CLEANING OF DIFFUSERS AT EDGEWORTH WASTEWATER TREATMENT PLANT

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ABSTRACT

The Edgeworth WWTW catchment area is 65,000 E.P. and treats an approx ADWF of 16ML/day. Edgeworth WWTW services the areas of Charlestown, Hillsborough, Cardiff, Boolaroo, Speers Point, Glendale, Edgeworth, Barnsley and Killingworth. Some of these areas, notably Cardiff and Hillsborough, contain industrial areas. There are a number of trade waste customers throughout the catchment

The original Edgeworth WWTW was constructed in 1933. The original plant consisted of primary sedimentation followed by four trickling filters and two humus tanks. Sludge was digested using covered cold anaerobic digesters.

The old plant was augmented in the following stages:

- 1968 Circular primary sedimentation tank
- 1971 Two additional trickling filters and an additional humus tank
- 1979 A heated digester control building, maturation pond and sludge lagoon
- 1980 New inlet works
- 1985 Two additional primary sedimentation tanks

In 1996 a new activated sludge plant was constructed and commissioned at the site.

Secondary treatment at Edgeworth Wastewater Treatment Works is by Modified Lutzack Ettinger (MLE) process. Flow is directed continuously between two bioreactors, which have an anoxic zone and an aerobic zone. Porous polyethylene disc diffusers supply air to the aerobic zones. There are 1306 diffuser discs in each bioreactor. These diffusers are subject to fouling and deterioration and need to be cleaned periodically. The inner surfaces may become clogged with air borne dust if the blower inlet air filtration system is defective. The outer surfaces become coated in attached biological and inorganic slimes. There has been excessive prolonged air outages due to power surges and blackouts and this will have contributed to solids settling on or entering the diffuser openings, adding to the fouling problem. Increased backpressure on the blowers and reduced oxygen transfer (seen in the inability to meet DO set points) are the best indicators of diffuser deterioration.

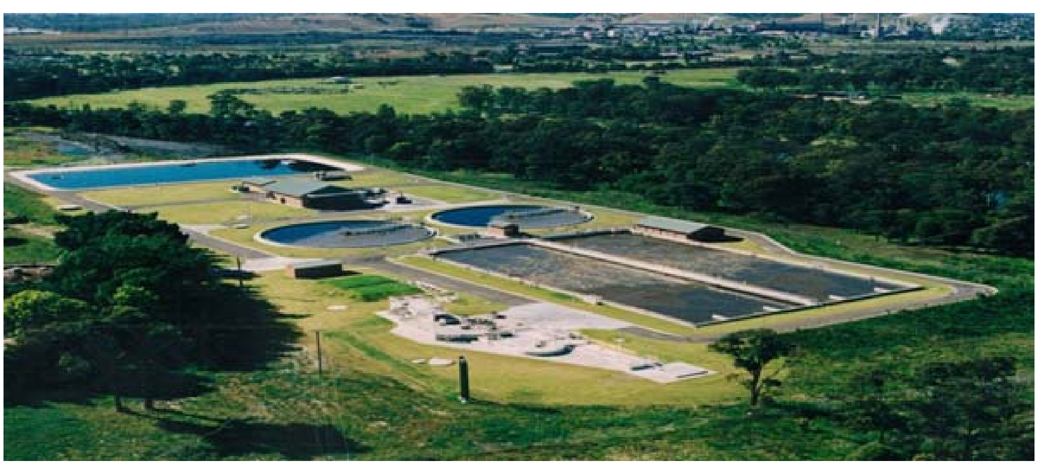

__Figure 1:__ ***HWC's Edgeworth WWTW***

To keep the plant operating at its optimum level, a number of different methods were trialled to clean the diffusers. Finally a method was devised where the bioreactors were only offline for a short amount of time. This is important to maintain adequate treatment. This paper will briefly describe the methods trialled and the procedure selected which now allows the quick and safe cleaning of the diffusers and the return of the bioreactors to service with minimum disruption to the process.

