Analysis of the Organocatalysts Ecocatalyst™ dosing on the Industrial System at Gippsland Water Factory

Author: Matthew O'Brien, EcoCatalysts Pty Ltd

Disclaimer

This report is a summarised version of the Case Study: Analysis of Ecocatalyst™ Dosing on the Industrial system at GWF written by Emily Scholes, Operations Analytical Consultant. A full copy of the case study is available.

Introduction

After approximately 3 years of operation of the Gippsland Water Factory anaerobic reactors was accumulating a significant layer of floating debris. This in turn formed a crust layer which comprised of a high level of Fats, oils and grease (FOG). The fatberg that formed was being moved 'glacial style' in the direction of the reactors flow.

The thickness of the crust which was up to 3 meters in some places which resulted in reduced hydraulic volume of the anaerobic reactors and thus decreased the hydraulic retention time available to process influent. Development of the Crust was also damaging to the infrastructure of the Digester.

The Organocatalysts product Ecocatalyst™ works by breaking down FOGs through cleaving the ester bonds and reducing the molecular structure into glycerol and dissolved fatty acids. Simultaneously breaks down the crust to increase the solubilisation of the substrates and additionally improving the biogas production.

Aim

The primary aim of the demonstration was to reduce the fatberg to protect the infrastructure of the anaerobic digester.

Method

The method of application of Ecocatalyst™ evolved as the demonstration progressed. Initial manual dosing occurred at the domestic inlet to target the fats in the domestic system before they get to the anaerobic reactors, appeared to be an effective tactic. Further into the demonstration automatic dosing was more favourable for consistent targeting of the crust without the time constraints and OH&S risks. The dosing into the system occurred at two points, the domestic inlet at a rate of 18 Litres/day and then directly into the crust at a rate of 36 Litres/day.

Results

Composition of the Fats within the Digester changed due to dosing, as illustrated below.

Figure 1: Appearance of Crust before and after commencement of dosing.

At the beginning of the trial the crust was observed to be quite dense. It also had a very noticeable smell which would normally be associated with putrescent fats. The consistency of the crust is now observed to be significantly more liquid. A number of the hatches contained a well homogenised liquefied crust.

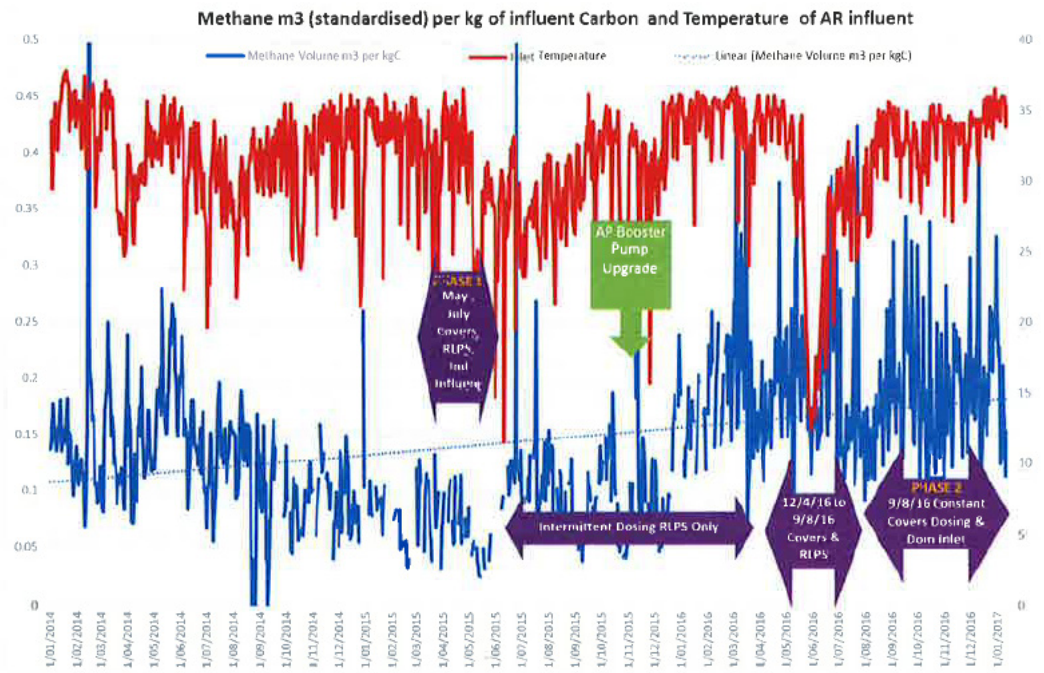

Figure 2: Methane m^3 per kg influent carbon (blue), influent temperature (red).

