than 1 mg/L NO<sub>2</sub>. Greater concentrations are found when a facility is partially nitrifying. Nitrates use up a lot of chlorine and interfere with disinfection in plants using chlorine gas or hypochlorite.

**Nitrogen Gas** (N<sub>2</sub>). The air we breathe is 78% N<sub>2</sub> and only 21% oxygen. The remaining one percent is argon and other inert materials.

