DHI CASE STORY

IMPROVED SLUDGE MANAGEMENT

Sludge Hydrolysis reduces sludge volume and creates additional carbon sources for denitrification

An average to large land-based fish farm (1000 tons feed/year) can produce up to 15 tons of sludge (dry matter) each month equivalent to 150 m3 wet sludge (10% TS in wet sludge) – with approximately 200 g of suspended solids (SS) per kilogram of fish feed. This sludge needs to be managed and discarded properly. The Danish Ministry of Science Innovation and Higher Education sought ways to improve sludge management on fish farms. DHI was able to define and carry out a suitable project for the Ministry, solving several problems in one blow.

Sludge from fish farms originates from three origins: fish feces, drum filters and biofilters. Particularly in recirculated fish farms significant sludge production takes place. It typically has a high content of fat and volatile suspended solids. Dewatering and managing the sludge is a challenging task, as it is very unstable.

IN THE RIGHT LIGHT, SLUDGE IS MUCH MORE THAN JUST A WASTE PRODUCT

Besides suspended solids, however, the sludge also contains high amounts of COD (chemical oxygen demand) and nutrients. Therefore, instead of considering sludge as a pure waste product, it can also be used as a source of carbon needed for denitrification. Nitrate commonly accumulates in the production water due to the intense nitrification that has to occur in the biofilters to change ammonia into nitrate. The micro-organisms reducing the nitrate (denitrifiers) require carbon as an energy source to carry out the reaction – e.g. from the sludge. However, it's not that straight-forward: As the sludge COD is in a particulate form, it is difficult to use as a carbon source. First, it has to be transformed into soluble COD.

SUMMARY

CLIENT

Ministry of Science Innovation and Higher Education

CHALLENGE

Effectively manage and discard the significant amounts of sludge produced in land-based fish farms

SOLUTION

Experiments on real aquaculture sludge revealed the ability of sludge hydrolysis to reduce sludge volume, improve its quality and provide a carbon source for denitrification

VALUE

- Significant sludge volume reduction through dewatering
- Reduced costs due to the generation of a free carbon source for denitrification
- Improved sludge quality
- One-third of sludge volume transferred into a soluble form

LOCATION / COUNTRY

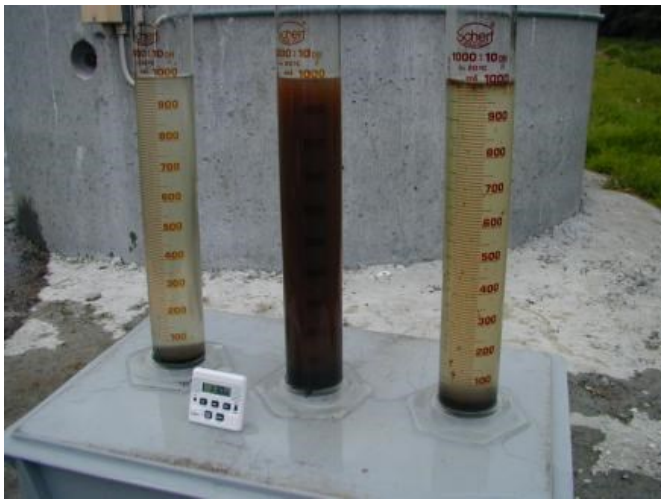
Hørsholm, Denmark

HYDROLYSIS EASES SLUDGE MANAGEMENT AND GENERATES A NEW CARBON SOURCE – ALMOST FOR FREE

The sludge, with all its solid contents, needs to be broken down into a soluble form. Hydrolysis breaks up long chain cellular material into simpler molecules. This will make it more easily degradable for the local microorganisms, which will then use it – amongst others - for denitrification. Besides improving the quality of the sludge, hydrolysation will reduce the need for an additional – externally supplied - carbon source for the denitrifikation process and can thereby considerably reduce expenses.

Moreover, once the sludge is in a more manageable form, it can be dewatered easily. This significantly reduces sludge volume.

The test was carried out on real aquaculture sludge collected from a recirculated fish farm. The sludge was up-concentrated to 2-3% TS content, the sludge types were mixed and then stirred for three days in a lab-scale reactor. It is important to mix the sludge types because the sludge hydrolysis is an enzymatic process with enzymes excreted from biofilter sludge. After three days it was clear that a significant amount of soluble, easily degradable COD was generated in the water phase which multiple tests verified.



REAL SLUDGE TESTING REVEALS A THREE TIMES HIGHER HYDROLYSIS POTENTIAL COMPARED TO WASTEWATER SLUDGE

The present experiment tested – for the first time ever – sludge hydrolysis on sludge from land-based aquaculture farms under anaerobic conditions. Before, such experiments had only been done on sludge from wastewater treatment plants. The results clearly underline the efficiency of this approach: The hydrolysis potential (rate of hydrolysis) was three times larger than sludge hydrolysis carried out on normal wastewater sludge. We believe that the reason is due to the fact that sludge from aquaculture production contains much more fat than sludge from municipal wastewater treatment plants that more easily can be hydrolyzed. This can also explain why aquaculture sludge normally is very difficult to dewater into dry matter as compared with sludge from wastewater treatment plants.

Moreover, the experiments revealed that easily degradable COD produced during hydrolysis can remove a significant amount of nitrate generated in the production water. At the same time, it can transform 30% of the sludge into soluble organic matter.

In large fish farms using, for example, 1,000 tonnes of fish feed per year, the sludge reduction caused by sludge hydrolysis accounts for up to 70 tonnes suspended solids or 700 m3 sludge per year (10% dewatered sludge).

At the same time easily degradable COD is generated, reducing the need for purchasing an expensive external carbon source and the sludge quality is assumed to be improved leading to potential increased dewatering of the sludge.

LAND-BASED AQUACULTURE FARMS WILL SEE MORE MANAGEABLE SLUDGE IN THE FUTURE

For years, methods have been created to facilitate the management of fish farm sludge. Owing to the collaborative effort of the Ministry of Science Innovation and Higher Education and DHI, land-based aquaculture farms will be able to manage their sludge better and get the most out of it.

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