AN OPERATOR'S PERSPECTIVE; THE FIRST NEREDA® WWTP IN KINGAROY, AUSTRALIA.

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ABSTRACT

In mid-2016, Aquatec Maxcon along with Royal HaskoningDHV commissioned Australia's first full-scale aerobic granular sludge (Nereda®) WWTP. The plant has met all its effluent and recycled water licence requirements, but has been a significant learning curve for the operators with its 21st century technology and new instrumentation, maintenance, and testing requirements. This is an operator's perspective of the Nereda® technology and everything else that enables the plant to run.

Figure 1: ***Kingaroy WWTP 2017***

Figure 2: ***The old Kingaroy WWTP***

1.0 INTRODUCTION

The township of Kingaroy is located approximately 200km north west from Brisbane within the South Burnett region of Queensland and is administered by the South Burnett Regional Council. It is known as the peanut capital of Australia. The current population is approximately 12,500 people with 9,000EP connected to the sewer system. The original waste water treatment plant was constructed around 1940 with many additions in later years to support the population increase over the next 70 years. The old plant consisted of 2 primary settling tanks, 2 trickling bio filters, 2 dortman/humus tanks, a secondary clarifier, chlorine contact tank, 3 lagoons and final pond with flume to the Stuart River. The solid stream consisted of 2 digesters with mixers for the addition of lime, 1 thickener with picket fence mechanism, belt press and 7 drying beds. Time and age took its toll and the town grew. Poor effluent quality results and significant deterioration of concrete, steel work and mounting costs on mechanical infrastructure led to the need for a 21st century plant.

2.0 THE BIRTH OF A WASTEWATER TREATMENT PLANT

In mid-2014, a submission was put forward to construct a new WWTP and remove the existing plant. *Aquatec Maxcon* was awarded the tender to design and construct the new plant and reuse the settling tanks from the existing plant, commission the new plant and train operators with the new technology. The new Nereda® plant was to be the first of its kind in Australia with Dutch granular activated sludge technology.

In late 2014, works began on Australia's first Nereda® WWTP by Aquatec Maxcon with MPA Electrical and QCGC.

The new plant was designed to remove nutrient loads, bacteria, and pollutants. It would also reduce the amount of effluent that was discharged into the Stuart River and send that treated effluent back to the community as class A recycled water fit for irrigation of sporting, recreational and school ovals. The effluent was to be of the standard that is required for filtration and dual disinfection for reclamation.

May 2016 saw the cut over of the raw sewer main and the first influent pumped into the bio-reactors, and the plant was ready for commissioning. Eager operators took advantage to observe the commissioning of the new plant. Within days of operating, the plant met all its final effluent DEHP Licence conditions; with low ammonia, total nitrogen, total phosphorous and faecal coliforms. Except for the granulation, commissioning of the plant was well underway. The Aquatec Maxcon and Dutch commissioning engineers came to oversee the nearly completed project and were very pleased. The training covered the Nereda® system operating principles, sample collection and analysis and troubleshooting of the system should the need arise. The sample analysis focused on how to measure MLSS, SVI_5 and SVI_{30} and its comparison, granulation percentages/formulation and WAS monitoring programme.

Figure 3: ***Commission team 2016***

Figure 4: ***Aerial Photograph 2016***

3.0 NEREDA® TECHNOLOGY

Nereda® technology, or Aerobic Granular Sludge technology, has been developed, refined, and mastered by Royal HaskoningDHV with years of trials. I believe this will be the new standard in biological treatment of municipal wastewater. The process within the bioreactor manipulates and encourages the formation of activated sludge or biomass to encourage granulation and grow granules. These granules are responsible for the removal and uptake of phosphate and achieve excellent settling results. With faster settling the granules within the granulated bio-reactors can process more influent. Another major benefit is plant footprint is

at most, half the size of a conventional oxidation ditch treatment plant, resulting in significantly reduced capital expenditure.

Figure 5 and 6: ***Faster granule settling achieved with new Nereda® technology***

The liquid process flow of our Nereda® plant is as follows: we receive approximately 1.8ML of influent daily; it enters via 450mm pipe into the screening and grit removal. The influent enters the balance tank which holds the screened influent until the bioreactors call for feeding. The plant has a design ADWF of 2.62ML/d, but is currently operating with approximately 1.8ML/d.

There are three (3) main phases of the Nereda® process:

- **Feeding** to feed and displace the effluent at the top of the bio-reactors,
- **Aeration** to aerate/mix the biomass to nitrify/denitrify.
- **Settling** before displacement of final effluent with the start of the next feed phase.

Depending on batch size, it can be completed within three - four hours. The granules within the bioreactor are the workers. They form fast settling biomass including PAO (phosphate accumulating organisms). Each granule can work or operate in anaerobic, anoxic, and aerobic conditions. These granules perform differently to any other bacteria or biomass occurring within traditional anaerobic or aerobic WWTP plants. These robust granules are right at home here in the Kingaroy WWTP reactor or any other Nereda® reactor. Each reactor is capable of MLSS of around 6000-8000mg/L and will run at peak performance. At present, the Kingaroy bioreactors are operating at 3500-6000mg/L and increasing steadily.

