August 23, 2019

CASE STUDY REPORT ON THE EFFECT OF BOC TREATMENT IN A 50K TONNE FOODWASTE AND SWINE SLURRY AD PLANT

1. ABSTRACT

Anaerobic digestion is the process of biological degradation and consumption of organic matter resulting in producing biogas consisting of CO2 and CH4.

Commercial success requires a fully optimised process, ensuring consumption of the food source is maximised in the shortest period of time possible, this requires a catalyst.

Bio-Organic Catalyst (BOC) has been used in this trial in two phases, firstly a controlled batch observation to ascertain the effect it would have on the consumption of the feedstock in a controlled environment and secondly to observe this effect under a full-scale dosing regimen.

The controlled batch treated reactor consumed over 20% more than that of the control untreated reactor prompting a full-scale dosing which after 35 days has shown a 12% increase in gas yield as well as modest 3% increase in gas purity.

The following report is on the trial, the results and recommendations.

2. THE SITE

The site has two primary digesters, each 3,000M3 in size, fed by a day tank via a hydrolysis tank. The feedstock consists of predominately food waste mixed with swine effluent and waste dog meal, a total annual feed of 50,000T.

The site is located in Leicester, UK and is able to preselect food waste ensuring an ODM loading is consistent.

Power generating capacity is 1.5mWh generated through two 750kWh CHP engines, these engines are fed by 7.685M M3 of biogas and an average of 57.95% CH4 content.

Table 1 Technical details of the operation

PLANT TECHNICAL DATA	
Year of plant construction	
Year in service	
Plant size	1.5MW
Digester volume	4,500M^3
HRT	25 to 30 days
Process Temperature	40^o
Feedstock	Co-digestion of food waste, pig slurry and dog food

3. CONCEPT

The plant was running at between 70% and 75% capacity and had applied to increase the intake license to 60,000T to increase this capacity. The conditions set for the increase in this tonnage required a vast capital investment with certain EA regulations required to be met.

Alternatively, it could seek treatment technology that would accelerate the solubility of the Volatile Solids which would optimise the plant's output.

A trial consisting of two phases was established. The first stage would set out to prove the accelerated and increased removal of the Volatile solids in a controlled batch scale trial and the second stage would, based on the results of the batch trial, install a full-scale treatment in the fermenters.

4. METHODOLOGY

The trial used the Bio-Organic Catalyst (BOC), a Biotechnology derived from a non-lethal heat stressed protein from an aerobic yeast fermentation process with added non-ionic surfactant. The product contains no active enzymes or bacteria, instead stimulate the vitality of indigenous microbes within the microbiome, resulting in enhanced biological robustness. This leads to an accelerated transition to the methanogenic phase as well as solubilizing further volatile solids, an increased biological robustness and a higher Methane purity in the Biogas.

Studies have shown a correlation to biomethane yield improvements and Total Solids and Total Volatile Solids consumption.

Further distinctive qualitative characteristics of digestate exhibit substantial odour reductions, which follows from a complete consumption of the TVS components.

The catalyst comes in the liquid form and is dosed to a selected place early in the systems process. In this case prior to the hydrolysis tank.

A. FIRST STAGE TRIAL – CONTROLLED BATCH RECTORS

Two 1,000l IBC were equipped with heating jackets and mixers as seen in Figure 1. Each IBC was filled with 880l of digestate from Digester 3 (primary digester) and 80l of fresh soup from the pre-mixing tank. One was treated with 12ml of EcoCat™ the other had no treatment and was considered as a control.

These were sealed and heated to 38oC with the stirrers constantly on. Replicating the digester conditions onsite.

The trial started on the 25th April and was completed on the 9th May a total of 14 days. In this time 5 samples were drawn and were analysed for VFA, VS, ODM and NH_4.

Figure 1 Controlled Batch Reactors in situ

B. SECOND STAGE TRIAL – FULL-SCALE TREATMENT

The dosing was done using a simple peristaltic dosing pump attached to the side of an IBC filled with a 10% and 20% solution. The dosing was installed prior to the hydrolysis tank.

A total of 80l/day was dosed, initially at 20% solution reducing to 10% after 20 days and finally increasing again to 20% after a further 20 days. The dosing commenced on the 9th May and continues today at 20%.

The adjusted solutions were to illustrate the performance in differing strengths using a high and low rate. At 10% a total of 8l/day would be treated and 20% is 16l/day.

The rate is calculated on ODM loading and is between 250ml/T and 500ml/T

5. RESULTS

The results were encouraging and showed headline results:

i. A 25% increase in TVS consumption in the treated digester. Treated digester consumed 16.1kg whilst only 12.9kg in the control digester.
ii. Visually the digesters showed significant differences. In the control a film of mould had formed over the surface after the stirrers had been removed whilst the treated digester was clean.
iii. Gas yield increased by 12% from the 18 months average up to the trial and an 18% increase in average daily gas readings.
iv. CH4 in the gas increased from an average of 57.95% to 60.11% an increase of 3.7% increase in gas purity.

