DETECTING ODOUR POTENTIAL AT AN INDUSTRIAL TREATMENT PLANT

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ABSTRACT

In 1998 Norske Skog, then known as Australian Newsprint Mills, started an extensive program to reduce odour that was being generated from its effluent treatment plant. Section 4 (iii) of the Pollution reduction Program issued to (then) Australian Newsprint Mills Ltd on June 15th 1998 required the company to:

> *"Prepare and submit a report to the EPA on preferred options for introduction of in-line continuous monitoring that identify the onset of conditions for anaerobic decay within individual plant units. The report must identify operational contingency plans when the onset of conditions for anaerobic decay are detected by the monitors."*

The purpose of this report is to summarise the work done to fulfil the EPA requirement.

At the AWWOA conference in 1998, the first findings were reported on the odour reduction program about to undertaken. This paper highlights the success we achieved in implementing this program as well as further steps that were taken to identify odour potential.

1.0 BACKGROUND

Norske-Skog (previously Australian Newsprint Mills) has been operating since 1981. It is situated on the Hume Highway 13 km north of Albury. The mill produces newsprint through a mix of wood fibre from Pinus Radiata, and recycled fibre from recycled newspaper and magazines. The treatment plant processes on average 8 megalitres per day of effluent. Treating pulp and paper effluent can be broken into three easy components - settle, cool and treat. The traditional way to treat this type of effluent is to store it as long as is needed to lower the solids and temperature then either use an anaerobic treatment process (ie larger ponds), or as in our case an aerated biological process. Both of these can lead to one thing - strong odour. In 1998 the Mill along with its neighbours, and the EPA, mapped out a plan to reduce odour.

The purpose of this report is to summarise the work done to fulfil the EPA requirement to reduce the odours so that they could no longer be detected by neighboring houses, and if detected they were detected, allow immediate actions to be undertaken to reduce the odours. After putting into place major changes to the treatment plant, the challenge then was to find a reliable early detection program. Odour could then be dealt with before it became detectable by the neighbours.

2.0 PLANT CHANGES

The main plant changes made to remove odour being generated were two fold. The first was to reduce the retention time within the plant and the other was to raise the pH. Retention time reduction was carried out in two parts of the plant - at the Primary Clarifier and at the Equalisation Storage, or Cooling Ponds. To reduce the retention time in the Primary Clarifier, flows were diverted to one Clarifier, instead of splitting all flow to two clarifiers. This reduced retention time from 25 hrs average to 14 hours.

The capacity of the underflow pumps was increased so the thickened underflow could be removed at a larger volume to the presses. This reduced the chance for sulphur producing bacteria to populate in any anaerobic pockets.

To reduce the retention time in the buffer storage section of the plant, an unused aeration tank was converted to an Aeration Feed Tank (AFT). Large earthen cooling ponds with a retention time of around 50 hours had previously been in place. After converting to the AFT, the average retention time of 24 hours was achieved.

The purpose of the AFT, as an equalisation basin, is to:

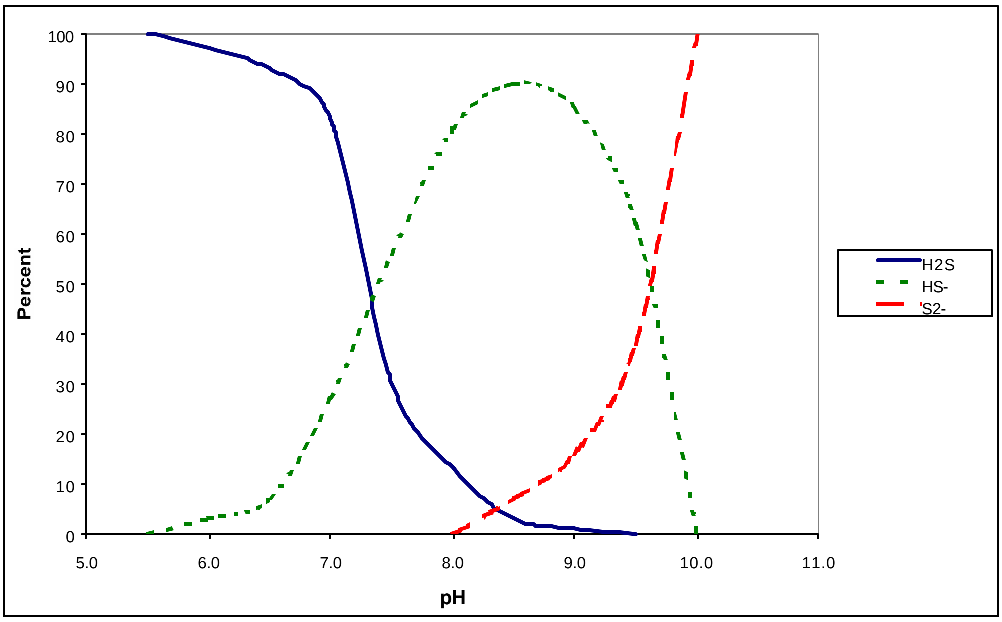
- Cool the effluent to less than 40°C to ensure efficient biological treatment.
- Buffer flow surges through the plant to protect the biological process.
- Buffer spike loads of toxic or high organic material to protect the biological process.
- Ensure adequate mixing to prevent deposition of solids and assist with pH control.