When Nereda® is in ‘feeding’ phase the raw influent is pumped into the bioreactor displacing the final effluent from the previous batch which has a turbidity of around 1NTU-3NTU and is pumped to the clarifier to be stored and further polished. The Nereda® process does not require further clarification, but the clarifier was left in place to be used as storage and feed the filter feed tank. The filter feed tank supplies effluent to the filter feed pumps for the recycled water facility. When the filter feed tank is full, the treated effluent is diverted toward lagoons, disinfected with hypo with detention time around 30min, and then discharged into the lagoon and finally the flume into the Stuart River.

There are multiple barriers to meet Class A recycle water requirements including effluent dosed with alum and fed into pressure filters at 20L/s, and being double disinfected by UV and sodium hypochlorite and fed into the contact tank before being stored. There are standalone pumps each supplying customers via telemetry that have a requirement for the Class A Water. Each pressure filter is serviced by air scour and backwash pumps and wet rack to ensure turbidity, transmissivity, and chlorination monitoring for SCADA interface.

The solid streams are transferred from the bio-reactor to the WAS buffer tank. This wasted sludge is pumped to the thickener. The thickener is kept at 30,000mg/l with the assistance of poly added at the time of wasting. The solids are pushed through the bottom via hydraulic loading of the thickener, enters the aerobic digester for a three-stage digestion and maturation prior to being pumped to the gravity drainage deck and belt filter press for disposal. The final digested sludge is around 13000mg/l. Sludge dryness is approximately 15% with a capture of at least 91%-95%.

4.0 EFFLUENT AND INFLUENT QUALITY

Kingaroy influent is typical domestic sewage and there are no major industries that rely on us to process their waste. The online analysers that capture data at the balance tank feeds this information to the Nereda® Aquasuite© Controller. This allows the controller to adjust and operate to each batch that is fed into the reactors. Below is the median influent and effluent characteristics we receive at Kingaroy WWTP.

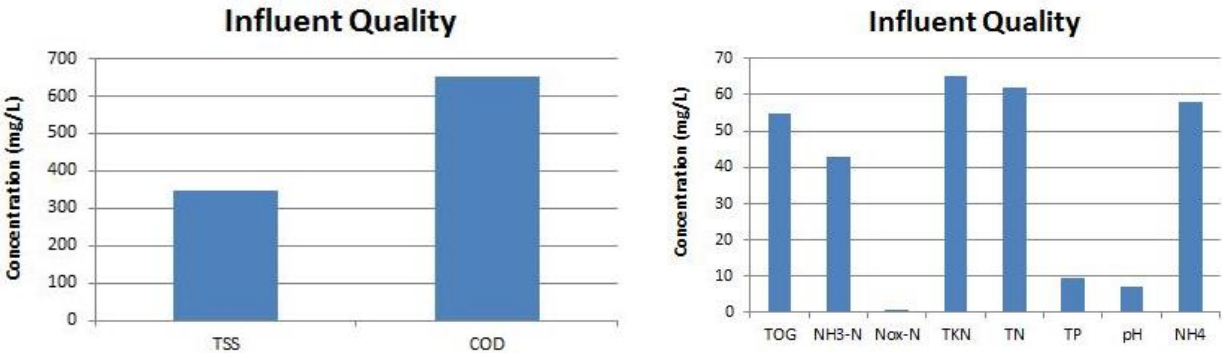

Figure 7 and 8: ***The median influent characteristics to Kingaroy WWTP.***

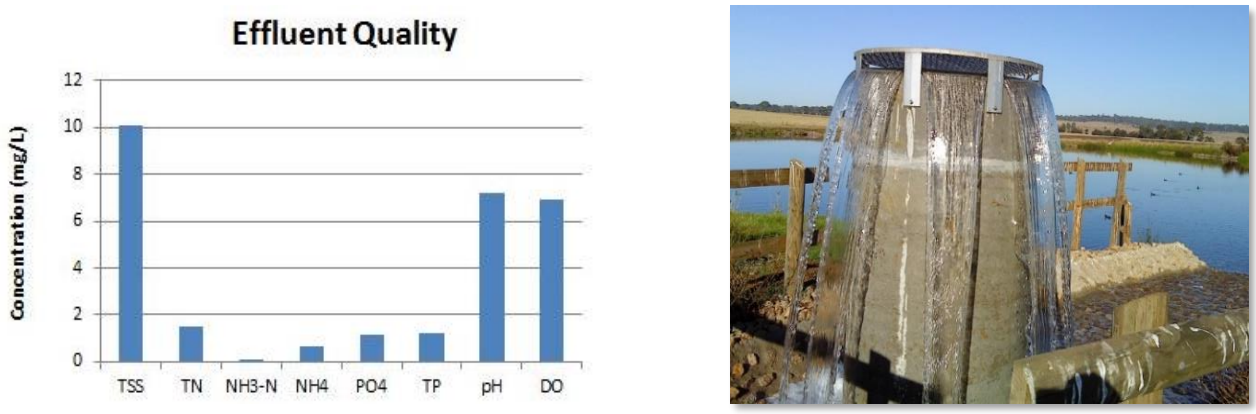

Figure 9 and 10: ***The median effluent characteristics and final lagoon outfall.***

