Metabolix

Bio-industrial Evolution

Metabolix DP9002 for Denitrification Aquarium in Applications

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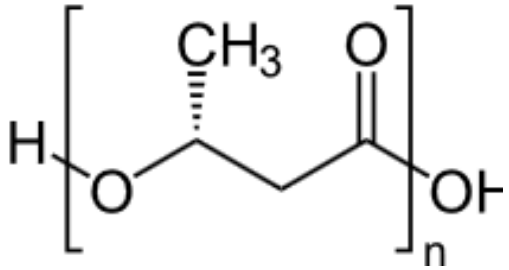
Overview

- What are Polyhydroxyalkanoates (PHAs)
- Three Nitrogen Conversion Pathways
- Conventional versus New Denitrification
- Oceanic Corals Canada Study
- References – Denitrification

Polyhydroxyalkanoates (PHAs)

- Polyhydroxyalkanoates (PHAs) are linear polyesters produced by bacterial fermentation of sugar or lipids
- PHAs produced by bacteria to store carbon and energy
- Polyhydroxybutyrates (PHBs) are polyhydroxyalkanoates (PHAs)
- The simplest and most commonly occurring form of PHA is poly-ß-hydroxybutyrate (P3HB) a PHB (produced by fermentative production)
- P3HB consists of 1,000 to 30,000 hydroxy fatty acid monomers



Structure of poly-(R)-3-hydroxybutyrate (P3HB), a polyhydroxyalkanoate

Three Nitrogen Conversion Pathways

- Three nitrogen conversion pathways traditionally used for the removal of ammonia–nitrogen in water treatment, aquaculture and aquarium systems
  - 1) Photoautotrophic removal by algae
  - 2) Autotrophic bacterial conversion of ammonia–nitrogen to nitrate–nitrogen
  - 3) Heterotrophic bacterial conversion of ammonia–nitrogen directly to microbial biomass
- PHA/PHB is used as a carbon source for
  - 2) Autotrophic bacterial conversion pathway
  - 3) Heterotrophic bacterial conversion pathway

