

Anammox

Anaerobic Ammonium Oxidation (Anammox) for Nitrogen Removal

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Our Objective is to Remove Ammonium

Ammonium Issues:

- Ammonium-NH₄⁺ in water causes public health threats and fish toxicity
- NH₄⁺ is present in municipal wastewater at high concentration
- The conventional method of NH₄⁺ removal is energy intensive with high C-footprint

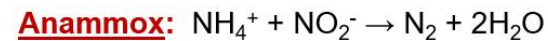


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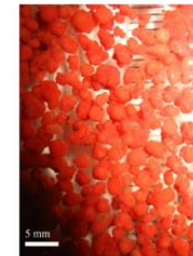


Solution:

- The Anammox process removes NH₄⁺ more economically with less C-footprint



- The performance of the Anammox process will be investigated in an expanded granular sludge bed (EGSB) bioreactor



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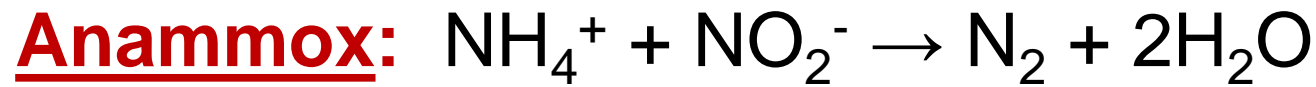
Ammonium Issues:

- Ammonium- NH_4^+ in water causes public health threats and fish toxicity
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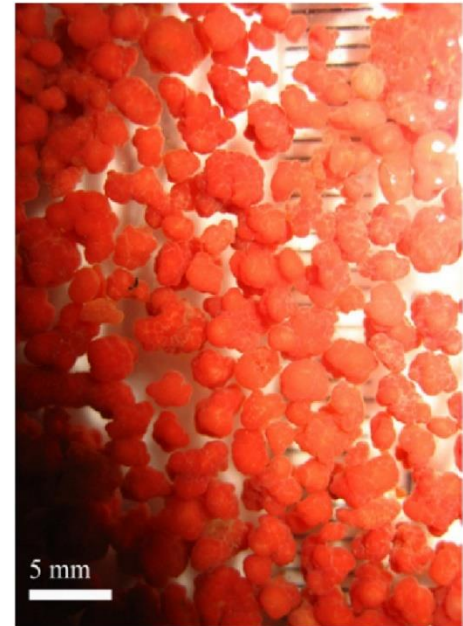


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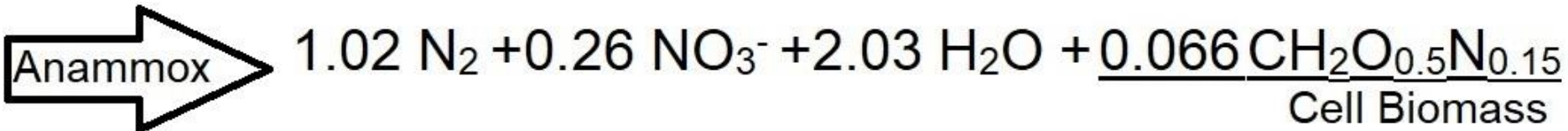
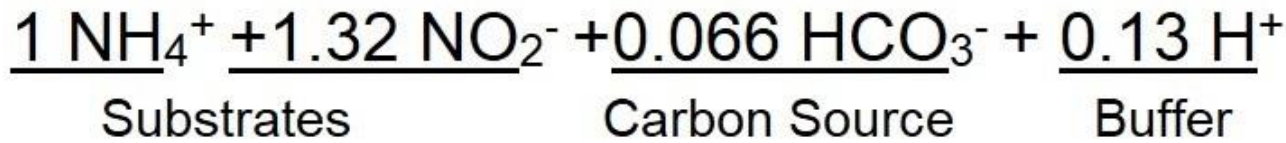
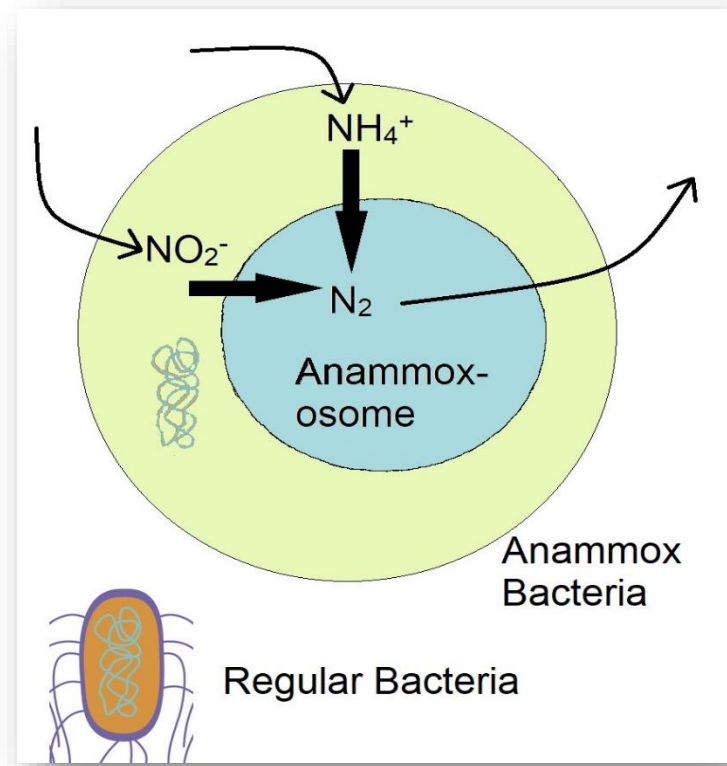
- The performance of the Anammox process will be investigated in an expanded granular sludge bed (EGSB) bioreactor



