AMMONIA REMOVAL USING "MLE" PROCESS – EXPERIENCES AT BALLARAT NORTH

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ABSTRACT

Ballarat North Wastewater Treatment Plant is one of the few Victorian plants remaining that discharge secondary class effluent to inland waters. With recent changes to the existing EPA discharge licence, Ammonia and Total Nitrogen limits have been set such that the traditional biological trickling filters struggle to achieve. To this end Central Highlands Water has been investigating a number of options to achieve compliance. It was decided to design and build a small pilot plant using an activated sludge process in the Modified Ludzack-Ettinger configuration, which has subsequently produced encouraging results. Having a high proportion of trade waste in the influent, CHW then decided to duplicate the pilot plant and test the process on a single industrial source, which has high ammonia concentrations. The pilot systems have successfully met ammonia removal efficiencies in excess of 95% and concentrations of less than 1.0 mg/L.

KEY WORDS

Ammonia, Modified Ludzak-Ettinger (MLE), Ballarat North Wastewater Treatment Plant (BNTP), 'a' Recycle, Biological Trickling Filters (BTF), Mixed Liquor Suspended Solids (MLSS).

1.0 INTRODUCTION

Ballarat North Wastewater Treatment Plant (BNTP) was designed and built in the 1960s and consists of a conventional secondary treatment process using primary treatment, biological trickling filters and final clarification. Over the years minor upgrades have been made to improve plant performance such as chemically dosing to reduce phosphorus concentrations. BNTP receives trade waste from the largest customers of the Authority, with the organic load from these contributors accounting for about 70% of the total load on the plant.

Central Highlands Water has plans to augment the Ballarat North plant over the next few years. However the existing plant currently suffers from extreme overload conditions brought about by an expanding catchment load and also a high industrial discharge from a number of sources. Therefore a need was established to investigate what, if any, interim options were available to CHW to achieve the Licence requirements for a short-term period.

2.0 METHODOLOGY

The scope of the investigations was to determine works that were necessary for short term compliance with the existing EPA discharge requirements, keeping in mind the longer term objectives of the plant. Thus an interim solution was sought to meet the enforced targets until the major augmentation under 'SmartCycle' is commissioned towards the end of 2005.

In order to reduce the ammonia and also the total nitrogen leaving the plant, additional nitrification/ denitrification capacity at the plant was required. To this end a decision was made to pursue the potential for a high rate activated sludge solids contact process to be added to the existing BTF to treat part or the entire flow stream.

The principle is based on the BTF continuing to produce the current filtrate quality and part or all of this filtrate stream then being directed to the solids contact process to effect additional nitrification. If an anoxic zone or an intermittent operation of the aeration cycle is incorporated, this would assist in delivering denitrification which would reduce the nitrates and in turn reduce the total nitrogen leaving the process.

3.0 DISCUSSION

Because of the significant and strong trade waste component, it was decided to proceed as follows:

1. Prove the ability of the waste to flocculate by firstly establishing a basic activated sludge process train;

2. If 1 was successful, trial the MLE process on Settled Sewage with its additional carbon source;

3. Subsequently trial the MLE process on various blends of Filtrate + Settled Sewage.

The primary objective was to establish how well the MLE process in series with the biological trickling filtration plant, could nitrify and denitrify the Ballarat North raw sewage. A secondary objective was to establish just how low a sludge age (SRT) the process could successfully be operated at bearing in mind the very low sewage temperature.

The initial attempt at the pilot plant utilized two tanks, one for aeration and one for clarification. Also a smaller drum was used as wet well for the Return Activated Sludge (RAS) to be pumped back to the aeration tank via a small submersible pump. Air was supplied by a small blower through four 6" stone diffusers.

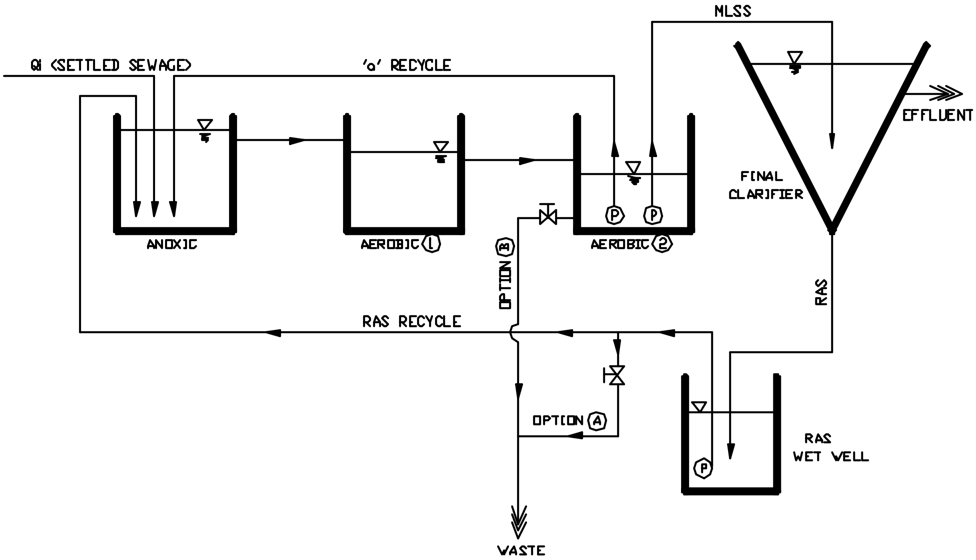
Initially the pilot study was to be conducted using filtrate from the BTF plant. However the biomass was slow to develop, and this was attributed to the C:N:P ratio of the filtrate being around 3.3:4.6:1. Seeding with RAS from the Ballarat South Treatment Plant (BSTP) was commenced and introduced into the pilot plant RAS wet well. This seeding process was repeated over several days with little success. Given the slow progress it was decided to switch from filtrate to settled sewage with a more optimal C:N:P ratio of 10:4.6:1. Once this configuration started building biomass with intense seeding from BSTP, some good results were achieved with an 80% reduction in Ammonia in a couple of grab samples which gave some confidence in the process.

