final report

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Evaluation of an Electro-Coagulation/Electro-Advanced Oxidation Technology for removing Total Phosphate from Abattoir Effluent

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Executive summary

Inovin Water Technologies (**Inovin**) was commissioned to conduct site-based treatment compatibility testing and analysis on a Queensland abattoir's (**Test Site**) process effluent streams using Electro-Coagulation/Electro-Advanced Oxidation technology.

The waste water effluent streams that were tested and analysed included:

1. Covered Anaerobic Lagoon Effluent – CAL EFF
2. Covered Anaerobic Lagoon Influent – CAL INF
3. Abattoir Red Stream - RED
4. Abattoir Green Stream - GREEN

Inovin deployed their Laboratory Mobile Cell (**LMC**) in the form of a 20' sea container to the Test Site abattoir operation to commence on-site analysis on the four above-mentioned streams individually. The Inovin LMC contains a continuous flow waste water treatment system including the WaterMiner® Electrocoagulation / Electro-Advanced oxidisation (**EC/EAO**) reactor technology.

Each stream was tested with the EC/EAO technology to ascertain each waste stream's contaminant reduction. Third party NATA approved laboratory analysis was performed on the individual stream control samples and the ultimate treated effluent utilising the EC/EAO for validated results on the system performance.

The EC/EAO technology achieved significant contaminant reduction in key areas including Total Nitrogen 48%, Phosphorous 99%, BOD 97%, COD 90%, TSS 99%, FOG 98% and Magnesium 39%. Ammonia and Potassium reduction were minor in affect being 15% and 9% respectfully. Sodium in the form of NaCl increased as NaCl had to be injected to linearize conductivity of the heavily contaminated streams.

The benefit gained from this analysis is in the form of the ability to provide a full scale continuous flow treatment solution to all meat industry participants with waste water contamination issues. The ability to treat and irrigate in an environmentally sustainable method is critical to the future of the meat industry in Australia as a whole.

Blending of all streams is a practical solution depleting complexity and delivering significantly cleaner effluent to the land parcels in the form of irrigation water hence improving plant growth and feed quality.

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1 Electro-Coagulation/Electro-Advanced Oxidation Technology

1.1 Treatment of Abattoir Effluent

Electro-Coagulation/Electro-Advanced Oxidation (**EC/EAO**) technology presents an option for removal of Total Phosphate (TP) and Total Nitrogen (TN) from abattoir effluent.

This project seeks to evaluate the technical and environmental merit of EC/EAO at the Test Site's processing facility in Qld.

2 Project objectives

2.1 Assessment of Merit of Electrocoagulation/Electro-Advanced Oxidation

Full Test Parameters for Control Effluent and Treated Effluent to determine overall compatibility was undertaken by a 3rd Party NATA Accredited Laboratory for verification of results:

- EA005P - pH by PC Titrator
- EA010P - Conductivity by PC Titrator
- EA025 - Total suspended solids
- ED037P - Alkalinity by PC Titrator for hydroxide, carbonate, bicarbonate and total alkalinity
- ED045G - Chloride by discrete analyser
- ED093F - Dissolved major cations for sodium, calcium, magnesium and potassium
- EK055G - Ammonia as N by discrete analyser
- EK057G - Nitrite as N by discrete analyser
- EK058G - Nitrate as N by discrete analyser
- EK061G - Total kjeldahl nitrogen by discrete analyser
- EK062G - Total nitrogen as N by discrete analyser
- EK067G - Total phosphorous as P by discrete analyser
- EP020 - Oil & grease
- EP026S - Chemical oxygen demand
- EP030 - Biochemical oxygen demand

The sludge created from the flocculation process was also tested against NSW Biosolids and Fertilizer Guidelines by a 3rd Party NATA Accredited Laboratory for verification of results to ensure it is suitable as a soil conditioner/fertilizer or top dressing.

3 Methodology

3.1 Lab Mobile Cell - Containerized Unit Wastewater Onsite Testing

Inovin supplied a Lab Mobile Cell (LMC) within which its core technology an Electro-Coagulation/Electro-Advanced Oxidation Reactor which was utilized to treat different Abattoir Effluent Streams to test its effectiveness at the Test Site.

The WaterMiner® EC/EAO reactor has two zones which replace multiple traditional treatment steps in one single continuous flow process. The primary zone is the Electrocoagulation zone where the

contaminated influent is subjected to a low voltage charge via a rotating cathode and fixed sacrificial anode plate. The sacrificial anode plate typically made of iron sacrifices iron negatively charged molecules to attract themselves to positively charged contaminants. The contaminants in conjunction with the sacrificial molecules create a coagulated mass.