Mechanisms:

- **Double Time:**

- **Anammox: 9-10 days**
- **E-Coli: 20 minutes**



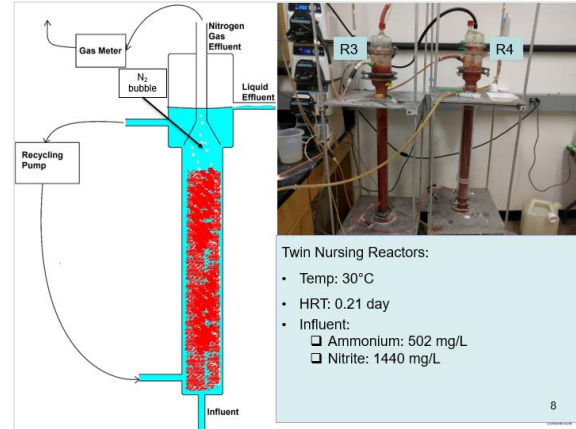
EGSB Bioreactor

EGSB: Expanded Granular Sludge Bed

- The reactor was continuously fed with synthetic wastewater
- The performance was monitored by measuring the Nutrient-N (NH_4^+ & NO_2^-) in influent and effluent samples using ion chromatography
- Also, the volume of N_2 gas produced was measured over time



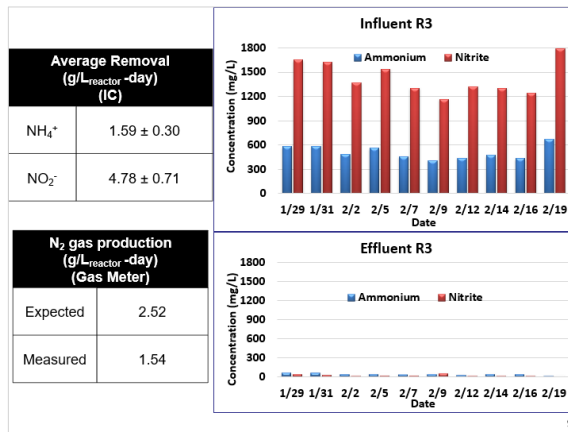
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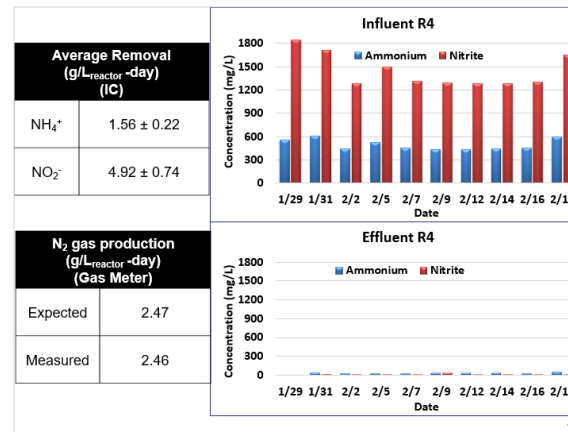
Twin Nursing Reactors:

- Temp: 30°C
- HRT: 0.21 day
- Influent:
 - Ammonium: 502 mg/L
 - Nitrite: 1440 mg/L