A. FIRST STAGE TRIAL

The results of this stage would determine whether a treatment would be installed in the main reactors. The trial was determining two variables, the VS and ODM consumption and the effect it may have on NH4-N build up.

Samples were drawn periodically in the trial and the results were plotted graphically. Both reactors consumption rate was similar up to day 5 in the process, however, from day 5 onwards the treated reactor continued consuming the VS. Despite the treated reactors initial VS concentration being higher it ended up with less after the trial by 2.25%

The total consumption in the treated reactor was 16.8kg of VS, in the control reactor a total of 13.7kg was consumed in the same time, a 23% increased consumption of VS, 27% of the Dry Matter was consumed.

Table 2 Results on consumption of VS and ODM in the controlled batch reactors

Trial Consumption Rates in Trial						
	Volatile Solids			ODM		
Date of Sample	Treated	Control		Treated	Control	
25/04/2019	-	-		-	-	
29/04/2019	11.2	10.4	8%	11.2	9.8	14%
02/05/2019	13.5	11.6	16%	13.3	10.8	23%
07/05/2019	14.9	12.2	22%	14.8	12.0	23%
09/05/2019	16.1	12.9	25%	15.9	12.1	31%
14/05/2019	16.8	13.7	23%	16.5	13.0	27%

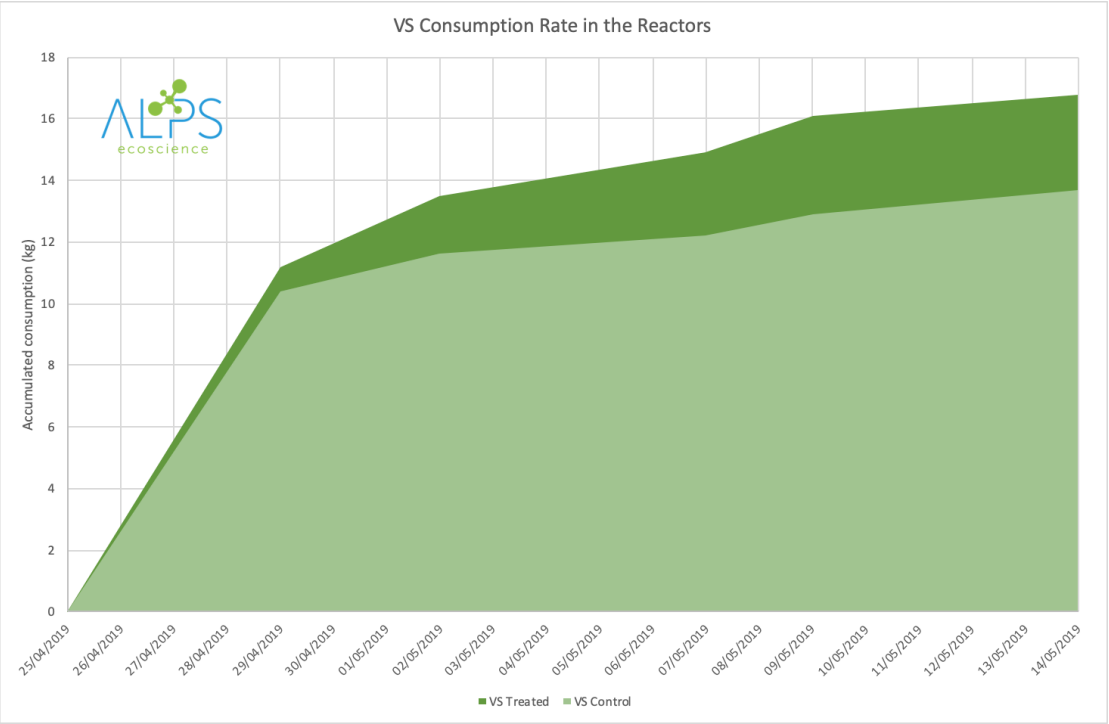
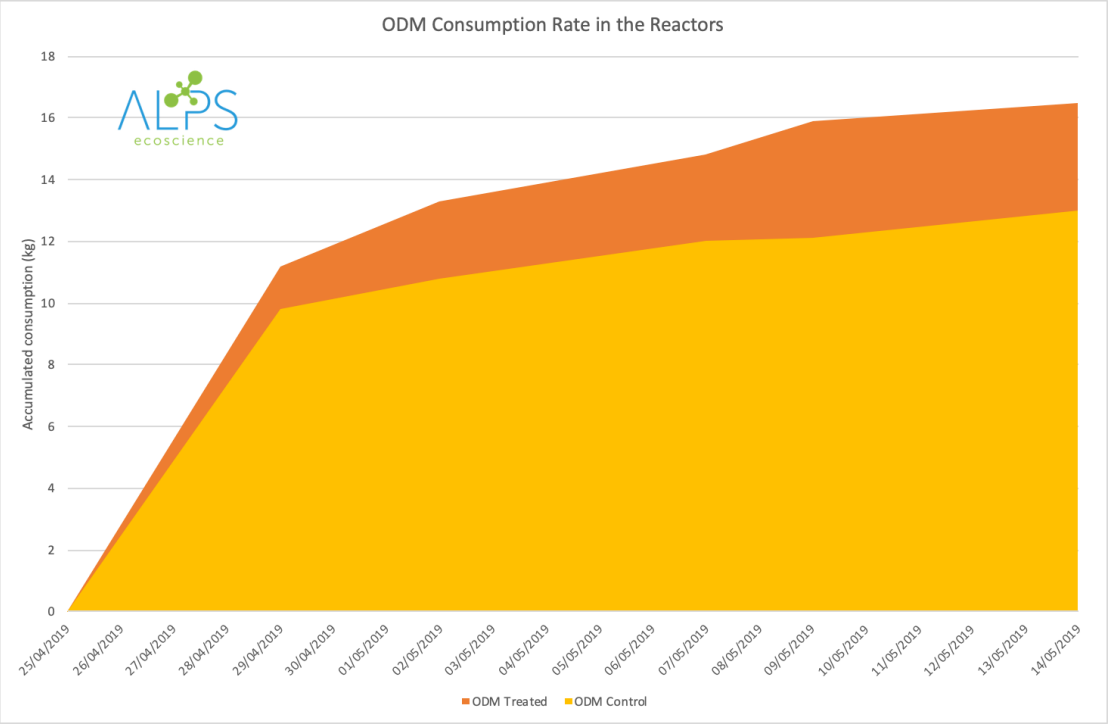


