final report

Project code: P.PSH.0336

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Date submitted: May 2008

PUBLISHED BY
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Laboratory SBR trials for tannery wastewater

This is an MLA Donor Company funded project.

Meat & Livestock Australia and the MLA Donor Company acknowledge the matching funds provided by the Australian Government to support the research and development detailed in this publication.

1 Background

Northern Cooperative Meat Company (NCMC) has contracted Dr Mike Johns of Johns Environmental Pty Ltd. (Brisbane, QLD) to design the upgrade of the wastewater treatment system. A key component of the upgrade is to investigate whether tannery wastewater can be biologically treated in Sequencing Batch Reactor activated sludge technology (SBR) to reduce COD and nitrogen concentrations to permit its storage and sustainable irrigation.

Tannery wastewater is complex and difficult to treat biologically. It is known to contain potent inhibitors of nitrifying bacteria, which can render biological nitrogen removal infeasible. Unfortunately, there is little information available with which to screen the nitrification inhibition impact of tannery wastewater from the Casino Hide Tanners (CHT) process. However, at least two inhibitors were identified to be present at troublesome levels.

In view of the potential downsides of attempting to treat the tannery wastewater by SBR, Dr Johns recommended that trials be conducted to validate the proposed SBR process options and identify whether successful treatment of the tannery wastewater could be achieved, either alone, or in combination with abattoir effluent. Crucial to the definition of success is the reduction of nitrogen load in the tannery wastewater – which comprises approximately 50% of the combined load from the abattoir and tannery.

The Advanced Water Management Centre (AWMC) at The University of Queensland is internationally recognized as a leading research centre in biological nutrient removal, particularly using SBR technology. They kindly agreed to conduct the trials under a research program designed by Dr Johns and supported by recommendations from AWMC.

2 Methodology

The trials were initiated on 3rd October and terminated on 27th November 2007.

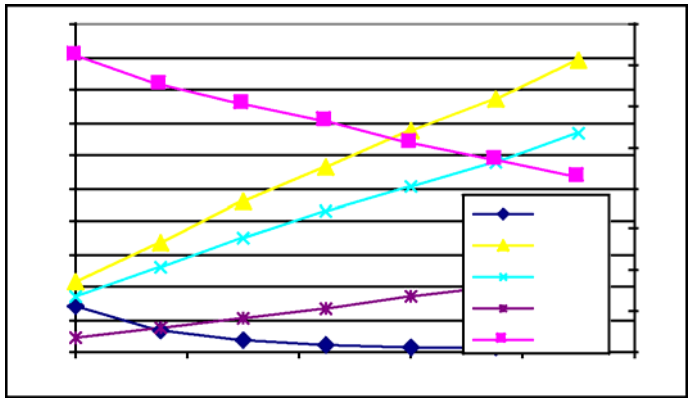
Effluents:
Raw tannery and anaerobic-pond treated effluent suitable for the trials was collected by Mr. Todd Westgate (NCMC) and transported under refrigeration to AWMC in Brisbane. Prior to being sent, the effluents were tested on-site at NCMC using a Hach spectrophotometer to ensure that COD and nitrogen concentrations were representative of the Johns Environmental design effluent quality. On arrival at AWMC, the effluents were stored at 4°C in a cold room until use. Testing by AWMC indicated little change in effluent quality on storage during the trials.

Trial SBRs:
The trials involved operating two 4.5 working volume SBRs in a laboratory at about 19 - 22°C. An SBR is pictured on the cover of this report. The SBRs are fully computer-controlled so that the design SBR cycle can run automatically. Dissolved oxygen set points are operated during aeration. Feed addition, effluent removal and sludge wasting are performed automatically to the SBR design conditions specified by Johns Environmental. Experience on a related MLA project has shown that scale up from these lab units can be performed with accuracy.

The SBRs were seeded with a BNR sludge retrieved from a pilot scale SBR unit running on a MLA-funded project at Teys Bros. abattoir in Beenleigh. This sludge is well adapted to abattoir effluent and contained excellent nitrogen and phosphorus removing micro flora. In general, this sludge was also used in Batch Nitrification Tests (BNT). The SBRs were started on 3rd October 2007. Regular testing was performed for a range of contaminants using the AWMC laboratory.

Batch Nitrification Tests (BNT):
Since bacterial nitrification was the most affected biological process during the trials, BNT were performed to measure nitrification rates. This test involved treating a quantity of effluent with BNR sludge in a large beaker and monitoring the disappearance of ammonia nitrogen, appearance of nitrite/nitrate nitrogen and sludge concentration with time (usually up to 100 mins). This permitted nitrification rates to be calculated.

Results from BNT showing rapid fall in ammonia (RHS)
& resulting rise in NOx-N (LHS) with time (mins).



3 Final Trial Outcomes

1. Tannery wastewater contains biodegradable chemical(s) which powerfully inhibit nitrifying bacteria essential for achieving nitrogen removal in SBRs.

2. Nitrogen removal can not be achieved in a single stage, “tannery-only” SBR, even at long HRT and sludge ages. Sludge acclimation was not observed within the 2 month trial for this effluent. It is believed that the high contaminant concentrations and nitrification inhibition are responsible for this result.

3. The mixed abattoir/tannery SBR was originally proposed by Johns Environmental on the basis that:
   - dilution of tannery by abattoir effluent, and
   - a period of microbial acclimation

   would permit biological nitrogen removal. The trials have proven that this is correct. A single stage SBR run on the 1:4 tannery: abattoir mixture can achieve nitrogen removal appropriate for irrigation to land and/or reuse under the design conditions.

4. A period of microbial acclimation will be required for the full-scale SBR unit before full nitrification kicks in. This acclimation period appears to be of the order of 1 month, during which time nitrogen removal will be negligible, but COD removal will be substantially complete. This will need to be factored into the start-up commissioning phase.

4 Summary

The laboratory trials were proven to be valuable since complete inhibition of nitrogen removal by tannery wastewater occurs.

Conditions for the successful operation of a SBR co-treating tannery and abattoir wastewaters have been confirmed.