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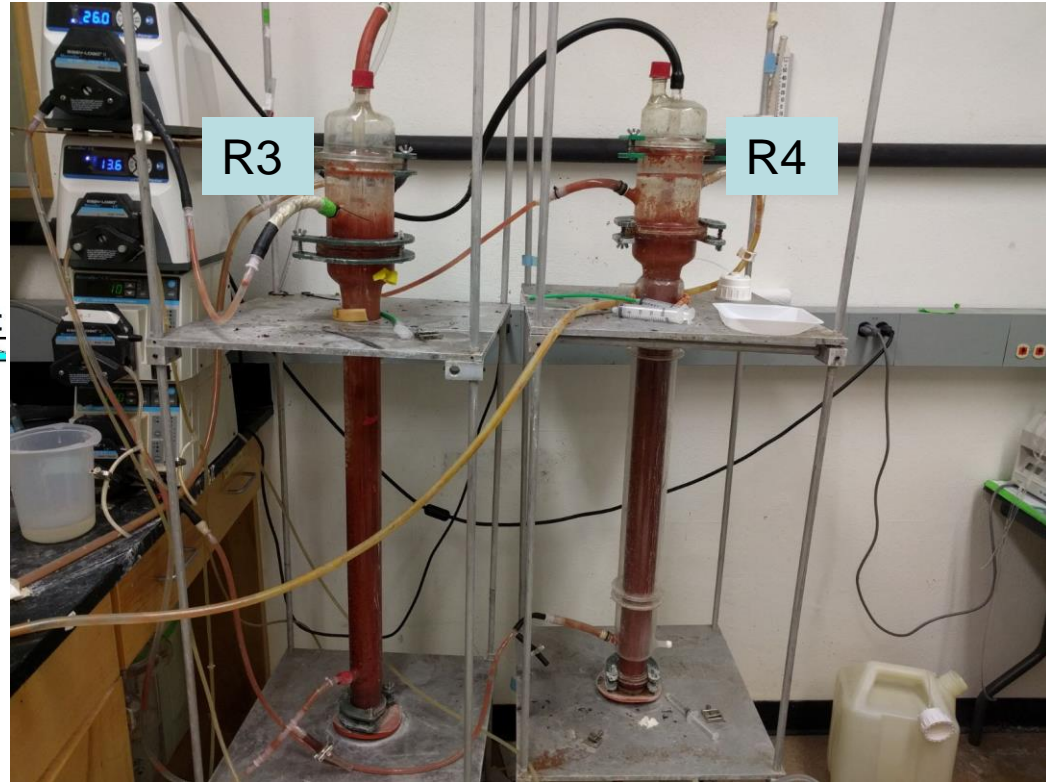
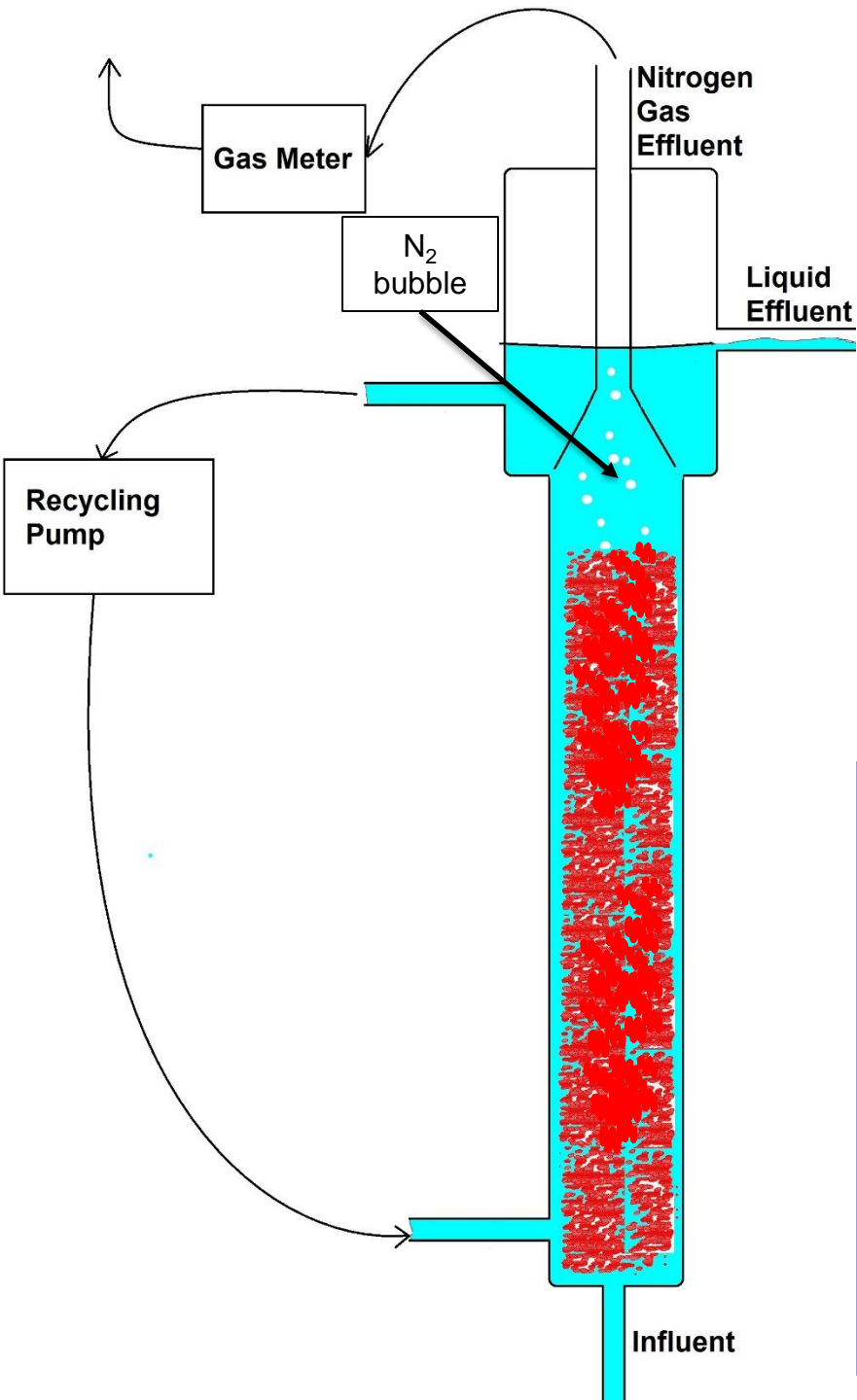
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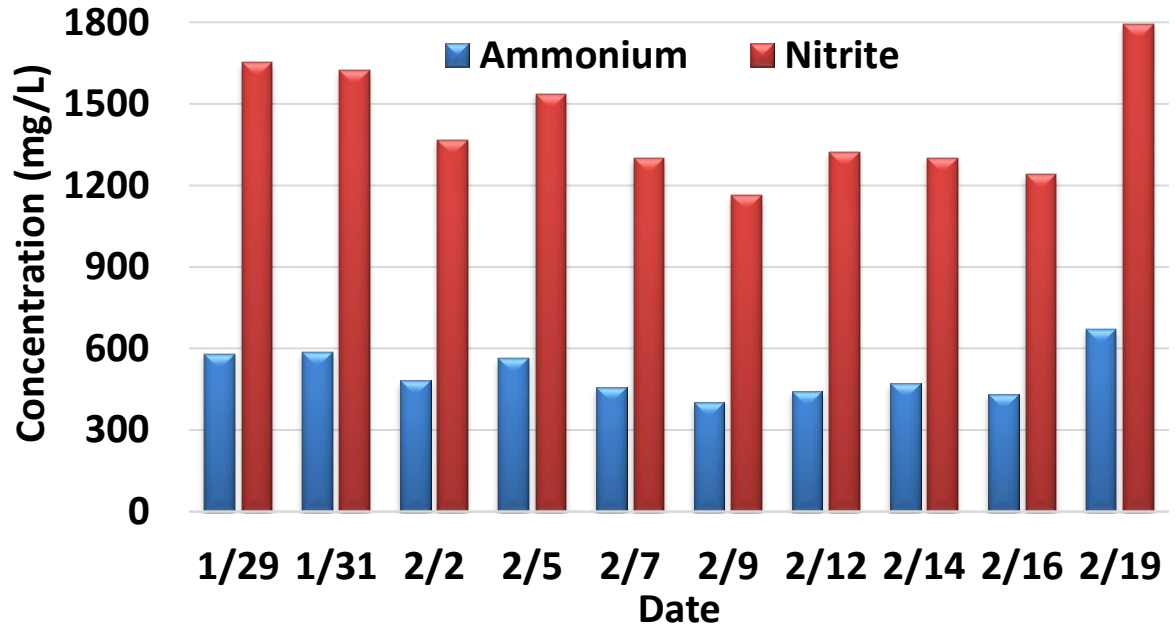
**Average Removal
(g/L_{reactor} -day)
(IC)**