1.0 INTRODUCTION

1.1 Wastewater Treatment Process

The upgrade at Edgeworth WWTW was completed in 1996. The new plant at Edgeworth has a design capacity of 70,000 EP with an Average Dry Weather Flow (ADWF) of 16ML/day and a Peak Wet Weather Flow (PWWF) of 141.5 ML/day.

Primary Treatment involves screening of raw sewage using a mechanical step screen. If blinding of the screen or screen failure occurs, the inlet flow overtops the channel into a side weir and flows to the screen bypass channel. A manually raked bar screen is located in the screen bypass channel. All flow then enters a Pista grit chamber for de-gritting.

Secondary Treatment comprises two bioreactors each measuring 75m x 24m and 5m deep with a capacity of approx 9,000kl each. Detention time is 24 hours at ADWF. Each bioreactor has a large anoxic zone at its inlet end. The aeration system consists of grids of porous disc diffusers on fixed pipework bolted to the floor. There are a total of 1306 diffusers per bioreactor.

Final Treated Effluent at Edgeworth gravitates to a large storage dam from where it is transported to Toronto WWTW maturation pond then onto Belmont WWTW ocean outfall. MLSS is maintained around 3000mg/L by wasting through a Gravity Drainage Deck and Belt Filter Press.

Sludge treatment is by way of dewatering through a gravity deck then a belt filter press then disposed of a landfill for rehabilitation at ex mine sites in the Hunter Valley.

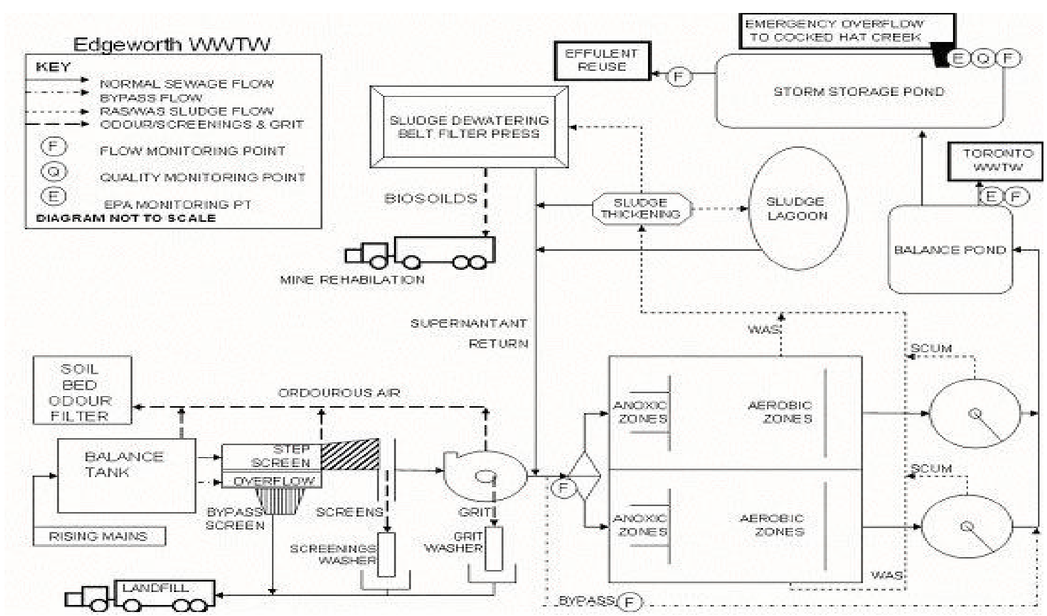

Figure 2: ***Schematic of the Edgeworth WWTW***

2.0 DESCRIPTION OF THE AERATION COMPONENTS

2.1 Blowers

Aeration for the treatment process is by diffused air supplied by blowers. There are three blowers onsite, one Lamson centrifugal blower and two Tuthill positive displacement blowers with variable-frequency drive units. These blowers discharge to a common manifold where pipes branch off to each bank of diffusers. Each branch of diffusers has a control valve which can be adjusted for flow balancing purposes. The blowers are designed to start automatically to maintain airflow through the diffusers using DO control The normal operating pressure of the blowers is around 50kPa.

