Nitrate is produced in the nitrification reactor via AOB and NOB. Nitritation occurs when ammonium is oxidized to nitrite by the chemotrophic AOB (rxn 2). Nitratation occurs when nitrite is then oxidized by the chemotrophic NOB to nitrate (rxn 2).

|  |  |
| --- | --- |
| Nitritation by AOB: NH4+ + 1.5O2 🡪 NO2- +2H+ + H2O [cite] | (rxn 1) |
| Nitratation by NOB: NO2- + 0.5O2 🡪 NO3-[cite] | (rxn 2) |

Approximately half of influent is fed to an aerobic nitritation reactor dominated by AOB where ammonium is converted to nitrite. Subsequently, nitrite and residual ammonium are anaerobically converted to di-nitrogen gas and a small amount of nitrate (rxn 4) by anammox.

|  |  |
| --- | --- |
| Anammox: NH4+ + 1.3 NO2- 🡪 N2 + 0.3 NO3-[1] | (rxn 4) |

|  |  |
| --- | --- |
| n-damo: CH4 + NO3-  🡪 CO2 + NO2- [2] | (rxn 5) |

NDAMO archaea are unique in their ability to reduce nitrate back to nitrite by using methane as an electron acceptor (rxn 5).

Sludge handling makes up a significant portion of operational costs incurred. In the US landfilling sludge can cost anywhere from $20-185/ton of sludge produced depending on multiple factors such as distance to the landfill. Furthermore, many plants are experiencing significant cost increases as permitting this disposal becomes more challenging with previously used local landfills. [Cite]

Anammox SHARON reactors are currently in use in over 75 full scale wastewater treatment plants to treatment high temperature, low carbon, high nitrogen anaerobic digester centrate which makes up only 1% of the mainstream flow.[cite]

Anammox remains unused in mainstream wastewater treatment because mainstream conditions are unfavorable to the anammox process. In this process, ammonium is oxidized to nitrite first by AOB. NOB and anammox then must compete for the resulting nitrite. If NOB activity is high, nitrate will accumulate and nitrogen removal will be insufficient. Currently, there are two control schemes implemented to limit NOB activity.

The first requires a high temperature influent stream (>25°C). At these higher temperatures, AOB have a higher growth rate than NOB and the reactor sludge retention time (SRT) can be controlled such that the NOB will be washed out before the AOB, and AOB will dominate[cite]. Because mainstream temperatures are typically cooler, this control scheme will not work for mainstream treatment.

The second takes advantage of the difference in oxygen affinity between AOB and NOB. AOB have a higher affinity for oxygen than NOB, with the affinity of AOB typically around 0.5 mg/L and the affinity of NOB typically around 0.9 mg/L [cite]. Given this, if dissolved oxygen levels are controlled between these two affinities, AOB will outcompete NOB for oxygen, and AOB will dominate. However, when attempting this control scheme, it was found that AOB activity was inhibited and were unable to supply sufficient nitrite to the anammox. This resulted in high ammonium levels in the effluent.[cite] These high levels are acceptable for sidestream centrate treatment, where the resulting stream only makes up 1% of total effluent from the plant, however this is not acceptable in mainstream treatment.

**From ryan:** However, when attempting this control scheme, it was found that AOB activity was inhibited and were unable to supply sufficient nitrite to the anammox, resulting in high ammonium levels in the effluent.[cite] These high levels are acceptable for sidestream centrate treatment, where the resulting stream only makes up 1% of total effluent from the plant, however this is not acceptable in mainstream treatment.