

Section 3 Nutrient Removal

Nutrient removal generally refers to “mineralised” nutrients that comprise nitrogen and phosphorous. The most cost effective way to remove nutrients is through biological action; however there are also physico-chemical methodologies that may be employed.

Nitrogen Removal

Nitrogen (N) is derived from the degradation of organic and inorganic nitrogen. In wastewater, it is usually through degradation of protein waste such as urine and animal carcasses. Proteins are converted to ammonia through aerobic and anaerobic breakdown by general saprophytic bacteria. Ammonia becomes ammonium in the water phase, facilitating biological transformation to nitrite and nitrate by autotrophic bacteria (nitrifiers). These species need an abundance of oxygen (4.3 mg/O₂ per mg NH₃) and plenty of residual alkalinity in the non hydroxyl range. As the pH climbs over 8.0 ammonium reverts to ammonia which is toxic to bacteria and nitrification begins to fail. Where ammonia is converted to nitrate, alkalinity is used and the pH drops significantly. Therefore pH is critical.

Under aerobic conditions nitrogen will remain in the final effluent as nitrate. In order to meet discharge consent levels it is often necessary to remove this through denitrification. In activated sludge plants, the return sludge (rich in nitrate) is returned to an anoxic tank (non aerated) and blended with influent containing high strength BOD. The bacteria will use the oxygen molecule of NO₃ and liberate nitrogen, which bubbles to the surface and goes into the atmosphere. The denitrified wastewater is then allowed to enter the plant. In smaller plants where an anoxic plant is tank is unavailable, this is overcome by turning down the aeration (using an inverter) or putting it on a timer.

In cases where there are extremely high levels of ammonia and a low to neutral pH, zeolite can be added which mops up ammonia and locks it into the sludge. This would offer a physico-chemical solution.

Phosphorous Removal.

Phosphorus (P) occurs in wastewaters almost solely as phosphates. These phosphates include organic phosphate, polyphosphate (particulate P) and orthophosphate (inorganic P). While some literature describes phosphorous as having a limited gaseous cycle, it is negligible in a wastewater treatment plant scenario. Therefore, it can only be removed from final discharge by locking it into the sludge. This is generally done on a physico-chemical basis, but in certain circumstances organisms may store excess phosphorus in the form of polyphosphates for future use. This enhanced biological phosphorous removal (EBPR) works in the following circumstances:

Certain microorganisms, when subjected to completely anaerobic conditions, assimilate and store fermentation products produced by other facultative bacteria using stored polyphosphates as an energy source. The process releases free phosphorous into the mixed liquor.

When these bacteria flow into the aeration basin they take up phosphorous in excess, to remedy their former phosphorous starved condition. That is, they take in more phosphorous than they previously released. The phosphorous is removed from the wastewater stream by wasting of excess sludge generated in the treatment process.

Chemical removal of Phosphorous.

Phosphorous has a negative charge in water and does not tend to precipitate in a clarifier. By adding a metal salt, a cationic charge is introduced which reduces the negative charge to near neutral (zeta potential). This allows a floc to be formed that is amenable to sedimentation. Metal salts are referred to as coagulants and usually comprise aluminium or iron, each having their own merits and demerits.