CONTROLLING ODOURS FROM AN INUSTRIAL WASTEWATER TREATMENT PLANT

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AUSTRALIAN NEWSPRINT MILLS ODOUR MANAGEMENT PROGRAM

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ABSTRACT

Australian newsprint mills have been operating since 1981. They have experienced odour problems since the very beginning. Changes in the last 5 years to mill operations have lead to the EPA serving a notice of complaint from local residents in the surrounding area. In consultation with Bill Gunning from NLK – Canada, ANM has put the following odour management plan into progress.

1.0 BACKGROUND

Australian newsprint mills is situated in a rural setting 13 km north of Albury. It commenced operations in 1981. Along with its sister mills in Tasmania and New Zealand supplies 95% of Australia's newsprint needs. When the treatment plant was built at Albury and commissioned in 1981, it represented state of the art in treatment plant design for the times and during the 1980's was often used as a reference as one of the best operating facilities in the world for a TMP/Newsprint mill configuration. Albury was one of the first TMP\Newsprint mills to apply activated sludge technology to this type of effluent. Steps were taken over the years to further improve system design and operation, with the initial cooling pond being reduced in size from hydraulic retention of 42 hours to 27 hours based on the average 1987 flows. This was done to limit the retention time thereby reducing the potential for objectionable odour. A second primary clarifier was installed in 1988 to further reduce primary solids (fibre) carryover to the cooling ponds and secondary treatment.

The higher solids loading to the cooling ponds would aggravate odour release from this source, as well as have detrimental effects on biological treatment. The original system was designed for an effluent treatment flow of about 12 ML/d. Over the years and particularly in the 1990's, there has been a strong emphasis on water reuse and conservation such that the average effluent flow in 1997 was 8.6 ML/d, little more than two thirds of the original design. Introduction of a recycle fibre plant in 1993 and further expansion in 1995 has changed the characteristics of the mill effluent with higher levels of readily biodegradable substrates such as starch, residual surfactants from the de-inking process and elevated levels of sulphuric acid for pH control. These chemicals, coupled with the reduced flow in effluent, increase the potential for the development anaerobic conditions at various parts of the plant. Also to add to this, the mill directed all of its flow to a tree farm irrigation and discharge to the Murray River was curtailed with exception of indirect mill cooling water.

2.0 POTENTIAL SOURCES OF ODOUR AT THE ALBURY MILL

After reviewing the wastewater facility involving Bill Gunning form NLK Canada, the following potential odour sources which may contribute to ambient odour were identified:

- Cooling Pond
- Primary Clarifiers
- #1 Sludge Tank
- #2 Sludge Tank
- Spill Ponds
- #1 Splitter Box
- Tertiary Clarifier

- Sludge Dewatering Facility
- Sludge Bunker

After tests and consultation with NLK it was determined that of the nine potential sources of odour, the following three were of most significance:

- Cooling Ponds
- Primary Clarifiers
- Sludge Tanks

2.1 Cooling Ponds

These basins are shallow, with a water depth of about 1.5 m, and a combined volume of 9,600 m^3. Under normal operation, there is no mixing energy applied, or aeration. As a result, while the effluent is in these basins, it is essentially stagnant. Both cooling ponds operate in series, with a combined hydraulic retention of about 27 hours, under current operation. During summer months, spray coolers may be used to assist in effluent cooling. This cooling basin design was an industry standard in the 1980's and earlier, and is still in common use today.

The basins, in addition to providing radiant cooling, also act as settling ponds for any suspended solids that carried through the primary clarifiers and provide a degree of equalisation for variability in mill operation and raw effluent quality. The use of these basins was initiated in the Kraft pulping sector, either in lieu of primary clarifies or subsequent to them. For this reason, the application of mixing energy was discouraged. There were recognised benefits in maintaining as low a fibre load into the biological reactors as possible.

The rate of sludge build-up in the basins was defined by the effectiveness of the primary clarifiers. Dredging was usually infrequent. However the type of substrates in mechanical effluents are different than that from Kraft mills. There are more readily utilizable compounds in TMP/RCF effluents that can contribute to a higher level of biological activity in such ponds than with Kraft mill wastewater. In addition, residual levels of bleaching agents in Kraft mill wastewater can have a mild disaffection effect at this location in the treatment process. In the absence of aeration, the basin biology that develops will be anaerobic.