5.0 THE BENEFITS OF THE KINGAROY NEREDA® WWTP

- The new Nereda® Process plant footprint is at most, half the size of a conventional treatment plant, so less walking for me! It is more energy efficient compared to most aerobic treatment plants, is chemical efficient (almost no addition once full granulation occurs), is compact no moving parts, and has a reduced amount of mechanical equipment as everything happens within one tank.
- Remote monitoring– Ability to dial into the network and start/stop/operate the plant from anywhere in the world.
- Principal Contractor was actively involved in operation/commissioning/training and available to assist after hours. Royal HaskoningDHV and Aquatec Maxcon are always keen to talk to new rookies and assist with any issues.
- Operatable flexibility – ability to adjust any operable parameters.
- Availability of redundancy – With duty/standby and duty/standby/assist we now have greater flexibility when performing maintenance on equipment without having critical equipment offline.
- On-line instruments and SCADA interface to allow all instruments to be interactive with the operator and programing logic to integrate with characteristics to operate with the Nereda Aquasuite© controller to perform all controller functions including batch sizes.
- Effluent discharged from the reactor is suitable for recycled water reclamation. During summer, up to half of the influent is reused for sporting fields and a golf course. This recycled water has a turbidity of <1NTU and faecal coliforms of <1cfu/100mL.
- If power fails or there is disturbance in the power generation grid, the on-site generator will assist and continue until a reliable continual power source is returned.
- All processes for the liquid stream are started and completed within 1 bioreactor. There is lower investment and no moving parts within the bioreactor.
- Kingaroy at present has a maximum of 2.6ML a day, but should the town grow, we only require another reactor. Most of the infrastructure is in place.
- Excellent treatment with better nutrient, bacteria, and pollutant removal. Low total nitrogen (TN), total phosphorus (TP) and ammonia (NH3-N).
- Royal HaskoningDHV are monitoring the process all the time and tweaking the recipe, to achieve a more efficient plant.
- *And finally, the best thing;* ***we made it onto a stamp****!*

<u>Figure 11:</u> ***The Kingaroy WWTP made it onto a stamp by Netherlands Post – We are recognised up there with Dirk Hartog! He is on the same stamp series.***

The stamps featured the relationship between two countries highlighting the exchange of knowledge and the innovative technology of Royal HaskoningDHV, to make use of

sustainable Dutch technology, used in the Kingaroy WWTP for South Burnett Regional Council.

6.0 OUT WITH THE OLD AND IN WITH THE NEW

The new system requires more maintenance than previously to keep the plant running at its optimum. The following differences to the old plant are:

- There are online analysers that are required to be kept in peak condition including replacing reagents. All instruments are Hach supplied instruments – Amtax, Phosphax, Filtrax, D.O. probes, Nitrate Probes, Suspended Solids, pH probes, Ultraturb, UVT and Chlorine analyser. This equipment requires regular maintenance and calibration. The equipment is very expensive and we have arranged a service agreement with Hach. In saying that, the effluent licence is much stricter and we are passing on all criteria by a significant margin.
- Power usage has increased due to the use of blowers and pumps compared to the old trickling filter plant that was mainly gravity driven.
- Meeting the licence criteria and producing Class A recycled water for use within the community.
- If the Nereda Aquasuite© controller crashes, the system will revert to the back-up or emergency recipe. There is a high-end server with standby hard drive and CPU. As long as this is maintained there will not be issues.

7.0 OUR NEW COUSINS IN RIO DE JANEIRO (NEREDA® BROTHERHOOD)

I visited the Rio de Janeiro Nereda® plant in Deodora, Brazil, where they received very similar results. Release characteristics vary due to the environmental licence and local authorities around the world, and how regulated the country is. The Deodora plant was built in two stages - 64ML/d and secondary stage 84ML/d. This treats wastewater for 480,000 EP. Should you wish to know more about Nereda® and other treatment plants, visit me at Kingaroy or see the following websites: https://www.royalhaskoningdhv.com/en-gb/nereda/plants/australia-kingaroy/4001 and http://www.aquatecmaxcon.com.au/technologies/sewage-treatment/nereda-aerobic-granular-biomass

Figure 12: ***Google Earth Image of Deodora WWTP.*** **Figure 13:** ***Foz Aguas 5 staff (Manager, Andy Watson and Senior Operator)*** **Figure 14:** ***Nereda® Reactor Bridge Deodora WWTP January 2017.***