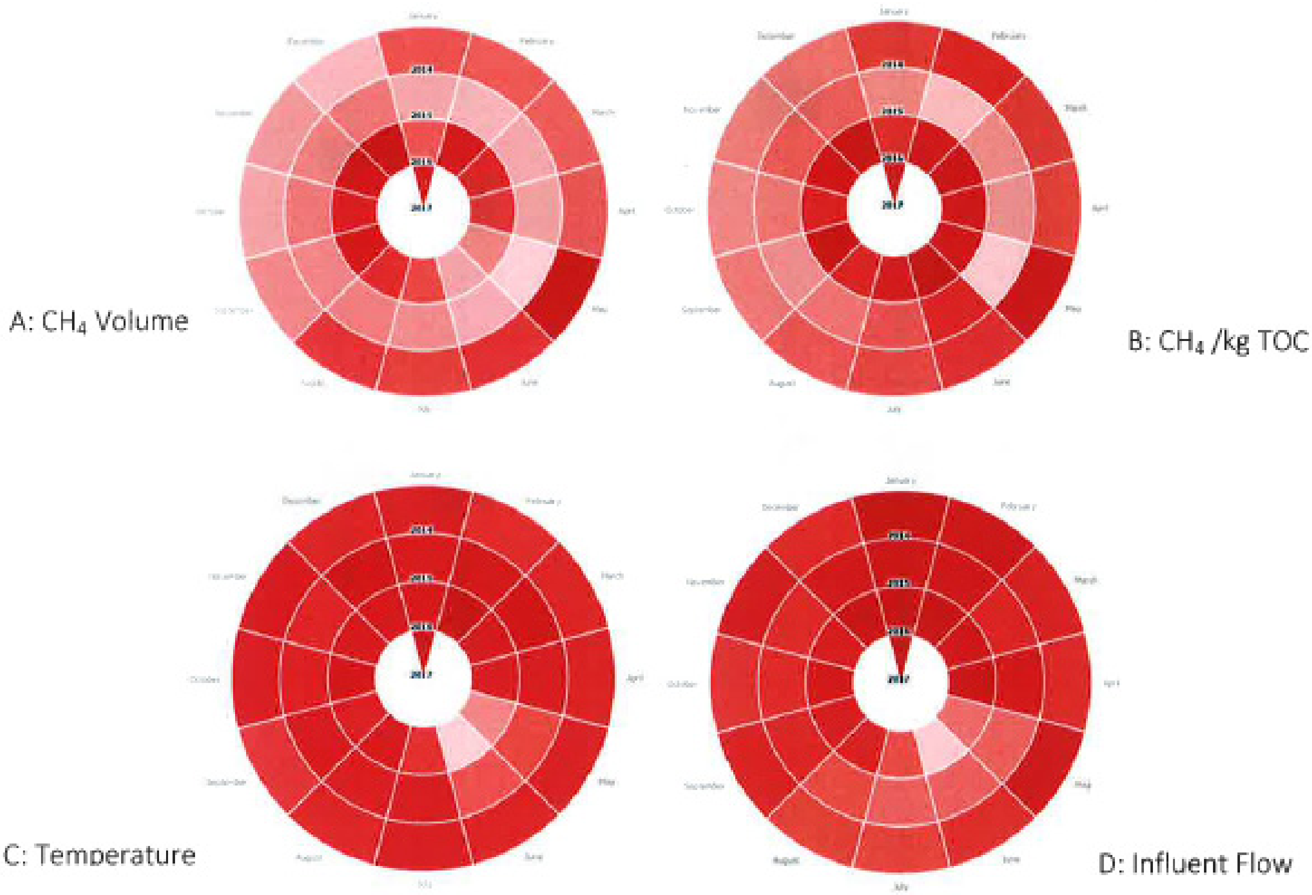

Figure 3: Annualised Spiralograms A: Methane Volume (std 25°C), B: Methane Volume (std 25°C) per kg of Influent Organic Carbon, C: AR Inlet Temperature, D: AR Influent Volume