| | |
|------------------------------|-------------|
| NH ₄ ⁺ | 1.59 ± 0.30 |
| NO ₂ ⁻ | 4.78 ± 0.71 |

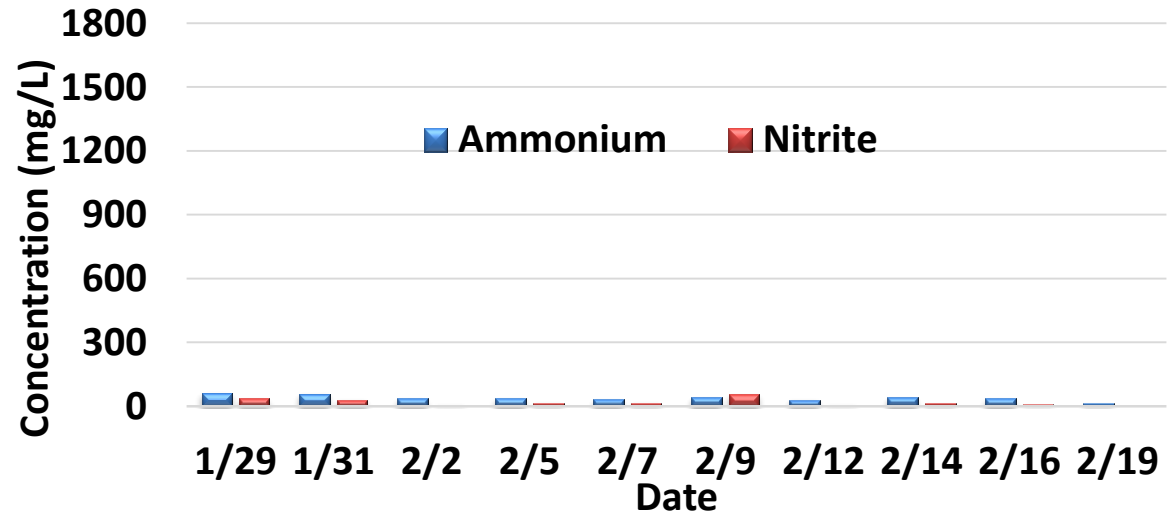
**N₂ gas production
(g/L_{reactor} -day)
(Gas Meter)**

| | |
|----------|------|
| Expected | 2.52 |
| Measured | 1.54 |

Influent R3



Effluent R3



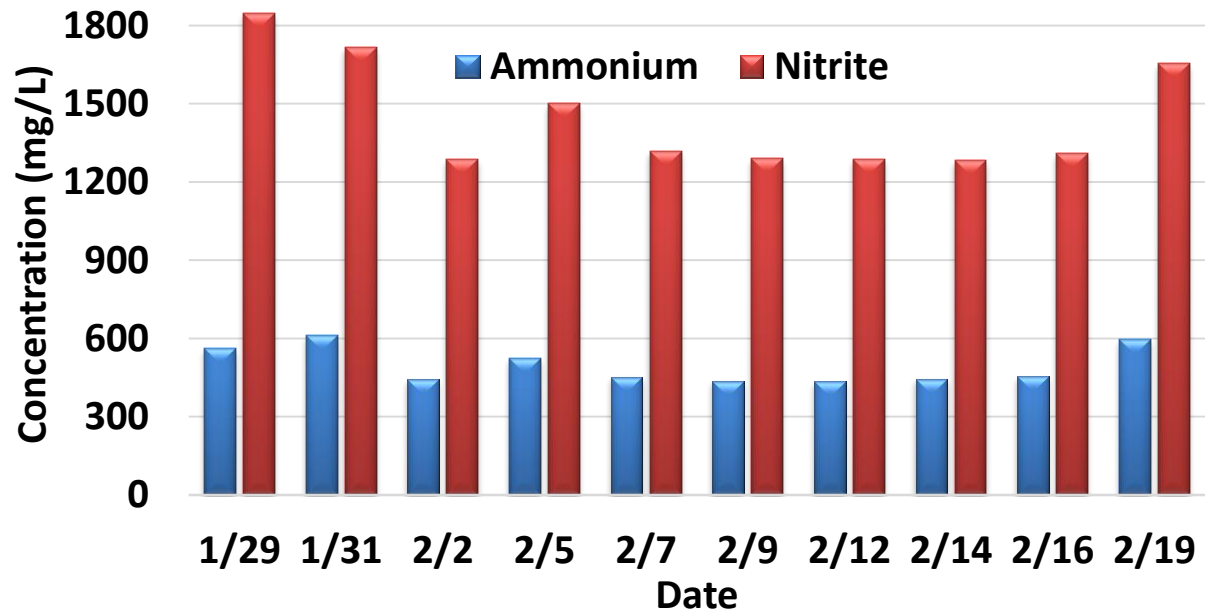
**Average Removal
(g/L_{reactor} -day)
(IC)**