Conventional versus New Denitrification

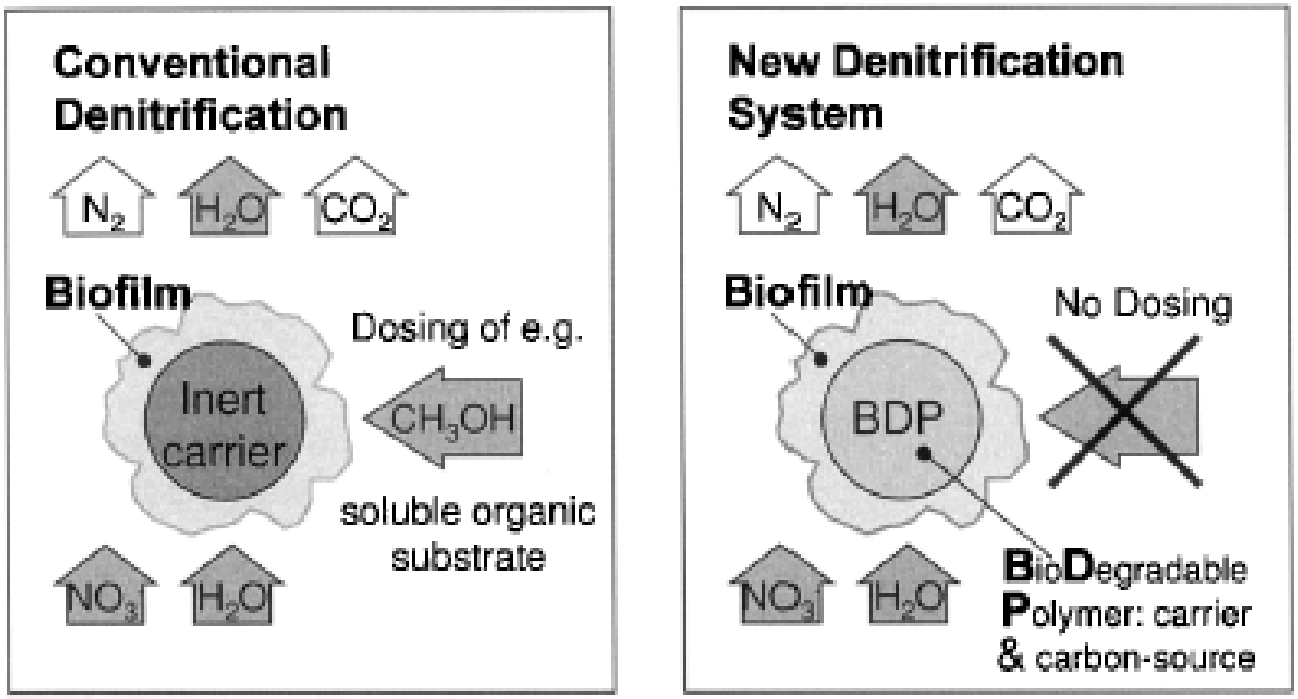


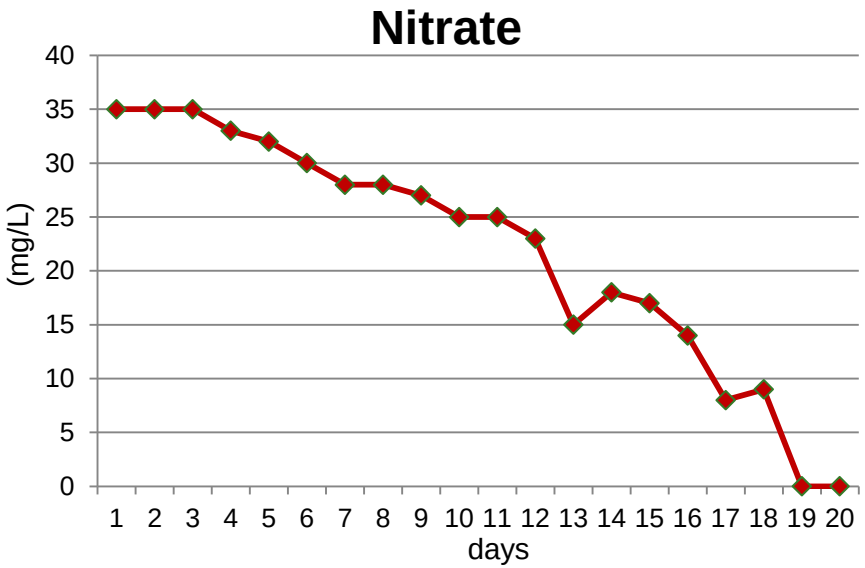
Fig. 2. Denitrification processes with different organic substrates.

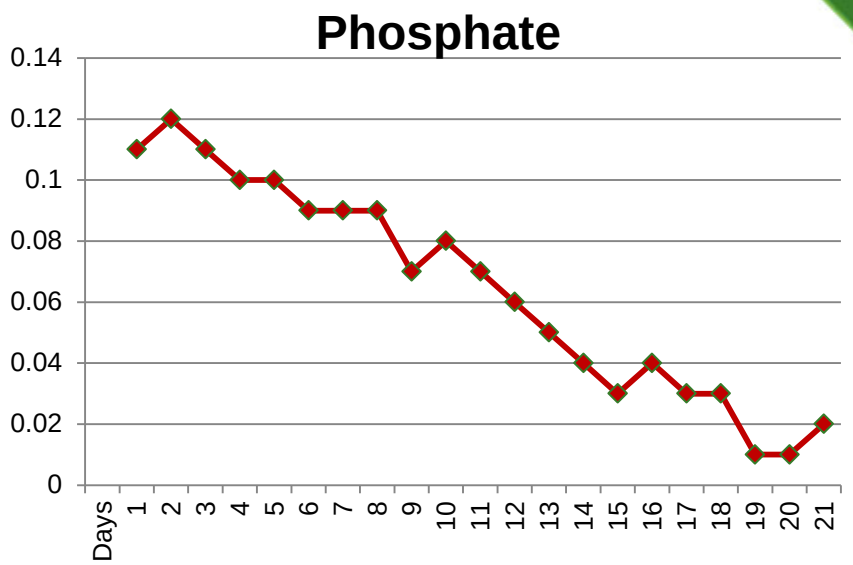
Source: Boley et.al., Biodegradable polymers as solid substrate and biofilm carrier for denitrification in recirculated aquaculture systems, Aquacultural Engineering 22 (2000) 75-85

DP9002 for Denitrification

- Small, white to light brown colored pellets developed for denitrification in aquariums

Oceanic Corals Canada Study





Test Aquarium Specifications

- 175 gallons
- Computer controlled lighting cycles and mineral additives
- 22 fish, various corals and inverts
- Daily feeding regimen is identical controlled amounts
- Protein Skimmer runs 24/7
- No water changes were during time of study

Fluidized Reactor Specifications

- Vertex UF-20 with 1460 grams of PHA Pellets
- Water flow = 265 GPH

Source: Oceanic Corals Canada, 2010

Data for PHA in Denitrification

- PHA is comparable with other carbon-based systems
  - Efficiency rate of approx. 2.4 – 7 g PHA / g of N_2*
- PHA is also active in phosphate removal
- PHA is certified Marine Biodegradable per ASTM 7081
- 100% Bio-based
- No fillers

* Source: Gutierrez-Wing et.al., Polyhydroxyalkanoates as a carbon source for denitrification of water, World Environmental and Water Resources Congress 2007

References – Denitrification

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4. Ebeling J M, Timmons M B, Bisogni JJ (2006) Engineering analysis of the stoichiometry of photoautotrophic, autotrophic, and heterotrophic removal of ammonia–nitrogen in aquaculture systems. Aquaculture 257: 346-358

5. Gutierrez-Wing M T, Rusch K A, Malone R F (2007) Polyhydroxyalkanoates as a carbon source for Denitrification of waters. World Environmental and Water Resources Congress 2007

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7. Qin L, Liu Y, Tay J-H (2005) Denitrification on poly-b-hydroxybutyrate in microbial granular sludge sequencing batch reactor. Water Research 39: 1503-1510

8. Van Rijn J, Tal Y, Schreier H J (2006) Denitrification in recirculating systems: Theory and applications. Aquacultural Engineering 34: 364-376

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