To ensure adequate mixing in the AFT we added 10 aspirators located in position to circulate the flow.

2.1 pH Control

The next change was to maintain the pH in the AFT by adding lime controlling the pH to between 7.5 and 8.2. As shown in Fig 1, when raising the pH above 7.5, the chances of H_2S being produced are reduced by transforming the H_2S into HS^- and S^{2-}. These are both aqueous species and do not smell, whereas when H_2S is formed as a gas, it has a very offensive characteristic odour (rotten egg gas). This forms the basis for the focus on pH control in controlling odour, as maintaining a pH above 7.5 significantly reduces the proportion of the sulfide that can exist as H_2S. There is approximately eight times as much odour (H_2S) generated at pH 7.0 compared to pH 8.0 for a given dissolved sulfide level.

Figure 1: ***pH Effects on Percentages of Gas Production***



2.2 Control Measures

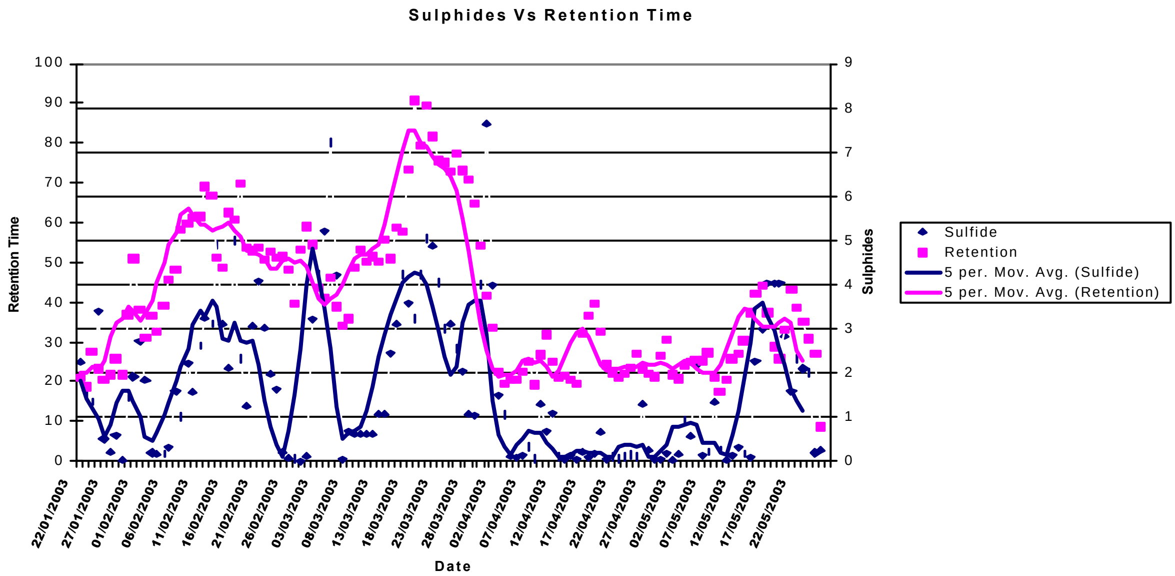
The study we carried out in 1999 identified areas that could be more closely monitored to control odour now the main engineering work had been completed. Any of the following could put us into an odour generating condition:

- ***Failure of the floating aspirators in the AFT.*** Evidence has shown that the sulfide level in the AFT significantly increases if the aspirators are off for any extended period of time (>4 hours). It is essential that if this occurs, the pH of the effluent is monitored closely to ensure it is within the appropriate range (7.7 to 8.2) to minimise the generation of H_2S.