Figure 3: ***Bioreactor #2 at the Edgeworth WWTW***

2.2 Diffusers

The diffusers are all Nopon HKL-215 units, which are 215mm in diameter. The porous discs split the supplied air stream into many small bubbles. The Oxygen is transferred through the wall of the air bubble and into the activated sludge. Smaller bubbles have a greater surface area and therefore will transfer more oxygen.

Figure 4: ***A Diffuser***

Figure 5: ***Diffuser in Bioreactor #1***

The creation of smaller bubbles requires finer pores in the diffuser. Finer pores give a greater pressure loss and thus require more power. Additionally, smaller pores are more likely to clog.

There has been excessive prolonged air outages due to power surges and blackouts and this will have contributed to solids settling on or entering the diffuser openings, adding to the fouling problem.

The diffusers were cleaned in 1999 by pressure cleaning and testing was undertaken on the viability of Acid Vapour dosing in 2002. Formic acid dosing was effective in reducing measured backpressure to about 10.5 – 14.5kPa at 1.0Nm3/h per diffuser air flow which was a reduction of about 5–6kPa in comparison with pre-dose rates. It is not known whether repeated dosages of Formic Acid would reduce backpressures further but it was thought it may be insufficient to remove significant accumulations of mixed liquor which had deeply penetrated the diffuser pores.

3.0 DIFFUSER OPERATION

Diffusers are critical in the Activated Sludge process.
The target Dissolved Oxygen (DO) level for the plant is 0.5mg/L which is the minimum level needed to maintain adequate treatment. Fouled diffuser lead to blowers being unable to deliver their capacity without them either releasing their pressure release valves or going into surge.

Diffuser blockage or failure results in:

- Increased Energy Costs
- Decrease in treatment efficiency
- Asset degradation.

3.1 Indicators of Diffuser Fouling

When the diffusers become fouled, backpressures can increase from 50kPa to as high as 65kPa. The increase in backpressure, as well as the low DO levels indicate some degree of diffuser fouling. Daily checks are done on backpressure readings and increases slowly over a number of months.

Tests completed in 2002, when it was suspected that the diffusers were badly fouled, indicated backpressures were up to 15-20kPa higher than tests done on new diffusers.

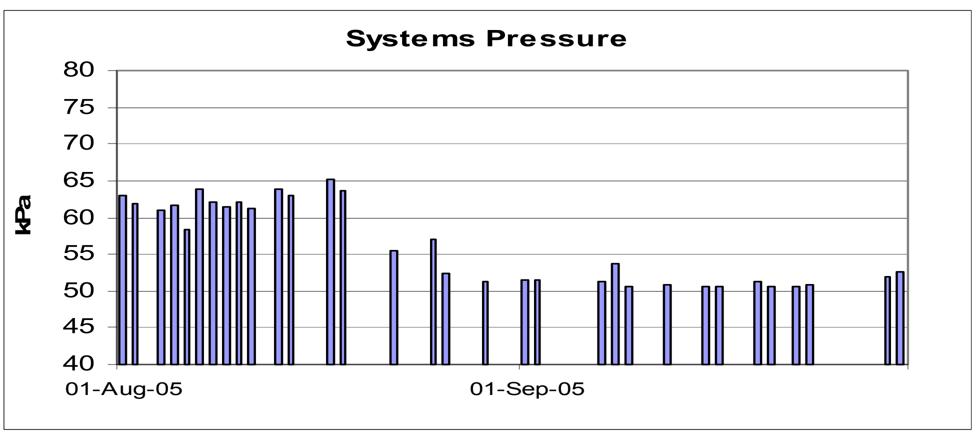

Figure 6: ***Graph showing backpressure changes before and after diffuser cleaning***

4.0 DIFFUSER CLEANING

Various methods have been trialled to de-foul the diffusers with some success. These include Acid Cleaning and Pressure Cleaning both after removing and while in-situ. Depending on weather conditions, it is possible to take one reactor off line to allow diffusers to be removed and cleaned. There is a need to be prepared to bring the bioreactor back online quickly if heavy rainfall is experienced.

