Ammonia

What is Ammonia?

Ammonia is a nutrient that contains nitrogen and hydrogen. Its chemical formula is NH_3 in the un-ionized state and NH_4^+ in the ionized form. Total ammonia is the sum of both NH_3 and NH_4^+. Total ammonia is what is measured analytically in water.

Why is it Important?

Ammonia is the preferred nitrogen-containing nutrient for plant growth. Ammonia can be converted to nitrite (NO_2) and nitrate (NO_3) by bacteria, and then used by plants. Nitrate and ammonia are the most common forms of nitrogen in aquatic systems. Nitrate predominates in unpolluted waters. Nitrogen can be an important factor controlling algal growth when other nutrients, such as phosphate, are abundant. If phosphate is not abundant it may limit algal growth rather than nitrogen. Ammonia is excreted by animals and produced during decomposition of plants and animals, thus returning nitrogen to the aquatic system.

Ammonia is also one of the most important pollutants because it is relatively common but can be toxic, causing lower reproduction and growth, or death. The neutral, un-ionized form (NH_3) is highly toxic to fish and other aquatic life.

How is it Measured?

Ammonia is analyzed by chemical titration. The method used in most test kits is called the salicylate method.

Always measure pH and temperature when you measure ammonia. Without these other measurements it will be difficult to know the toxicity of the ammonia.

The careful reporting of ammonia test results is very important. Do not simply tabulate your results as "NH_3" because this abbreviation is used for both total and un-ionized ammonia. Be sure you indicate which you are reporting. Results can be expressed as:

- total ammonia (mg/l),
- un-ionized ammonia (mg/l),
- total ammonia (as N, mg/l),
- un-ionized ammonia (as N, mg/l).

If you measure pH and temperature, you can convert total ammonia values to un-ionized ammonia using the attached table.

Example:

Your total ammonia (mg/l) = 2.0
pH = 8.0
Temperature = 25 Degrees C
Your sample is from a freshwater stream.
Find pH = 8 at the left side of the table, find 25 Degrees C and FW (freshwater) at the top of the table. Their intersection gives the percent un-ionized ammonia. The value is 5.28%

Un-ionized ammonia (mg/l) = total ammonia x percent un-ionized
= 2 x 0.0528
= 0.106 mg/l (un-ionized NH_3)

The "as N" values are based only on the nitrogen component of the molecule. To convert readings, use the equations in the table.

What Affects it in Water?

Natural factors that can affect the concentration of ammonia include: algal growth, decay of plant or animal material, and fecal matter. Other aspects of nitrogen cycling can also affect the amount of ammonia present.

Ammonia can also come from domestic, industrial or agricultural pollution, primarily from fertilizers, organic matter or fecal matter.

What are Acceptable Ranges?

The toxicity of ammonia is critically dependent on pH and temperature. The un-ionized form (NH_3) is more toxic than the ionized form (NH_4^+). As pH increases, NH_4^+ is converted to NH_3, and the toxicity increases. Higher temperatures also favor the more toxic form. **It is very important that you compare values of ammonia correctly. You must compare total ammonia to total ammonia, and compare un-ionized ammonia to un-ionized ammonia.** Are the values reported "as N" or not? Be careful, the scientific profession has not always been clear in their reporting!

Check the following section on water quality objectives for levels that should not be exceeded in your area.
Trout and salmon are more sensitive to ammonia than warm water fish such as bluegill. Fish tend to be more sensitive than invertebrates.

What are the Water Quality Objectives[1]?

The water quality objectives for ammonia vary from region to region. Check with the Regional Water Quality Control Board in your area. Water quality objectives are included in their Basin Plan.

There is no water quality objective for ammonia in ocean waters.

For the North Coast Region: There is no water quality objective for ammonia.

For the San Francisco Bay Region: The discharge of wastes shall not cause receiving waters to contain concentrations of un-ionized ammonia in excess of the following limits (in mg/l as N):

- Annual Median: 0.025
- Maximum for the Central San Francisco Bay and upstream: 0.16
- Maximum for the Lower San Francisco Bay and upstream: 0.4.

For the Central Coast Region: The discharge of wastes shall not cause concentrations of unionized ammonia to exceed 0.025 mg/l (as N) in receiving waters.

For the Los Angeles Region: In order to protect aquatic life (both coldwater and warm water species), the Basin Plan tabulates the concentrations of total ammonia and un-ionized ammonia that should not be exceeded.

For the Sacramento and San Joaquin Valleys: There is no water quality objective for ammonia.

For the Tulare Basin: Waters shall not contain un-ionized ammonia in amounts which adversely affect benefical uses. In no case shall the discharge of wastes cause concentrations of unionized ammonia to exceed 0.025 mg/l (as N) in receiving waters.

For the Lahontan Region: In order to protect aquatic life (both cold water and warm water species), the Basin Plan tabulates the concentrations of total ammonia and un-ionized ammonia that should not be exceeded. There is a site-specific ammonia

[1] A water quality objective is a law or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the uses of that particular waterbody and an antidegradation statement.

objective for the Owens River watershed.
For the Colorado River Basin Region: There is no water quality objective for ammonia.

For the Santa Ana Region: There are ammonia objectives for waters in this region. Tables are presented in the Basin Plan which indicate the un-ionized ammonia and total ammonia objective for various temperatures and pH. The objectives are expressed as NH_3 as N. Do not use the L.A. Regional Board's tables for this region. Refer to the Santa Ana Region Basin Plan. There is also a site-specific ammonia objective for the Santa Ana River system. Discharges to that system should not cause concentrations of un-ionized ammonia to exceed 0.098 mg/l (NH_3-N) as a 4 day average.

For the San Diego Region: The discharge of wastes shall not cause concentrations of un-ionized ammonia (NH_3) to exceed 0.025 mg/l (as N) in inland suface waters, enclosed bays and estuaries and coastal lagoons.