- ***A drop in AFT pH below 7.5.*** The majority of the days when odour was "noticeable" on site occurred when the pH in the AFT was lower than 7.5. It is important to note, however, that the lower the sulfide concentration, the less important pH becomes in controlling odour generation.

- ***A rise in the AFT operating level above 1.5 metres*** shows the effect of AFT operating level or retention on the dissolved sulfide concentration. There may be occasions when it is necessary to raise the AFT operating level higher than 1.5 metres, such as during major maintenance periods within the process plants. During these occasions, odour will be managed by close control of the pH in the AFT. Note that the normal operating level of the AFT will vary between 0.9 and 1.3 metres in order to buffer any large flow surges from the process. This can be seen clearly in Figure 2. When AFT retention rose, so to did the sulphide test results.

Figure 2: ***pH Effects on Percentages of Gas Production***

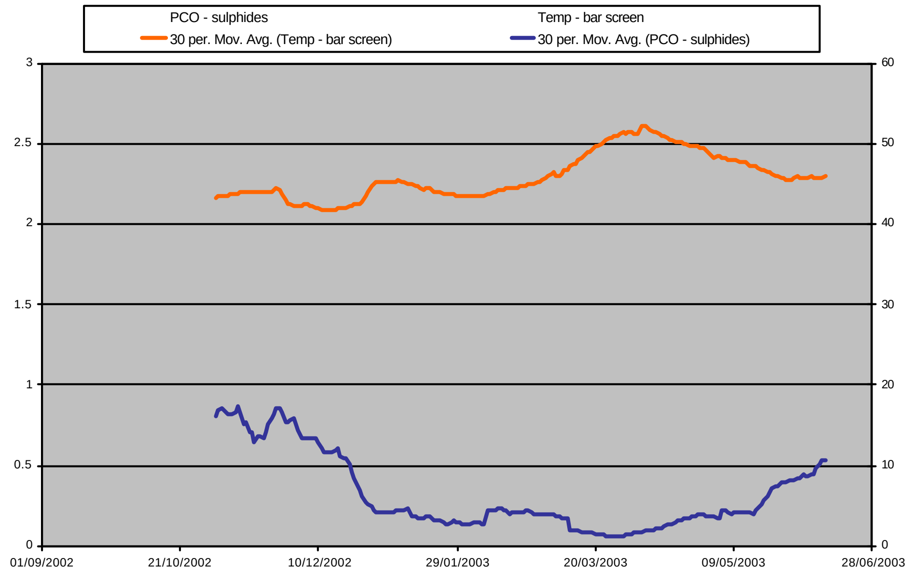


- Sludge build-up in the Primary Clarifier. A thick primary clarifier underflow increases the sludge residence time and the chance of sulfide generation. Note that although the primary clarifier is not a significant odour source, this situation requires monitoring to prevent extremely high sulfide levels being carried on to the AFT.

After successfully running under these operational parameters for two years, we experienced one major problem of high temperature due to the reduced retention time of the Primary and the Equalisation Basin (AFT).

This problem became larger when Pulp production required a raise in the operating temperature to reduce pitch deposits caused in the paper making process. Influent temperatures were to be raised from 50°C to an average 75°C. This gave us only two choices - either increase retention time and use chemical addition to reduce odour, or stick to our odour management plan and install cooling towers pre the aeration tanks. The cooling towers were an obvious and logical choice. This also then gave us the opportunity of using temperature to control odour by using the higher temperatures to kill, or slow down any odour producing bacteria. This has worked extremely well in the primary clarifier in reducing sulphides, as indicated in Figure 3.

Figure 3: ***Effects of Temperature on Sulfide Production***



3.0 ODOUR POTENTIAL

During the process of identifying the odour producing sections of the plant several test methods were used to identify odour. These included:

- Dissolved Sulfide testing using the HACH method #8131;
- Redox Potential using an inline probe;
- Subjective odour surveys using Mill Staff and Community members;
- Volatile Fatty Acids;
- Dissolved Sulfates.