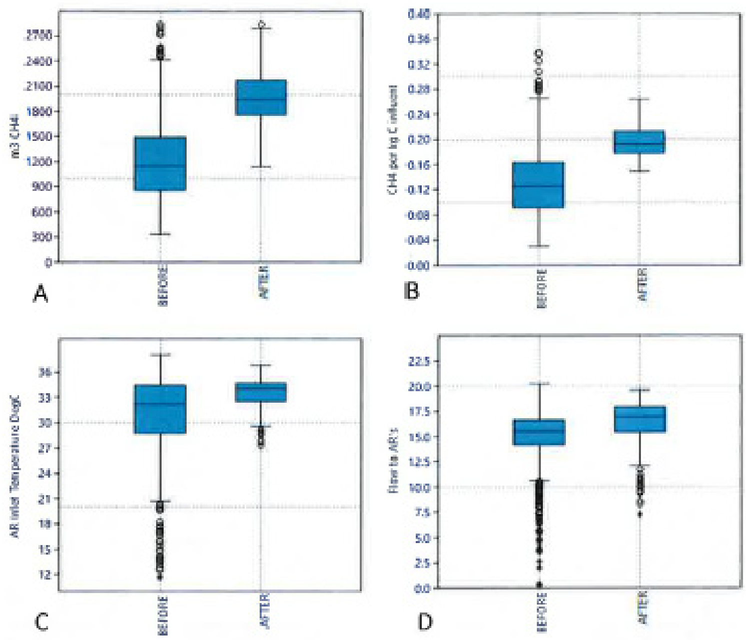

Figure 4: Before and after start of Phase 2. A: Methane m^3 per day, B: Methane per kg of Influent Carbon, C: AR Inlet temperature, D: Flow to the AR's.