Figure 7: ***Diffusers being cleaned***

4.1 Acid Cleaning

This is the preferred cleaning method by the supplier of the diffusers. Testing was undertaken using this method. A portable injector nozzle was screwed into a ¾ socket on the grid downcomer pipe and a portable dosing pump was used. Approx 7kg of 85% formic acid was dosed into each grid or about 15g per diffuser. While there was some decrease in backpressures, it was suggested by the diffuser supplier the large increase in backpressures were due to backflow of mixed liquor into the diffuser pores during the excessive and sometimes prolonged blower shutdowns the plant has experienced since the plant was commissioned. It was also possible backpressure increases were being caused by the hardening of the rubber of the internal check valves.

4.2 Acid Soaking

Acid soaking would require the diffusers to be removed from the plant and to be soaked in an acid bath. To do this, the bioreactor would need to be emptied and cleaned. This would be time consuming and require great care working with acid. As with above there were questions concerning what was the actual cause of the increase in backpressures and whether this method would remove slimes clogging the pores of the diffusers.

4.3 Pressure Cleaning Diffusers

Another method of cleaning the diffusers is to completely drain the Bioreactor and progressively remove the diffusers and clean both sides of each diffuser using high pressure water blasting. This would allow the replacing of the internal check valves. Again, this is a time consuming exercise and is previously mentioned, is dependant on weather conditions. Due to the large increase in backpressure and the heavy fouling of diffusers, this method was used in 1999 with great success. Some thought, and research was put into alternative methods of pressure cleaning diffusers where down time could be dramatically decreased. It took 2 to 3 weeks to clean diffusers by removing them and

pressure cleaning individually.
It was decided to attempt to clean diffusers while insitu by maintaining air flow through the diffusers and holding the pressure washer at an angle so not to further lodge accumulated biological and inorganic slimes. This proved very successful and it was decided to use this method to clean the diffusers with a crew following behind replacing the internal check valves.

5.0 CLEANING PROCEDURE USED

The following is a description of the cleaning procedure developed for the Edgeworth WWTW. MLSS was reduced in both bioreactors to approx 2500mg/L.

- Pump the contents of Bioreactor No 1 to Bioreactor No 2. Air valves need to be adjusted at regular intervals to maintain aeration pattern.
- Pump Bioreactor 1 empty and shut of air supply to the bioreactor when the level is approx 200mm above diffusers.
- Using Vacuum tankers remove accumulated sludge and grit from bioreactor floor.
- Crack open valves to supply a small amount of air flow through the diffusers.
- Clean each diffuser trying to ensure sludge/grit is not pushed into diffusers.
- Inspect complete diffuser system and replace any damaged components or pipe work.
- If replacing internal check valves have a second team following removing only one or two rows of diffusers in case bioreactor needs to be brought back online quickly due to wet weather. The internal check valves are easily removed using a small screwdriver. Placing the diffuser discs in a solution of dishwashing liquid and water assists in the reseating of the discs on the diffuser body.
- Refill bioreactor with either clarifier effluent or sewerage to a level of approx 300mm then introduce some air to check for leaks, uneven air pattern or badly seated diffusers.
- When satisfied everything in OK start RAS return pumps and allow sewerage to refill bioreactor.
- MLSS may be pumped from other bioreactor but we found this unnecessary as readjusting wasting can equalize MLSS.

The other bioreactor was then able to be emptied and the diffusers cleaned, again following the above procedure.

6.0 CONCLUSION

Formic Acid dosing was effective in increasing oxygen transfer efficiency but may not be sufficient to remove significant accumulations of mixed liquor if they have deeply penetrated the diffuser pores through periods of air outages.

While cleaning by removing each diffuser and high pressure water blasting is successful the extra down time is of concern. By cleaning diffusers in-situ using the above procedure this down time can be significantly reduced from almost 3 weeks down to 5 days. There is not much cost saving in reducing the time. The main benefit is the reduced risk to the process. In particular, the sludge age is halved causing reduced nitrification and less stable sludge. Also as the MLSS is greater with one tank, there is a risk of rising sludge blanket in the clarifiers as well as the hydraulic problems splitting evenly to each clarifier.