From trials on these methods it was agreed by all parties that Dissolved sulfides was a reliable test that could be carried out by operators on a daily basis. Test points identified to give us early indication were:

- Primary Overflow;
- Primary Underflow;
- AFT outlet.

A calculation that could be trended to give an early detection was then identified. Fortunately, Thistlethwayte, had developed an empirical correlation that predicts the equilibrium gas concentration of H_2S above a liquid of a given sulfide concentration, pH and temperature. This equation was developed after extensive work with sewage systems and is shown as follows:

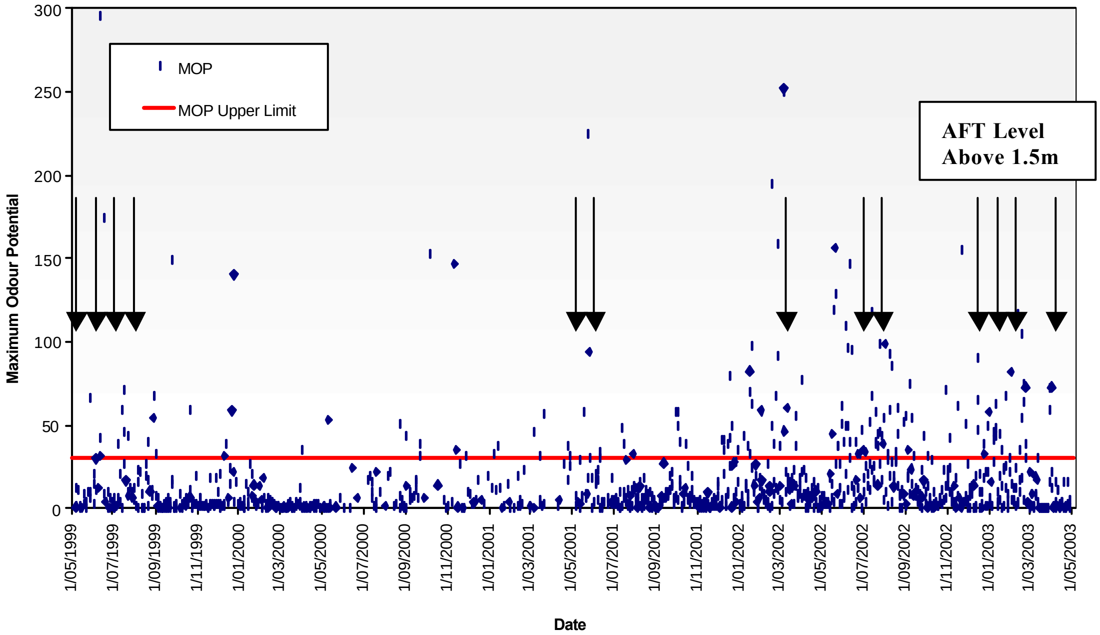
$$H_2S = TS \cdot 0.9 \cdot \frac{(T - 3.134)}{0.2333} \cdot \frac{1}{1 + K'\left[10^{(pH + 0.0081(T-68))}\right]}$$

Equation 1:
Where:

H_2S = equilibrium gas concentration of H2S (ppm)
TS = Total dissolved sulfide concentration of liquid (mg/L)
T = liquid temperature, deg F
K' = H_2S dissociation constant (1.7E-7 @ 20°C, 2E-7 @25 °C)
pH = pH of liquid

As depicted in Figure 4, (Thistlewayte) this calculation works well giving an early indication of potential for odours detectable by neighbours. When the odour potential rises above 30, odour complaints have been received, as indicated by the arrows.

Figure 4: ***Aeration Feed Tank Maximum Odour Potential***



The calculation method was too cumbersome, so a much simpler method was developed using the new operational parameters. The new calculation takes into account retention time and is (Retention Time x Temp x Sulphide) pH. The theory is that increasing retention time, temperature and sulphide can cause detectable odour, whereas a higher pH will reduce the risk. Once a calculation was formulated and operators were confident it was "useable", it was checked against the Thistlewayte calculation to make sure it was not drifting to far away from the previous work.