This potential will be further aggravated by the presence of sulphate ($SO_4^=$) and sulphur reducing bacteria in mill effluent, and the operation of the primary clarifiers. Anaerobic decay is often reflected in evidence of floating solids on the ponds. This is attributable to fine gas bubbles generated in the basin attaching to the solids, leading to resuspension. The larger the surface area of these basins, the greater the potential for ambient odour.

These two basins, as presently designed and operated, represent the greatest potential for generating objectionable odour.

2.2 Primary Clarifiers

These clarifiers are intended to reduce the level of primary solids, (principally fibre), to biological treatment and are also used to thicken sludge prior to further dewatering. When the mill was built, Albury had a single clarifier. Elevated levels of solids to secondary treatment, often characteristic of mechanical effluents due to a higher level of fines, led to a second clarifier being added in 1988. The two units are operated in parallel and provide a low residual solids carryover to the cooling pond.

With water reduction accomplishments, reduced effluent flow has now increased the hydraulic retention in each clarifier to greater than 18 hours. The industry norm ranges from about 2 - 10 hours. This long retention, coupled with sludge thickening, all in the absence of oxygen, increased the potential for anaerobic conditions to develop.

Other contributing factors include the presence of $SO_4^=$ in mill effluent and the addition of sludge dewatering pressate to #1 primary clarifier. The pressate is rich in biological solids and provides a continuing seed. Sulphur reducing bacteria are ubiquitous. Evidence of anaerobic decay in the clarifiers is shown by the drop in pH across the clarifiers which in 1997, averaged about 0.75 units. The pH drop is due to the generation of organic acids by facultative organisms operating under oxygen deficient conditions. The growth of these organisms in the clarifiers then seed the cooling ponds which follow. This condition is often referred to as septicity and the biological population found in the effluent can more resemble that typical for sewage treatment facilities.

2.3 #1 Sludge Storage Tank

This tank is located in the water treatment building. It has a volume of about 13 m^3, and a hydraulic retention under normal plant operation of about 30 minutes. The tank is used to blend waste sludge from various sources: primary, secondary, and tertiary clarifiers, prior to dewatering. The tank is equipped with a vent to atmosphere at an elevation of about 13 m, atop the water treatment building. In many mills, this blend tank can be a very significant source of foul odours. The contents are rich in biological solids and oxygen deficient. This provides prime conditions for development of anaerobic biology. Where possible, retention times are kept low. The risk of this tank going septic is aggravated by such conditions existing in the primary and tertiary clarifiers.

3.0 OPTIONS FOR ODOUR REDUCTION

Options to minimise odour in the three identified areas follow along with advantages and disadvantages. The options are set to meet the mills GOAL to “Minimise the release of objectionable odours at the Albury Mill”.

Odour generation from the wastewater treatment plant at a mechanical mill is attributable to the volatile byproducts of anaerobic digestion. The most effective way to address this issue is to minimise conditions throughout the plant that could promote the development of anaerobic biology. This can be accomplished by process modifications and/or changes to operating practices. In some cases, chemical additives may be required to augment other changes.

3.1 Cooling Ponds

Option 1 - ***Direct Primary Clarified Effluent To Small Cooling Pond. Decommission Large Pond.***

Advantages

- Small cooling pond will have theoretical hydraulic retention of about 4-6 hours at current effluent flows.
- Existing piping can accommodate one and possibly two spray coolers. A single unit will cool mill effluent by about 5°C under summer conditions. Existing effluent temperatures are typically less than 40°C.
- Allow the larger cooling pond to be decommissioned, drained, and cleaned.
- Existing aspirating aerators could be used to provide mixing and aeration. This should maintain positive dissolved oxygen levels and sufficient mixing energy to minimize settling of solids in the basin.

Disadvantages

- Inlet pond has inadequate surge capacity to accommodate variability in mill effluent flow.
- There is no existing connection to the spill basin, which is currently used to compliment flow surge capability in the cooling pond.
- The basin influent is adjacent to the discharge, increasing the risk of short circuiting.

System Modifications

- None.