During this overall initial period, there was little success due to major mechanical problems. This manifested itself causing difficulties in keeping solids in the systems and other issues. During this phase, numerous practical problems were experienced, such as difficulty in adjusting the MLSS flow to the clarifier without disturbing the sludge blanket and floc shearing through pumping. Perhaps the most significant operational problem was the inability to concentrate solids and then remove the settled solids from the two flat-bottomed clarifiers. To overcome this problem a single coned shape plastic tank was installed to act as a clarifier.

Once these initial practical problems were resolved, and although the plant consisted of the most basic activated sludge configuration, the pilot plant was clearly demonstrating significant nitrification and denitrification. Thus the suitability of the activated sludge process albeit in a basic conventional mode and using settled sewage, was proven.

The way forward from this point was to achieve a stable process for nitrification and denitrification. Consequently the incorporation of a denitrification step within the process was required. In this case a separate anoxic zone was needed and the Modified Ludzack-Ettinger (MLE) process was chosen as the way forward. Figure 1 and 2 shows the flow schematic of the MLE process and a picture of the MLE pilot plant.

<u>Figure 1</u>: ***Modified Ludzack-Ettinger Pilot Plant.***



<u>Figure 2</u>: ***Pilot Plant located at Ballarat North Wastewater Treatment Plant***

For a period the Pilot Plant was operated in a (MLE) process configuration at a sludge age (SRT) of 10 days. The SRT was known precisely by virtue of wasting a fixed flow-monitored quantity of MLSS each day. The changing of mode to the MLE process involved adding an anoxic zone and a recycle line from the aeration zone back to the anoxic zone'a' recycle or 'NML' (nitrified mixed liquor) recycle.

Having run in the MLE mode with settled sewage as the feed for some days, the target MLSS was reached and wasting from the system began. Initially wasting from the RAS line was chosen. This proved to give operational problems with scum and rising sludge and it was difficult to maintain an accurate assessment of the SRT with consequent loss of control. To overcome this, wasting was changed to the aeration tank to give better control over MLSS. The change in method produced excellent results with ammonia reductions of >90%. These results were continuously achieved over the following months with ammonia levels reducing by 99% consistently.

In order to achieve the initial aim of treating BTF filtrate through an additional process, the feed for the pilot was changed to give a 50:50 blend of filtrate and settled sewage. Settled sewage was added to the filtrate as a carbon source to aid in the process, especially for denitrification. The blend was then subsequently modified again to a 25:75 settled sewage/filtrate blend to push the system a little harder. Some modifications were made to the recycle rates and this process, once stabilised, also achieved an excellent reduction in ammonia. With the reduced proportion of settled sewage in the feed to the pilot plant, predictably denitrification suffered. Rather than continue and incorporate a larger denitrification zone, it was at this point that the trials were concluded.

Quite clearly, the trials proved that:

1. Whilst the Ballarat North raw sewage is very strong with a 70% industrial component, the MLE activated sludge process is extremely effective in reducing TKN in the settled sewage from around 80.0mg/L to <<1.0mg/L and TN < 10.0 mg/L.

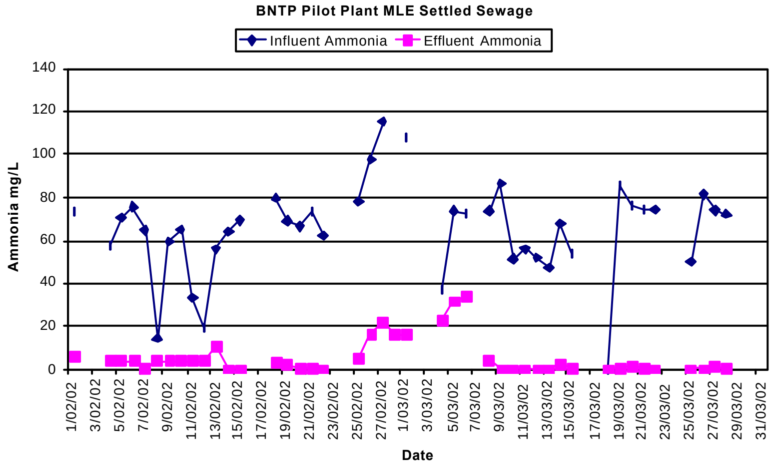
2. The MLE activated sludge process is very robust and repeatable.