The next step was a trouble shooting guide that when the new operational odour potential result reached above 200, could be used to make sure all is in place to control odour being detected . The following is the standard trouble shooting checklist that is followed when a high result or odour is detected by either external or internal complaints.

Table 1: ***Troubleshooting Guide for the WWTP***

CHECK POINT STEPS	PROBLEM INDICATOR	ACTION
Notification of internal or external odour generation	Either	Contact the shift coordinator, environmental personnel and/or production on-call

Plant Parameters:- • Bar screen chemical dosing system • Primary clarifier underflow concentration • AFT pH • AFT operating level • AFT aspirator operation • Tertiary clarifier underflow NFR	System not working correctly U/F concentration >1.5% Outside range 7.7 to 8.2 Level:- a) > 1.3m or, b) < 0.8 m Any not working T/C Underflow NFR >1000 mg/L	Remedy or contact maintenance if required Increase primary clarifier underflow pump rate if possible Adjust rotary valve timer on lime system as per procedure a) Increase flow rate to the aeration tanks if possible b) Decrease flow to the aeration tanks if possible Remedy or contact maintenance (log work order) Ensure desludging is operational
Complete odour monitoring sheet		Environmental personnel or production on-call to complete *Odour Monitoring Sheet* in conjunction with WWTP operators

Figure 5: *Odour Monitoring Sheet*

Odour Monitoring Sheet

(Attachment 10.5)

Details: - (record or tick appropriate box)

Date: [ ] Operator on duty: [ ]

Environmental Personnel/Production on-call: [ ]

Time: [AM / PM] Shift: Night [ ] Day [ ]

Incident: - (record or tick appropriate box)

Was the complaint reported internally or externally: Internal [ ] External [ ]

Plant Parameters: - (record or tick appropriate box)

Primary Clarifiers

Is the bar screen chemical dosing system operating normally: Yes [ ] No [ ]

If "NO", action taken: [ ]

Underflow concentration: [ ]

Note: - Concentration values >1.5% present a problem

If underflow >1.5%, action taken: [ ]

AFT

pH: [ ]

Note: - pH values outside range 7.7-8.2 present a problem

If pH outside range 7.7-8.2 in the AFT, action taken: [ ]

Operating level: [m]

Note: - Tank levels >1.3m or <0.8m present a problem

If tank levels >1.3m or <0.8m in the AFT, action taken: [ ]

Are all aspirators operational: Yes [ ] No [ ]

If "NO", how many are functional: [ ]

If "NO", action taken: [ ]

Sludge Building Fans

Tertiary clarifier underflow NFR: [mg/L]

Note: - If NFR >1000mg/L present a problem

If NFR >1000mg/L , action taken: [ ]

Plant Sulfides: - (record or tick appropriate box)

Note: - Refer to laboratory

Primary Clarifier Underflow: [ppm]

Primary Clarifier Overflow: [ppm]

AFT: [ppm]