| | |
|------------------------------|-------------|
| NH ₄ ⁺ | 1.56 ± 0.22 |
| NO ₂ ⁻ | 4.92 ± 0.74 |

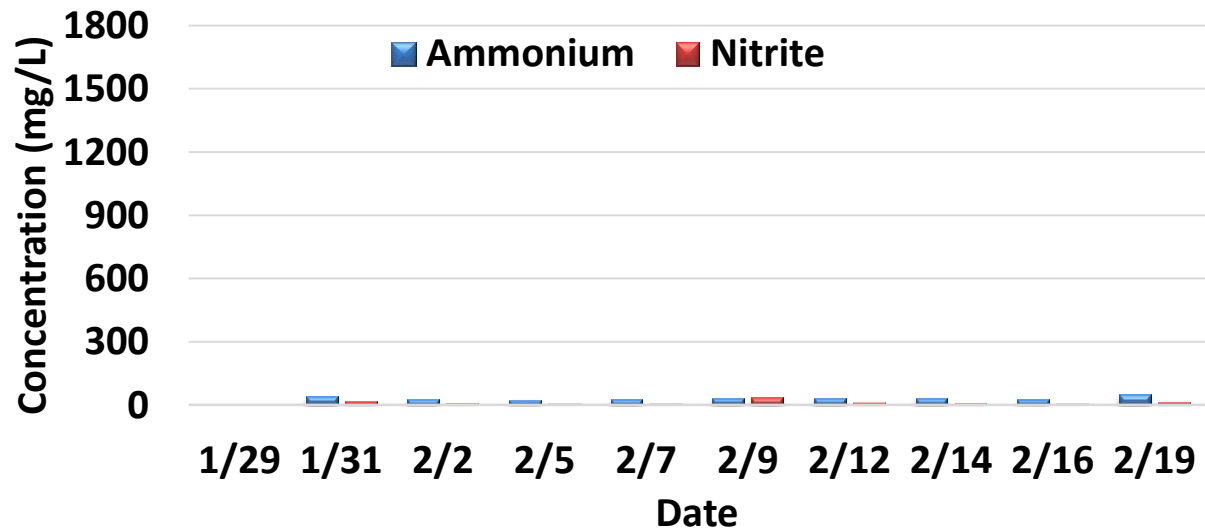
**N₂ gas production
(g/L_{reactor} -day)
(Gas Meter)**

| | |
|----------|------|
| Expected | 2.47 |
| Measured | 2.46 |

Influent R4



Effluent R4



Anammox Activity Bioassay

Batch Activity Test

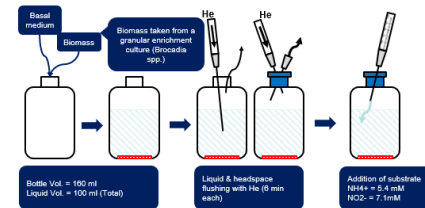
- To determine the max. specific anammox activity of the biomass, i.e., amount of N_2 gas per gram of dry biomass and per day.
- The experiment is performed in a 160ml serum flask
 - 100ml synthetic wastewater medium
 - 60ml Helium gas
 - 0.5g biomass
- Using Gas Chromatography, the N_2 content in gas samples is evaluated six times, once per hour.



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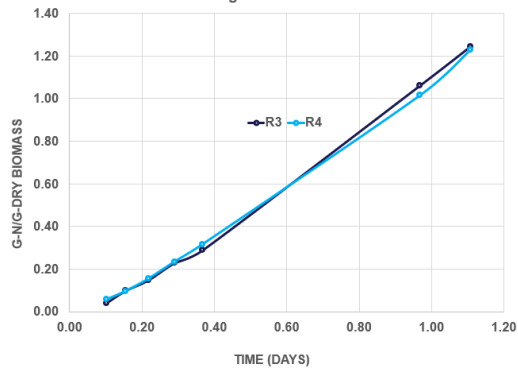
Anammox Activity Bioassay



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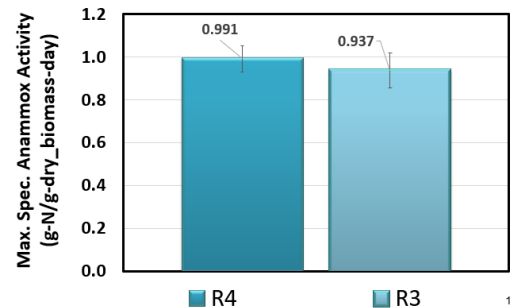


Nitrogen Gas Production



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Max. Specific Anammox Activity of the Reactor Biomass