The secondary zone is a fixed case non-sacrificial anode conducting to the same primary cathode where residual iron molecules in conjunction with mixed metal oxides create disinfection by production of Hydrogen Peroxide (Fentons Hydroxyl Radical). This process also creates bubbles which help the coagulated mass lift. This process is the most powerful disinfection process known to man.

The WaterMiner® reactor replaces the need for primary chemical coagulation, biological reaction, UV stabilisers, disinfection by means of chemical process such as H2O2 production / dosing units and deodorising plants all with one simple continuous flow technology.

The treated results were then analysed by a 3rd party NATA accredited Laboratory and compared to the “control sample” results to gauge compatibility with the different Effluent Streams at the Test Site. The equipment was operated by two technicians and included a spectrophotometer and reagents for onsite testing.

The treated waste streams included:

1. Covered Anaerobic Lagoon Effluent – CAL EFF
2. Covered Anaerobic Lagoon Influent – CAL INF
3. Abattoir Red Stream - RED
4. Abattoir Green Stream - GREEN

4 Results

CAL EFFLUENT

Testing parameters	1st Pass	2nd Pass	
Primary Voltage	9.1	-	(V)Volts
Primary Amperage	40	-	(A)Amps
Secondary Voltage	6.5	7	(V)Volts
Secondary Amperage	65	70	(A)Amps
Flow Rate	3	2	l/m
Polymer Pump Setting	65	3.5	(1-100)%
Conductivity	5 + 3.5	-	mS/cm
Effluent Turbidity	12.3	4.4	NTU
Influent Turbidity	1266	19	NTU

CAL INFLUENT

	1st Pass	2nd Pass	
Primary Voltage	8	3	(V)Volts
Primary Amperage	55	10	(A)Amps
Secondary Voltage	6	8.9	(V)Volts
Secondary Amperage	30	70	(A)Amps
Flow Rate	2	2	l/m
Polymer Pump Setting	50	10	(1-100)%
Conductivity	3+3	5.6	mS/cm
Effluent Turbidity	32	3.7	NTU
Influent Turbidity	2500+	132	NTU

RED

	1st Pass	2nd Pass	
Primary Voltage	9.5	3	(V)Volts
Primary Amperage	60	10	(A)Amps
Secondary Voltage	8.9	10.3	(V)Volts
Secondary Amperage	70	70	(A)Amps
Flow Rate	2	2	l/m
Polymer Pump Setting	50	10	(1-100)%
Conductivity	2+3	4.3	mS/cm
Effluent Turbidity	36	4.2	NTU
Influent Turbidity	2000	43	NTU

GREEN

	1st Pass	2nd Pass	
Primary Voltage	4.9	3	(V)Volts
Primary Amperage	60	10	(A)Amps
Secondary Voltage	5.7	5.8	(V)Volts
Secondary Amperage	65	73	(A)Amps
Flow Rate	2	2	l/m
Polymer Pump Setting	50	25	(1-100)%
Conductivity	5.7+8.3	12.5	mS/cm
Effluent Turbidity	54	12	NTU
Influent Turbidity	2000+	81	NTU

Summary of Treated Results

Average Contaminant Reduction					
Parameter	***Units***	***Control (Average)***	***1PFe (Average)***	***2PEAO (Average)***	***Average Reduction***
Ammonia	mg/l	245	228	206	15%
Total Nitrogen	mg/l	450	260	234	48%
Phosphorous	mg/l	71	1.3	0.6	99%
BOD	mg/l	5324	520	117	97%
COD	mg/l	8365	941	835	90%
TSS	mg/l	3910	44	6	99%
FOG	mg/l	1715	15	<5	99%
Magnesium	mg/l	23	16	14	39%
Sodium	mg/l	266	1097	1000	-
Potassium	mg/l	138	128	125	9%

5 Discussion

5.1 TP and TN Reduction in Abattoir Effluent

The EC/EAO technology achieved significant contaminant reduction in key areas including Total Nitrogen 48%, Phosphorous 99%, BOD 97%, COD 90%, TSS 99%, FOG 98% and Magnesium 39%. Ammonia and Potassium reduction were minor in affect being 15% and 9% respectfully.

Sodium in the form of NaCl increased as NaCl had to be injected to linearize conductivity of the heavily contaminated streams. For the Test Site, the addition of NaCl, renders the EC/EAO technology, by itself, unviable due to the need to reduce sodicity in the land on which it irrigates its treated waste water.

6 Conclusions/recommendations

The test results clearly show that EC/EAO can be an extremely effective technology to greatly reduce the levels of TP and TN in abattoir effluent.

However, if the effluent quality requires the addition of NaCl to make the EC/EAO technology work and this contrary to site requirements (e.g. applicable Environmental Authority), as it did with the Test Site, then supplementary technology is required to be considered to then remove the NaCl from the resultant treated effluent.