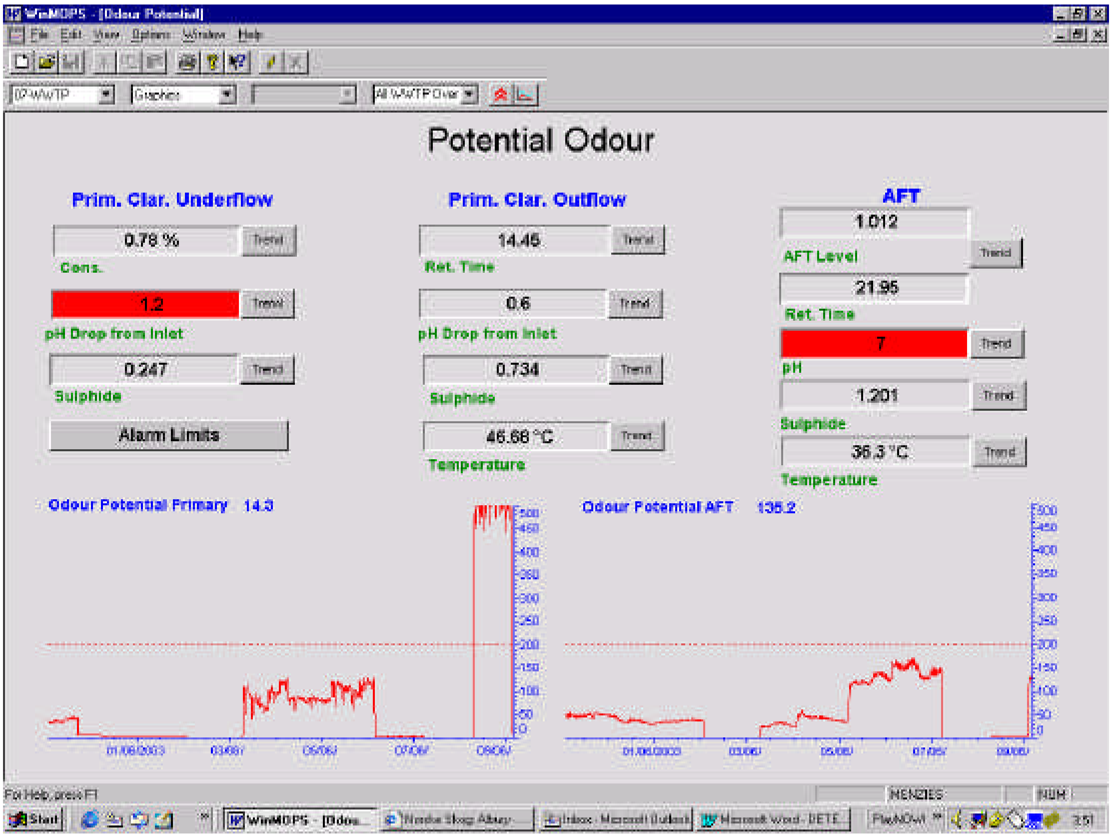
Other comments: [ ]

Note:- Environmental Personnel/Production on-call to complete form in conjunction with WWTP operators. Page 1 of 1

4.0 THE CHECKLIST

The next step was to make this odour trouble shooting checklist a live document that was accessible online at all times, instead of just when problems arose. By using the Mills online statistical data recording system known as MOP's, an operational sheet that collected all the parameters that we had previously identified was designed and put online. As can be seen by the online sheet depicted in Figure 5, it covers all sulfide results, retention times, pH and underflow cons %. When any result is out of its preset limit, it will alarm in red. This alerts the operator to possible odour problems that need attention. It also has the odour potential figure with a alarm limit. This way the operator can check the alarm against the odour figure to see if action is needed urgently or monitoring will need to be followed closely until the alarm is disabled.

Figure 5: ***Depiction of MOP's Alarm Screen***



5.0 HAS IT WORKED?

The Mill has enjoyed several years without a complaint from its neighbors and we thought that could well be attributed to the success of the odour potential figure. This was eventually tested when starting in February, after the mills process made changes to its dumping strategies causing the influent flows to per average day to increase and the WWTP process suffered causing the through-put to be reduced. This then resulted in the AFT level rising above its normal operating limits with the retention time going from 24 to 30 hrs to over 80 hours. This then related to the odour potential figure which was now well above 500, 300 units higher than the alarm limit. As you can see in Figure 4, within two weeks of this plant condition we started to receive odour complaints from our neighbors.

After getting the plant on track and reducing the influent flows the odour potential figure dropped below 200 and immediately complaints ceased. This gave an excellent indication that the online checklist was a very useful tool. This helps us now be able to predict when odour will become a problem for our neighbors and let us either correct the action before it becomes an odour complaint.

6.0 CONCLUSION

Several years of continual work on the odour problem at the Albury Mill have paid off with a total reduction if not removal of odour at the mill. It is only when we experience problems outside of the plants performance parameters that we see odour becoming a problem with our neighbours. In conclusion it would seem logical to work around these problems before they turn into issues, and this is successfully being accomplished by using the odour potential graphs and new plant parameters.

Trials using several odour reduction chemicals such as peroxide, biocide pellets and ferric chloride which give us a back up in times of plant problems have been used. One other area recently being worked with is measuring acid producing bacteria which not only cause odour related issues, but if present, have been identified as one of the possible causes of filamentous bacteria in our Activated Sludge system. It is hoped that measurement of this bacteria in the separate production streams may lead to reducing the bacteria and lead us to answering problems with future odour issues and plant performance.

So, as always with a water treatment plant, one problem solved only gives us time to solve the next issue.

7.0 REFERENCES

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