Wastewater Treatment Operations
Nutrient Supplement
Ammonia & Ortho-Phosphate

Within a biological (Secondary) wastewater treatment system, heterotrophic bacteria (bacteria which utilize/degrade carbon molecules as a food substrate, i.e.; BOD) require a number of nutrients in their diet to maintain growth and reproduction. A typical bacteria cell contains;

Bacteria Cell
↓
↓ 80% Water | ↓ 20% Dry Matter
↓
90% organic / 10% inorganic

↓ (organic)	↓ (inorganic)
53% carbon	50% P_2O_5
29% oxygen	15% SO_3
12% nitrogen	11% Na_2O
6% hydrogen	9% CaO
	8% MgO
	6% K_2O
	1% Fe_2O_3

Therefore, it is obvious that the major nutrient requirements for a bacteria in addition to the carbon and water (H2O) are nitrogen (12% of the 90% organic = 10.8% of the total dry weight), and phosphorus (21.5% of 50% x 10% = 2.15% of the inorganic content). The other micronutrients are generally not a limiting factor as they are usually available in the trace amounts needed.

The general rule is that a system will need 5 parts of Nitrogen and 1 part of phosphorous for every 100 parts of BOD to be degraded. This is true for a conventional activated sludge system (such as a winery WWTP), however, with a young sludge age (such as during a plant start-up or a BOD shock loading) the ratio would be 100 to 7 to 3 and for an extended aeration system (such as in an industrial treatment facility) the ratio would be closer to 100 to 3 to 0.5.

Therefore, when operation a secondary wastewater treatment system;

Step 1. Determine the influent average BOD loading, ammonia nitrogen and ortho-phosphate levels. If insufficient nitrogen or phosphorous appear to be available, calculate the amount in pounds of each that will be required for the system.

$$\text{Specific Nutrient Needed} = \frac{\text{Influent BOD (mg/l)}}{\text{Carbon :Nutrient Ratio } (100 \div \text{Nutrient ratio})}$$

Example: 170 mg/l BOD ÷ (100 ÷ 5 = 20) = 170 ÷ 20 = 8.5 mg/l of N needed

Step 2. Determine the nutrient shortage. If in this example the system has 4.5 parts of ammonia in the influent wastewater, the amount of nutrient shortage would be;

Amount Required - Amount in Influent = Amount Needed for this system.

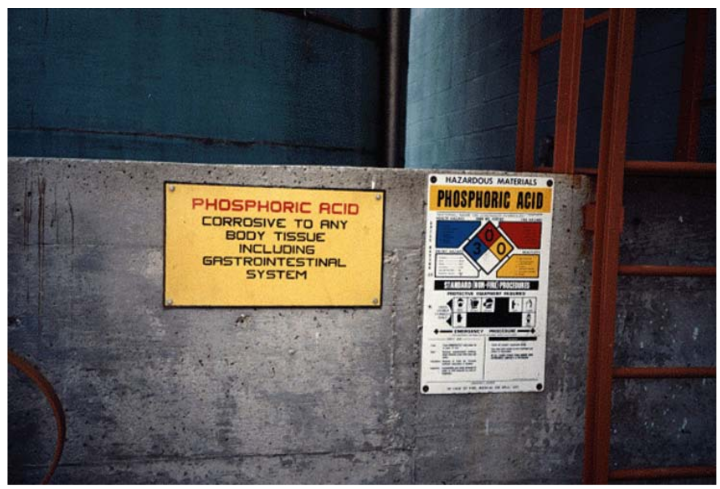
Example: If 8.5 mg/l is required and 4.5 mg/l is in the influent, the amount we need to add to the system would be 8.5 mg/l - 4.5 mg/l = 4.0 mg/l of N.

Step 3. Calculate the pounds of the respective nutrient to be added ;

Nutrient shortfall in mg/l x flow in MGD (millions of gallons per day) x 8.34

Example: If the flow is 1.5 MGD and the N shortfall is 4.0 mg/l;

1.5 x 4.0 x 8.34 = 50 pounds of N needed per day



Step 4. Determine pounds of a specific chemical containing the needed nutrient;

$$\text{Chemical lb/day} = \frac{\text{Nutrient lb/day required} \times \text{Nutrient atomic weight ratio}}{\text{concentration of the nutrient in the chemical (as a \%)}}$$

Example: The atomic weight ratio for urea is 2.14 {urea is $CO(NH_2)_2$}

atomic wt. of C = 12 x 1 = 12
atomic wt. of O = 16 x 1 = 16
atomic wt. of N = 14 x 2 = 28
atomic wt. of H = 1 x 4 = 4
total atomic wt. = 60 ÷ 28 (N) = 2.14

Therefore; if 50#/day of N is needed, (50 x 2.14) ÷ 46% N (0.46) concentration in Urea product = 233#/day of this particular grade of urea.

Some typical products that can be used as additives for N or P include;

Chemical Name	**Formula.**	**Nitrogen atomic weight ratio**	**Phosphorous atomic weight ratio**
Aqua Ammonia	NH_3OH	2.43	-
Phosphoric Acid	H_3PO_4	-	3.16
Ammonium Phosphate	$NH_4H_2PO_4$	8.21	3.71
Urea	$CO(NH_2)_2$	2.14	-
Trisodium Phosphate	Na_3PO_4	-	5.29
Disodium Phosphate	Na_2HPO_4	-	4.58
Monosodium Phosphate	NaH_2PO_4	-	3.87

Note: Do not use a polyphosphate or hexametaphosphate as a source for P, as they are very slow to hydrolyze, requiring a week or more to become an available source of PO_4 for the bacteria.

Also, be certain that PO_4 is measured as soluble PO_4 as phosphate tends to react very rapidly with iron (ferric chloride), aluminum (alum) or calcium to form stable complexes which again are unavailable to the bacteria (i.e.; filter the sample through a 0.45µ filter before testing.