CLEANAQ

BONUS
SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

Newsletter

Issue 1, June 2018

1. About the BONUS CLEANAQ project

The BONUS CLEANAQ project investigates novel water treatment technologies to further reduce the environmental impact from fish farming in recirculating aquaculture systems in the Baltic area.

The projects aims at making advances within cost-efficient nitrogen removal techniques such as single-sludge denitrification, woodchip denitrification as well as in non-microbial nutrient removal methods (N & P). Focus is on treatment of fish farm effluents at the different salinities prevailing in the Baltic Sea area.

FIGURE 1. SAMPLING AT COMMERCIAL RAS. COURTESY: CARLOS OCTAVIO LETELIER GORDO

2. Work performed since the beginning of the project

The particulate organic wastes generated within a recirculating aquaculture system represents a useful source of dissolved organic matter that can be used in the denitrification process to remove nitrate from water. In order for the organic matter to be used efficiently in denitrification in practice, it needs to be present at a relatively high ratio compared to the amount of nitrate present. The amount of organic matter found in discharge is strongly affected by the system management and design including type of water treatment devices installed in the RAS. It will thus show variations across different types of farms. The BONUS CLEANAQ project investigated the ratios of carbon to nitrogen (C:N) present within the effluents from 3 different commercial RAS over 45 days. The investigations revealed C:N ratios of 0.46 (freshwater simple re-use system), 5 (marine rainbow trout RAS) and 13.3 (marine indoor RAS, Atlantic Salmon). The results are gathered in a report providing guidelines to end-users on how to enhance the availability of the organic matter generated within RAS for use in the denitrification process in effluent (end-of-pipe) treatment.

In effluents from RAS where only little organic matter is present and single-sludge denitrification thus is not practical, cost-efficient denitrification of effluent water can still be obtained by applying woodchip beds. As part of the BONUS CLEANAQ project, the denitrification potential of woodchip beds at different salinities was tested. Woodchip filters had highest denitrification potential in freshwater and the denitrification potential was decreasing with increasing salinity (from 0 to 35 ppt) in an experiment lasting for one month. This trend was confirmed by molecular analyses of the bacterial communities in

the woodchips showing a decrease in denitrification gene copy number with increasing salinity.

To understand the functioning of woodchip denitrification, the microbiology as well as stable isotope measurements of three full-scale woodchip denitrification beds operated at commercial outdoor Model Trout Farms in Denmark were studied during two field trips. All three sites showed a high genetic

FIGURE 2. SAMPLING FOR MICROBIAL ANALYSES IN WOODCHIP BEDS AT COMMERCIAL RAS IN DENMARK. COURTESY: MATHIS VON AHNEN

potential for nitrate and N_2O reduction, and nitrate was efficiently removed at all sites. Water and woodchips seem to host the same denitrifiers. The microbial community in incoming water is similar between sites and changes in abundances of certain microbial groups was seen from inlet to outlet.

Moreover, experiments with and without bicarbonate in brackish and fresh water were done in Laukaa experimental RAS facility. RAS outlet waters were pumped to 12 woodchip reactors and bicarbonate was added to half of those. Water and woodchip samples were collected for microbial analysis. The microbial communities were determined by 16S rRNA sequencing.

FIGURE 3. EXPERIMENTAL WOODCHIP SET-UP AT LAUKAA, FINLAND. COURTESY: SANNI AALTO

3. Main results achieved during the reporting period

- Submission of a report, describing the C:N available in the fish waste and the carbon losses associated with water treatment devices in RAS. Design guidelines for enhancing the availability of carbon sources for improving the capacity of single-sludge denitrification are proposed, targeted to industrial end-users.

- Identification of the denitrification efficiency and microbial denitrification potential in laboratory woodchip bioreactors at different salinities as well as in full-scale, freshwater woodchip bioreactors operated under commercial conditions.

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