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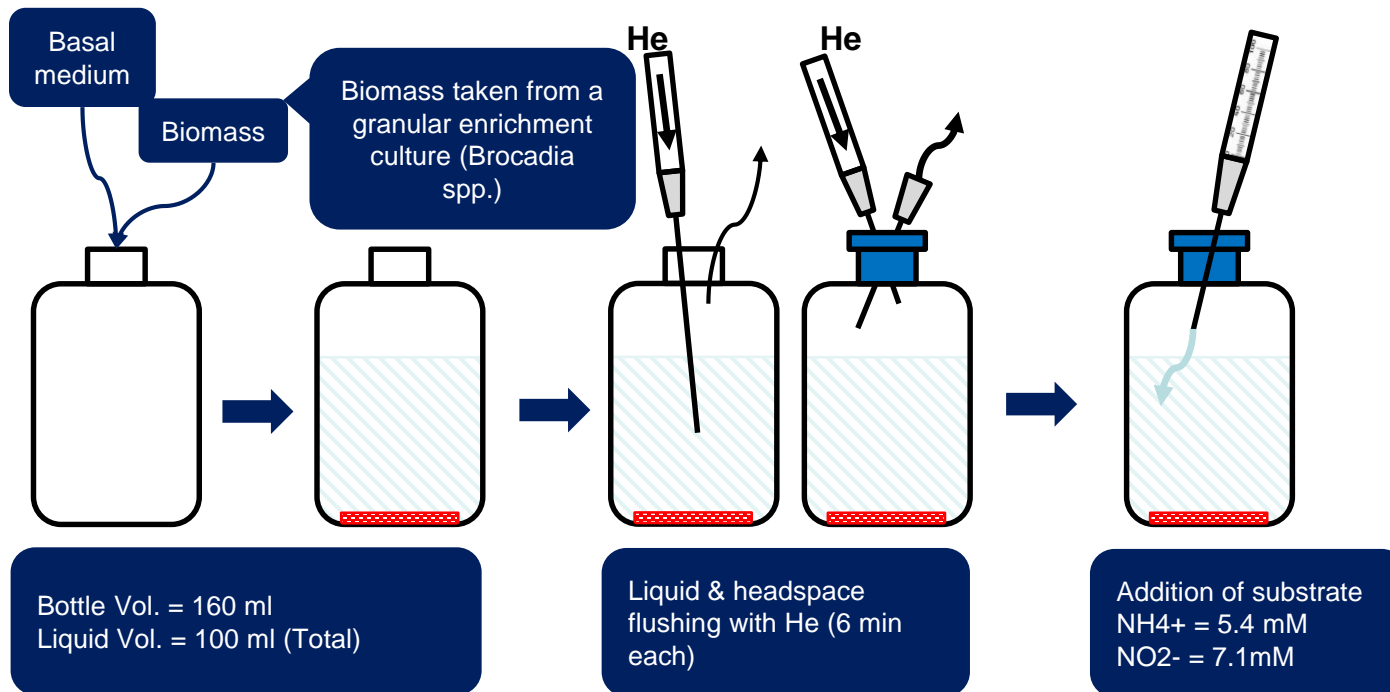