<u>**Option 2:**</u> ***Increase The Volume Of The Small Cooling Pond***

Advantages

- Would provide additional flow surge capability.
- Maintain existing tie-in (high level overflow) to spill basin.
- Retain the existing influent line to the larger pond. This would reduce the potential for short circuiting of effluent to pond discharge.
- Existing aspirating aerators can be used for proper mixing and aeration.
- The pond volume would double to about 4000 m^3, representing about 11 hours hydraulic retention. This would provide additional equalisation.
- The remainder of the large cooling pond could be decommissioned, drained, and cleaned. This would reduce cooling pond surface area in contact with the atmosphere.

Disadvantages

- Maintains a shallow earthen basin, which is difficult to mix properly.

System Modifications

- Install new berm across large cooling pond.
- Open channel between two sections of cooling pond.
- Install aspirating aerators to provide mixing and aeration.

Implementation

The estimate includes provision for a new compacted gravel berm across the large cooling pond. To facilitate installation of the berm, primary clarified effluent would be directed to the small pond and 1 or 2 aspirating aerators installed to provide a suitable flow pattern consistent with minimising short circuiting. The large pond would be drained. Once the berm is completed, a channel would be opened between the two cells. To minimise silt and mud contamination throughout the pond and in the bioreactors and secondary/tertiary clarifiers, sheet piling would be used to isolate the downstream end of the channel, prior to excavation. A section of concrete sewer pipe would be used to connect the two cells. Aspirating aerators would be used to provide aeration and mixing in both cells.

<u>**Option 3:**</u> ***Aerate And Mix Existing Cooling Ponds***

Advantages

- Aspirating aerators are on site to provide mixing and aeration.
- Maintains current flow surge capacity in cooling ponds.

Disadvantages

- Effective mixing of shallow earthen basins is difficult to achieve.
- Higher power consumption required for larger basins. Current equalisation capability of about 27 hours retention is excessive to mill requirements.
- May increase the level of silt carryover to secondary treatment.

- Effluent from the existing pond is seeping through the wall of #3 aeration tank and may compromise the structural integrity of this tank.

System Modifications

- Installation of the aspirating aerators and suitable erosion protection for the bottom of the basins. Cost estimate assumes electrical power is available at the cooling ponds.

Implementation

The six aspirating aerators would be installed, with at least one unit in the small pond. To minimise erosion of the earthen basins, suitable bottom protection would be provided. Once the units are positioned, the effectiveness of the mixing pattern can be evaluated both visually and through inlet/outlet NFR readings. Relocate some units if necessary.

Option 4: ***Use #3 Aeration Tank For Equalisation/Cooling***

Advantages

- Existing cooling ponds could be decommissioned, drained, and cleaned, thereby removing the major source of treatment plant odour.
- At 4 m water depth, the tank has a hydraulic retention of about 29 hours. This would provide equalisation capability well in excess of mill requirements.
- Spray coolers could be used in the tank as required to maintain proper effluent temperatures for biological treatment.
- Tank operation can be configured to provide variable volume and thus flow equalisation. With water level operating in a range of 2-4 m, this would represent some 14 hours of effluent flow.
- The tank is concrete lined and thus easier to keep mixed and aerated. No concerns with erosion.
- Two options for aeration/mixing: aspirating aerators (on site) or drill holes in existing 16 fine bubble aeration headers along bottom of basin and use existing Turbo blower.
- Existing tank lift pumps are adequate to supply the bioreactors. Each of two pumps has a rated capacity of 200 lps, while average effluent flow in 1997 was 100 lps.
- Reduced use of spill basin and thus potential for odour from this source.

Disadvantages

- No connection from this tank to spill basin. This is not deemed critical, as primary clarified effluent can be diverted to the spill pond prior to cooling.

System Modifications

- New tie-ins are required for primary clarified effluent to tank inlet and pump discharge to bioreactors.
- One FIC loop will be necessary to provide flow equalization capability.
- Remove existing membrane laterals on aeration headers and replace with plugs. Drill 4 mm holes in the headers along bottom of basin. Use existing Turbo blowers. Alternate is to use four aspirating aerators to provide mixing/aeration.

