Denitrifying granules in a marine Upflow Anoxic Sludge Bed (UASB) reactor

Marine land-based Recirculating Aquaculture Systems (RAS) are generally perceived as environmentally friendly aquatic production systems. To promote their sustainability even further and reduce the discharge of nutrients, there is a need for cost-effective end-of-pipe treatment technologies for removing nutrients. This includes nitrate-nitrogen (NO₃⁻-N) for which well-proven technologies for freshwater systems exist, while similar technologies for saltwater systems are less advanced. Granular technology has been developed since the 1970s in wastewater treatment under the upflow anaerobic sludge bed (UASB) concept. This concept is based on the enrichment of different bacterial aggregations into a compact granule, optimizing synergistic and syntrophic bacterial processes by reducing the diffusion distance of substrates between the different bacterial consortia forming the granule. The following study examined the: 1) granular formation; and 2) nitrate removal capacity of a marine Upflow Anoxic Sludge Bed (UASB) reactor operating at different up-flow velocities (0.40–2.11 m/h). The results showed that marine denitrifying granules developed within 27 days using preconditioned rainbow trout (Oncorhynchus mykiss) organic matter waste, and that the highest specific denitrification rate (321.9 ± 13.1 mg NO₃⁻-N/g Total Volatile Suspended Solids (TVSS)/d) was found at an upflow velocity of 0.97 m/h. The marine UASB denitrifying granule reactor had a total capacity of removing 14.9 kg NO₃⁻-N/m³ reactor volume per day at a hydraulic retention time of 1.9h, making it a strong candidate for end-of-pipe denitrification of marine RAS effluent as well as for in-line treatment in marine systems.

General information
Publication status: Published
Organisations: National Institute of Aquatic Resources, Section for Aquaculture
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Pages: 42-49
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Aquacultural Engineering
Volume: 84
ISSN (Print): 0144-8609
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
Original language: English
Keywords: Denitrification, Granular sludge, Upflow Anoxic Sludge Bed
DOIs:
Source: FindIt
Source-ID: 2442393665
Research output: Contribution to journal › Journal article – Annual report year: 2019 › Research › peer-review