Batch Activity Test

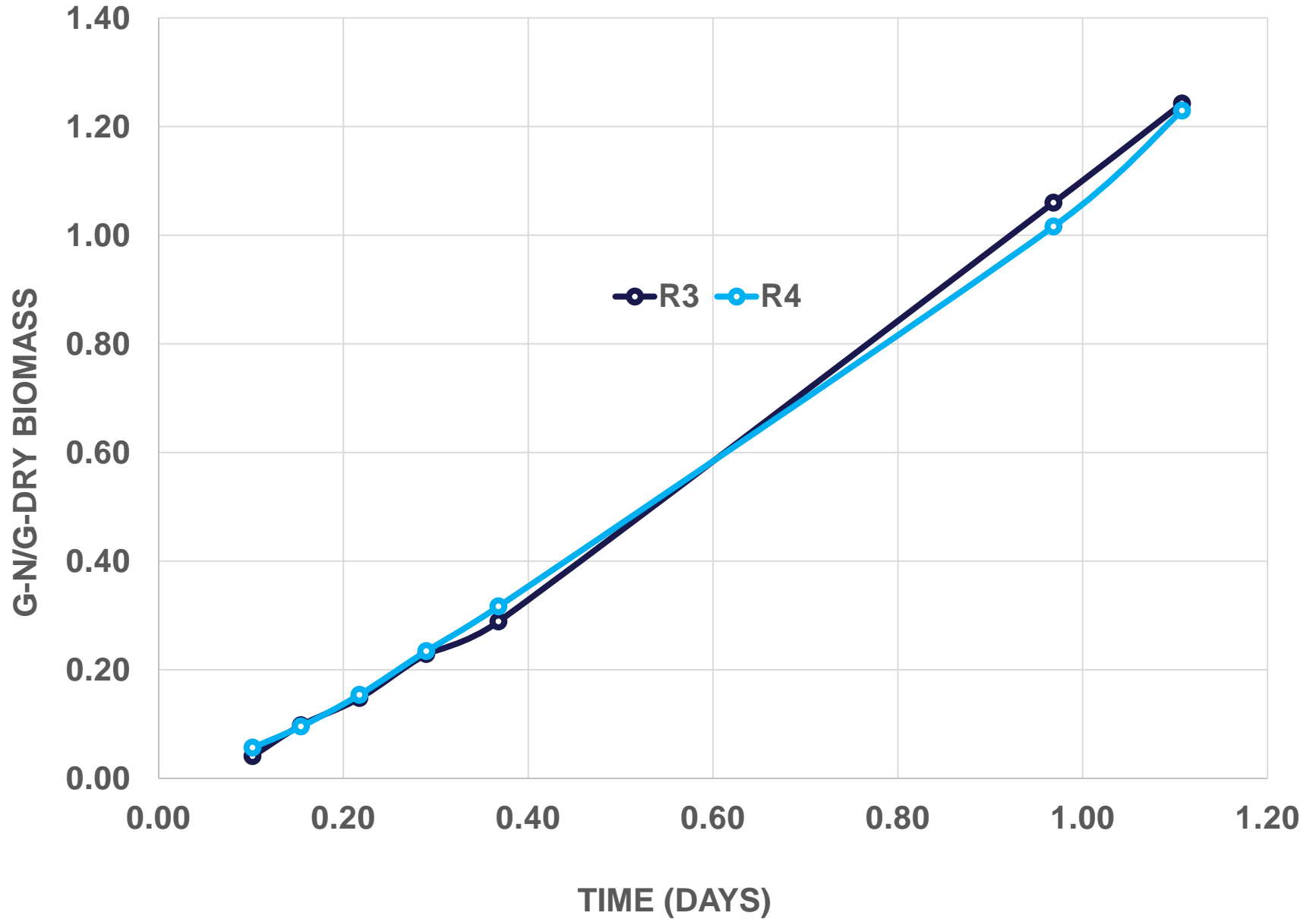
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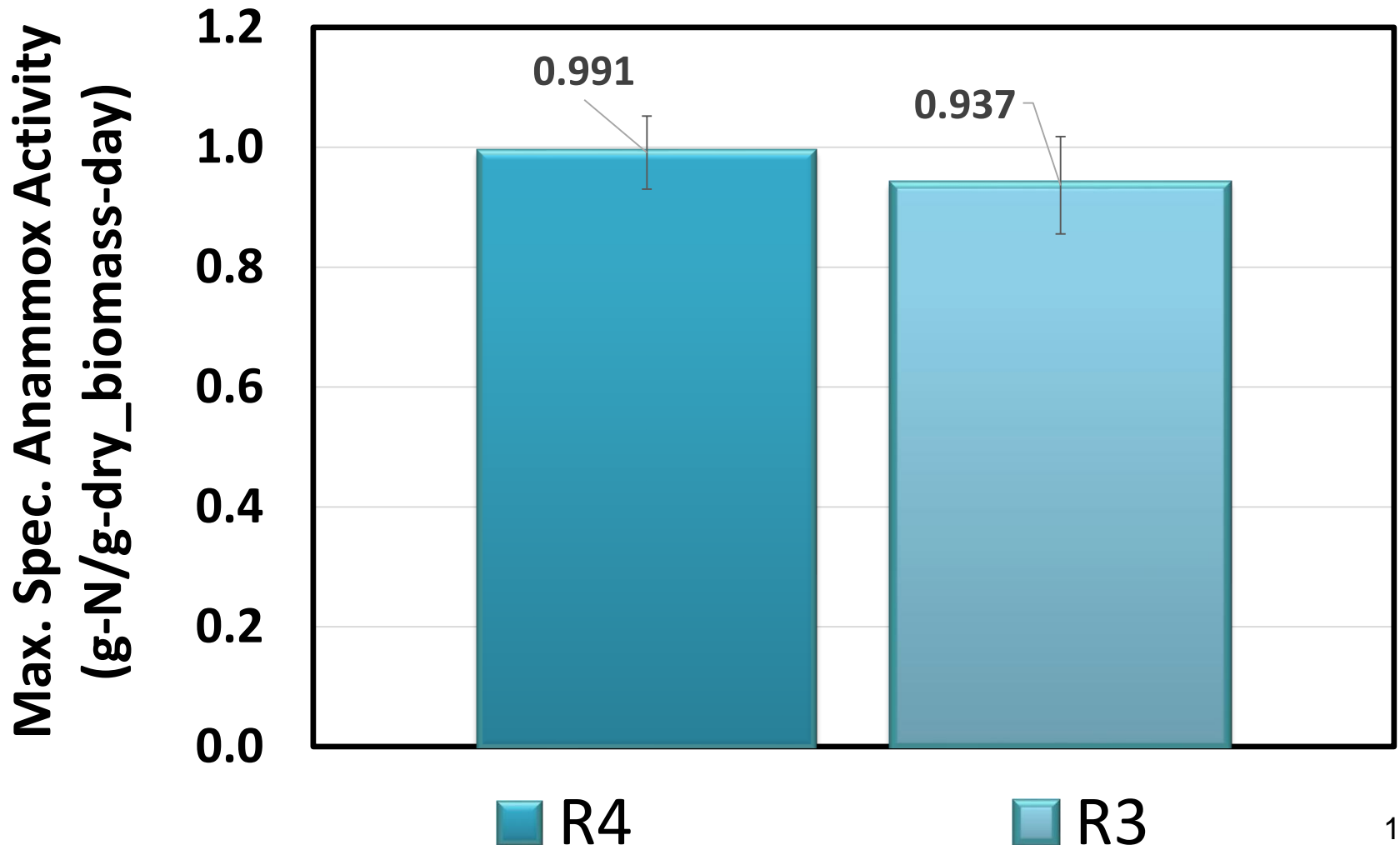
Anammox Activity Bioassay



Nitrogen Gas Production



Max. Specific Anammox Activity of the Reactor Biomass



Conclusions

- The continuous Anammox bioreactors provided high NH_4^+ and NO_2^- removal efficiency (93% on average).
- Based on the batch bioassays, the max. specific activity of the biomass was 1 g N/(gram dry biomass x day).
- Due to the advantages of the Anammox Process, Pima County Water Reclamation Department is interested in implementing this process.



Acknowledgements

- I would like to thank Dr. Reyes Sierra for introducing me to the water treatment field which made me more determinant of my future careers.
- Special Thanks to Dr. Guangbin Li, Nivrutti Lakhey, Derek Swartzendruber, and Hezhou Ding for teaching and assisting me in the lab work.
- Also, Thanks to NASA Space Grant for its support during this internship experience.