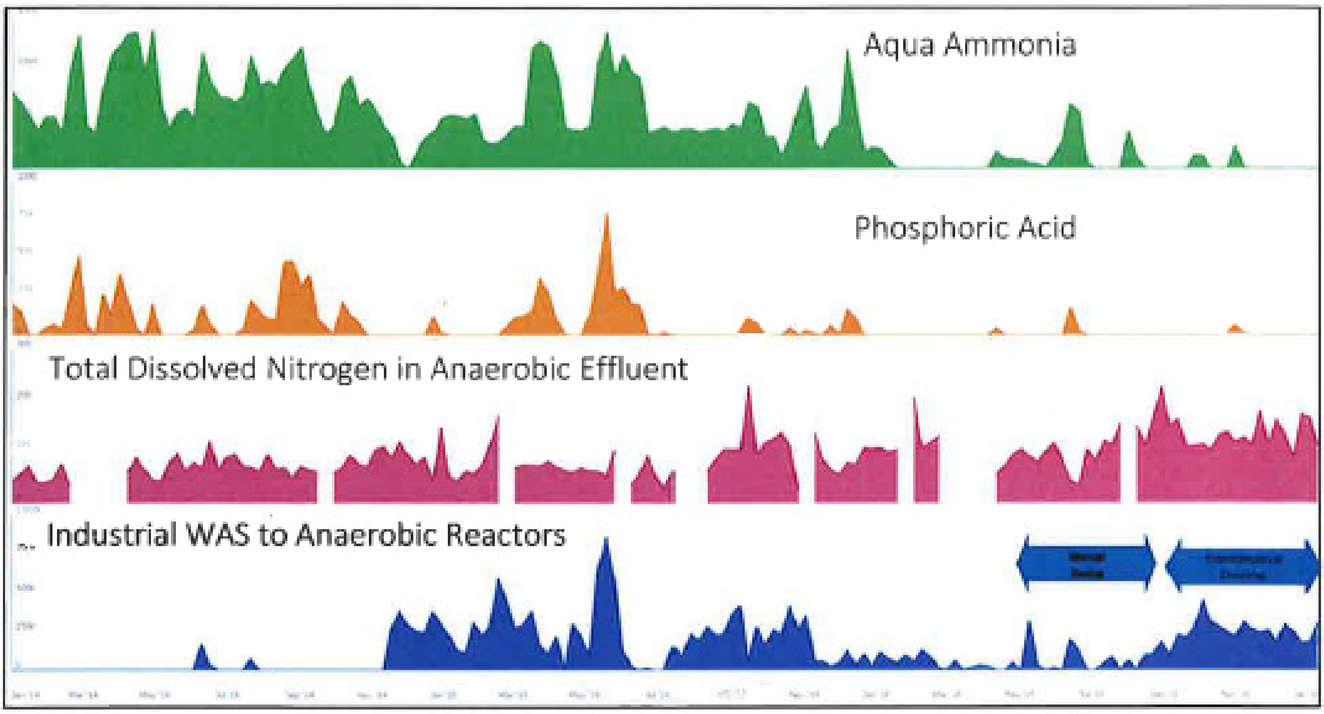

Figure 5: Aqua Ammonia (green) and Phosphoric Acid (orange) dosing to the MBR and Dissolved Total Nitrogen in the Anaerobic Effluent (purple) to the MBR and Industrial Waste Activate Sludge to the Anaerobic Reactors (blue).

Discussion:

The crust level has been reduced markedly from the high levels occuring at the start of the demostration (Figure 1). The Organocatalyst Ecocatalyst™ has hydrolysised the fats to reduce the size and form of the fatberg. By cleaving the lipid ester bonds and reducing their molecular structure to essential fatty acids and water soluable glycerol. The resulting fatty acids are in a state where they can be used more efficently in the methanogenesis phase. The reduction in size of the fatbergs relieved pressure on the infastructer of the digestor and prevented the fatberg tearing the digestors covers.

The development of approriate dosing procedure and understanding of the characteristics of the system is illustrated in figure 2. During Phase 1 of the demostration cover dosing occured weekly and continual dosing into the Return Liquor Pump Station. Whilst this reduced the crust layer, it occurred during a period of sporadic flow from AP and cold conditions. After Phase 1 dosing occurred intermittently at the Return Liquid Pump Station only. It is difficult to evaluate the effect of the sporadic dosing.

Phase 2 is a period where much higher confidence analysis can be performed. Dosing in this period had been constant at both the Domestic Inlet and directly into the covers. We can see that during this time methane conversion per kilogram of carbon produced excellent results.

Figure 3A shows that the volume of methane has been noticeably higher in the Phase 2 continuous dosing period. Figure 3B shows that in 2016-2017 carbon conversion to methane produced excellent results with higher methane to influent Total Organic Carbon (TOC) ratios. Figure 3C and 3D show during a consistant temperature, Ecocatalyst™ improved the influent flow which contributed to increased methane production.

Biogas production has been excellent through the period of continuous dosing. Methane volumes averaged 1973m^3/day, compared with 1206m^3/day previously (Figure 4). Conversion of TOC rates increased from 0.132m^3/kg Carbon to an average of 0.197 m^3/kg Carbon. From the increase in the mean temperature of the reactors, we would expect a 4% increase in production. The actual Methane production increase achieved was 63% during this dosing period. This increase in Methane production has occurred as a result of Ecocatalyst™ performing its role in the breakdown of fats. This allows the products of this process to be presented to the anaerobic microflora of the digester in a form easier to convert.

Before Ecocatalyst™ was introduced into the system the Digester relied on the addition of liquid nutrients to keep it functioning at a reasonable level. Nutrients such as phosphate particularly nitrate and ammonia were limiting factors in the system. As a result, aqua ammonia and phosphoric acid is dosed into the Methane Bio Reactor (MBR). On average, the volume of chemicals dosed into the MBR before Phase 2 was 490L/day of aqua ammonia and 76L/day of phosphoric acid. Since continuous dosing of Ecocatalyst™ the mean average was reduced to 24L/day of aqua ammonia and 2.1L/day of phosphoric acid (Figure 5). This reduction in the additional expensive consumables has allowed the system to become more economically efficient.

Conclusion:

This demonstration on Ecocatalyst™ at the Gippsland Water Factory has shown that by incorporating this Organocatalysis into the anaerobic digester not only reduces the stress on the infrastructure but also improved the efficiency of the system. Through the process of Hydrolysis, fats are being broken down and the resulting fatty acids are being used by the system with a far greater efficiency. The primary aim of protecting the digesters infrastructure was achieved and it had the additional benefit of reducing costs in consumables and improving the Digesters production rate of Biogas.