3. Even treating low sewage temperatures, the activated sludge process performs extremely well at very low SRTs.

4.0 RESULTS

Significant analysis of the waste was completed together with analysis of flow regimes, recycle rates, WAS rates, RAS rates and sludge age. The design and modelling for this project was undertaken by Zemek Environmental Pty Ltd. The model predictions were very close to the actual results analysed in the field. The pilot produced excellent results with significant reductions in BOD, phosphorus, ammonia and nitrate. Graph 1 depicts the levels of ammonia in the feed and the concentration leaving the process for pilot plant using the settled sewage as the only feed.

Graph 1: ***BNTP Pilot Plant – MLE Settled Sewage***



During this period the pilot plant performed extremely well. Typically the pilot plant designed as a MLE process without any detailed consideration to its design for bio-P removal, has produced the following results:

- Ammonia - < 4.0 mg/L (the initial testing apparatus was limited to a minimum reading of 4.0mg/L however based on CHW laboratory results this value was typically < 1.0 mg/L)

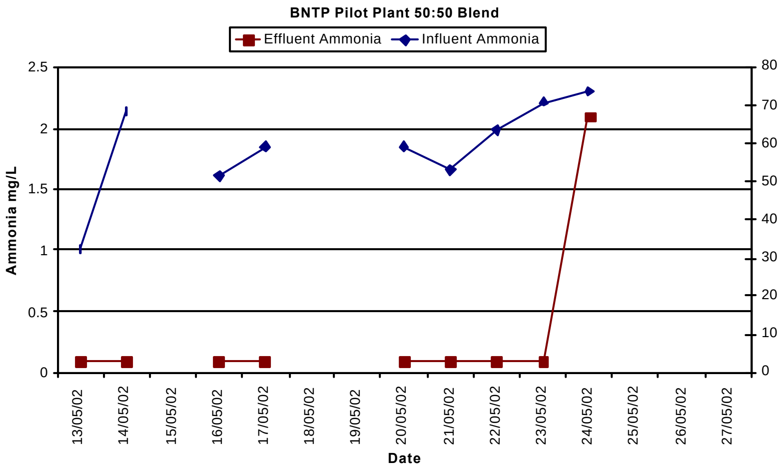
- Total Nitrogen ~ < 10.0 mg/L

- Ortho phosphorus ~ < 0.6 mg/L

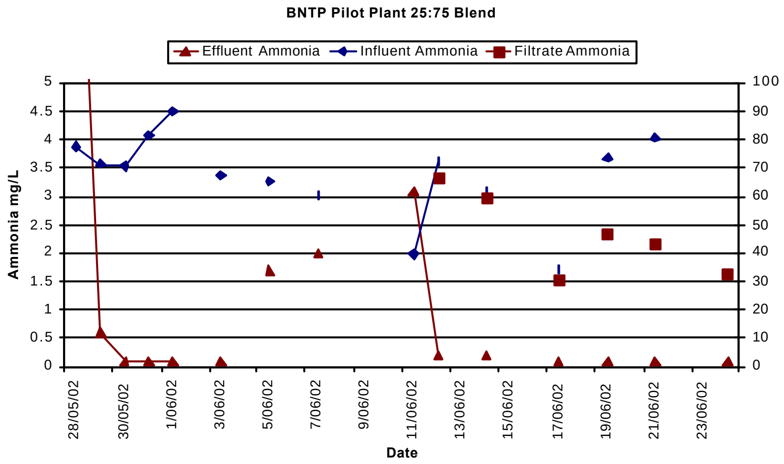
- SVI ~ 123

Graphs 2 and 3 depict outcomes gained by using a combined feed of settled sewage and biological trickling filter filtrate. As shown the pilot performed very well with significant reductions, up 99%, in ammonia concentrations.

Graph 2: ***BNTP Pilot Plant – MLE 50% Settled Sewage : 50% BTF Filtrate***



Graph 3: ***BNTP Pilot Plant – MLE 25% Settled Sewage : 75% BTF Filtrate***



The above pilot plant results are based on grab samples taken morning and afternoon. Frequent "reality" checks were made of the on site test results by taking duplicate samples and having spot-check analyses taken in the CHW laboratory.

5.0 CONCLUSION

Experience and knowledge gained during the pilot process has proven that the MLE process is a robust activated sludge configuration. The process design was aggressive as defined by the low sludge age (SRT) of around 10 days and < 8 days in summer, whilst still producing excellent results with low levels of ammonia leaving the process. The process also produced excellent performance with respect to the reduction in parameters such as BOD and phosphorus concentrations. Modelling of the process has produced functional design criteria for which an interim plant could be based.

6.0 ACKNOWLEDGMENTS

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