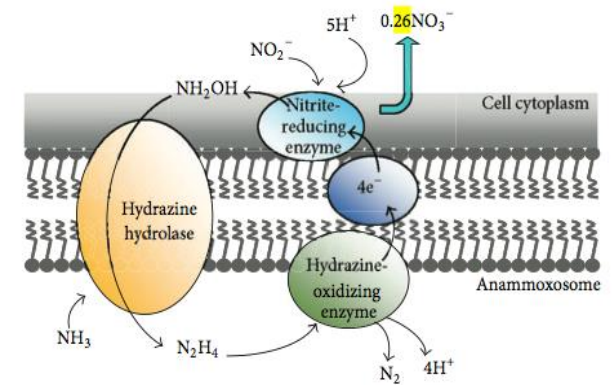
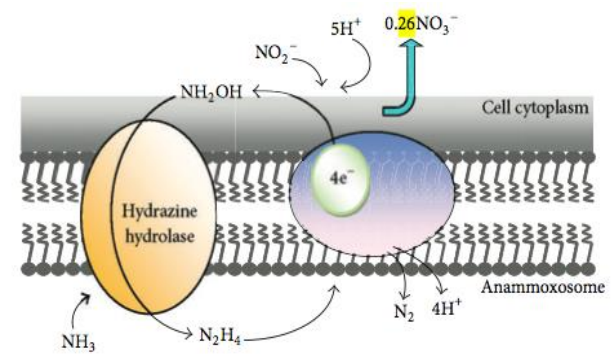
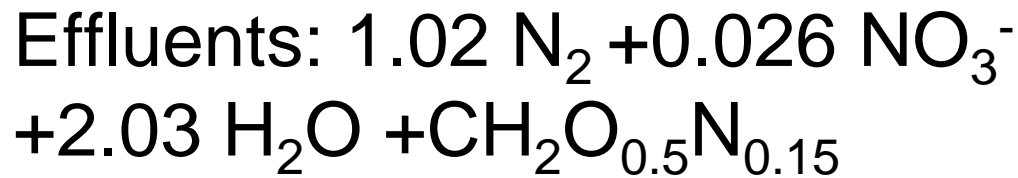
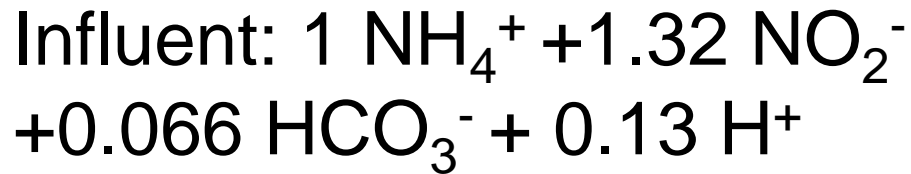
Thank
you



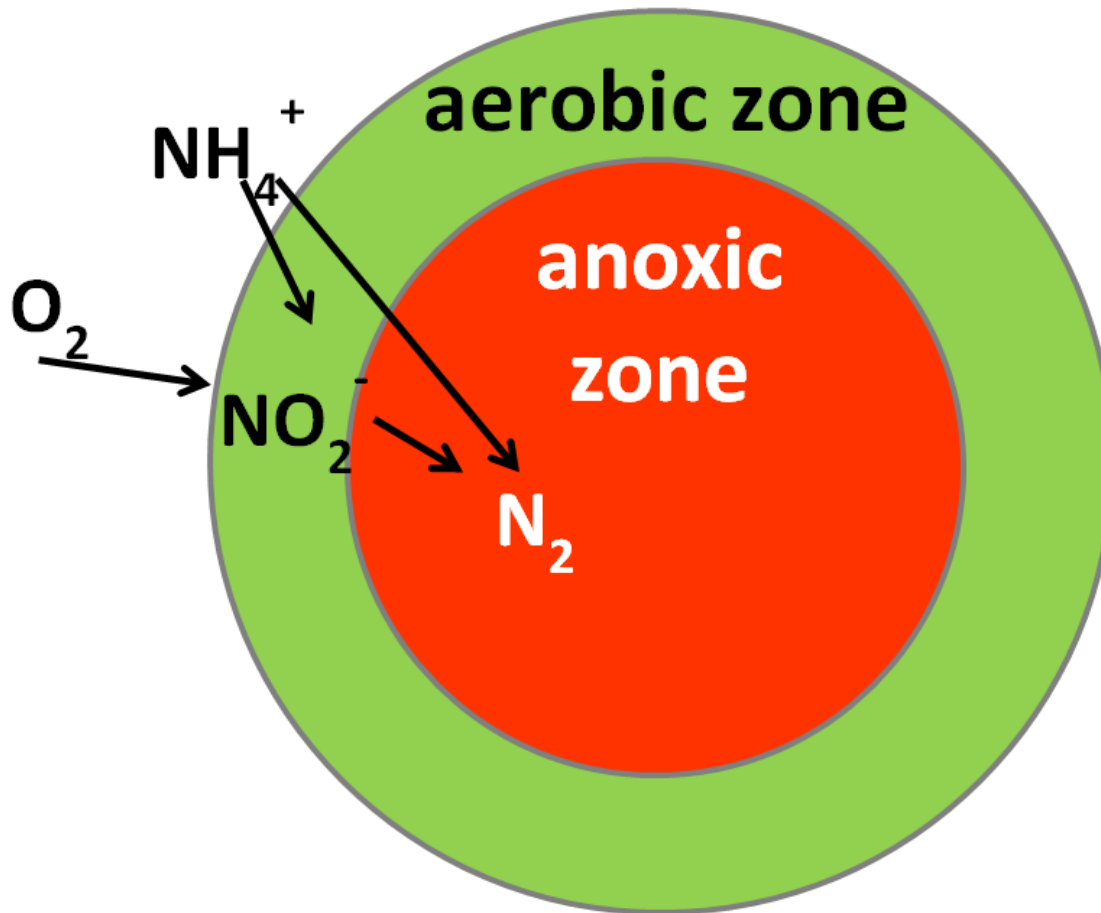
Appendices



Mechanisms:



<https://en.wikipedia.org/wiki/Anammox>



https://www.ugent.be/bw/biosysteemtechniek/en/research/biosystems-control/completed_research_projects/research-castrobarros.htm





Anammox
Bacteria

Medium

Helium
gas

Sealing
Cap

Serum
flask

C1

T1-1

T2-1

T3-1

T4-1