Implementation

Two of four tie-ins could be accomplished on the run, without impacting treatment plant operation. The other two tie-ins would require a shutdown of flow from the primary clarifiers to the cooling ponds. Provision exists to divert primary clarified effluent to the spill basin, which has a capacity of about 40-44 hours. This would provide adequate time to complete the two tie-ins.

3.2 Primary Clarifiers

In order to minimise odour from the primary clarifiers, the following changes to operating practices would be recommended:

- Direct sludge dewatering pressate to the bioreactors. At the present time, this flow is split between #1 primary clarifier and the #1 splitter box. Pressate is rich in biological solids and can act as a continual seed in the primary clarifier.
- Review the existing sludge pumping schedule for both primary clarifiers. Within the limits of sludge dewatering capability, minimise sludge thickening in the clarifier to reduce residence time in an oxygen deficient environment.
- Evaluate one primary clarifier rather than two. Existing clarifier residence times exceed 18 hours, with a rise rate (each) of about 4.5 m^3/m^2D. A single clarifier would still be conservatively sized at about 9 m^3/m^2D. Some level of increase in NFR for primary clarified effluent would be anticipated.

There would be no capital costs associated with these proposed modifications.

3.3 #1 Sludge Tank

This tank blends primary, secondary, and tertiary sludge prior to dewatering. Conditions are conducive for the development of anaerobic biology and resultant odour. During the site visit, odour from this area would be deemed minor. Operating practices should be reviewed to try and maintain low tank inventories wherever possible. Should odour become a concern, biocides or $FeCl_3$ could be added to the tank. These and other potential mitigative measures could be evaluated in a study. Ferric chloride will precipitate sulphur and, while not eliminating anaerobic activity, can address H_2S and significantly reduce odour from this area.

Should this approach be used, the level of iron in treated mill effluent and sludge would have to be evaluated as to any potential detrimental impact on tree farm irrigation or sludge application to land.

System Modifications

- To provide adequate mixing, the primary, secondary, and tertiary sludges would have to be combined in a single line upstream of the tank, $FeCl_3$ added, and then a static mixer used to ensure thorough mixing prior to entering the tank.
- A $FeCl_3$ storage and delivery system would be required.
- Dosage control would be established by the operator based on the sulphide level in the sludge.

Implementation

- Combine sludge lines, with appropriate block valves.
- Install static mixer.
- Install $FeCl_3$ storage and delivery system.

4.0 THE IMPLEMENTATION PLAN

From these options listed above the following changes will be implemented:

4.1 Cooling Pond

- Convert #3 Aeration tank to cooling pond utilizing existing blowers and converting diffusers from fine bubble to a more course air distribution. Placing 10 floating aspairators on the top of the pond to keep effluent in suspension and slightly aerated.

4.2 Primaries

- Divert all flows to 1# primary and take #2 out of service .Press Filtarte has been redirected to the Aeration tanks

4.3 Sludge Tanks

- Sludge tank #2 to be taken out of service, once #2 Primary has been retired. Direct all sludge underflows to the smaller and covered #1 Tank. Reduce the amount of time the sludge stays in the tank by increasing press throughput.

5.0 THE RESULTS SO FAR

At the time of writing this Paper, points **4.2** and **4.3** have been undertaken and noticeable reductions have been recorded in an Odour survey conducted by ANM personal with local residents. Work on the conversion of the #3 Aeration tank has commenced and should be operational by the end of August. Testing has commenced around the plant for Mercaptans and Hydrogen Sulphide levels as well as pH at all possible sites for any major pH drops. Trials have also commenced with the use of Peroxide and Ferrous Chloride being dosed to the Primary Clarifier, and have reduced the sulphide levels to zero.

6.0 CONCLUSIONS

The program outlined above will address the predominant sources of odour (cooling ponds and primary clarifiers) and deliver a significant reduction in objectionable odour excursions and complaints in the surrounding area. The measures proposed would address the principal components of system design that are susceptible to the development of anaerobic conditions.

Operating practices would be reviewed and revised as deemed necessary to promote a continuing reduction in treatment plant odour. The monitoring program proposed should both indicate the effectiveness of the changes to the facility as well as identify any deficiencies that would require further remedial measures.

7.0 REFERENCES

Odour Management, Australian Newsprint Mills. Gunning W.H. NLK ,Vancouver Canada. Project #EA2464A