Figure 2 The difference in consumption over time of the VS in the reactors



The BOC has been seen to reduce total nitrogen and Ammonium in wastewater treatment systems aerobically. The trials samples included NH4-N and the results are shown in Figure 4 below.

Initially the Treated reactor “held” the build-up of Ammonia while the control rapidly increased, however the treated reactor rapidly increased thereafter.

The results are inconclusive, but it may be possible through a continued dosing system to hold these levels at a sub inhibition level in the reactor.

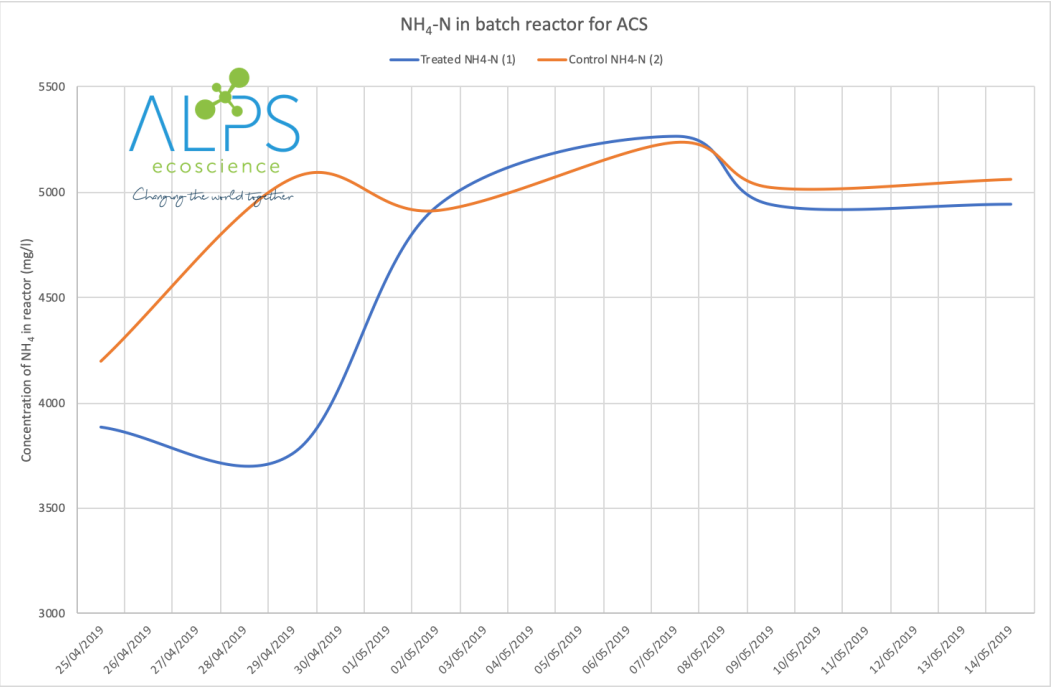


Figure 3 Ammonium results in the reactors

B. SECOND STAGE OF TRIAL

The full-scale treatment started on the 9th May and was dosed using a simple peristaltic pump attached to the IBC.

Results were positive and benchmarked on the 18 months average of the digesters performance. Yield data was analysed as well as certain biological performance in the form of pH and Fostac.

Yield improved 12% from an average of 149M3/T of fresh material to 167M3/T. Daily average gas went from 21,055M3/day to 24,600M3/day an increase of 18%

Methane content increased to 60.11% from 57.95% as shown in Figure 6 below.

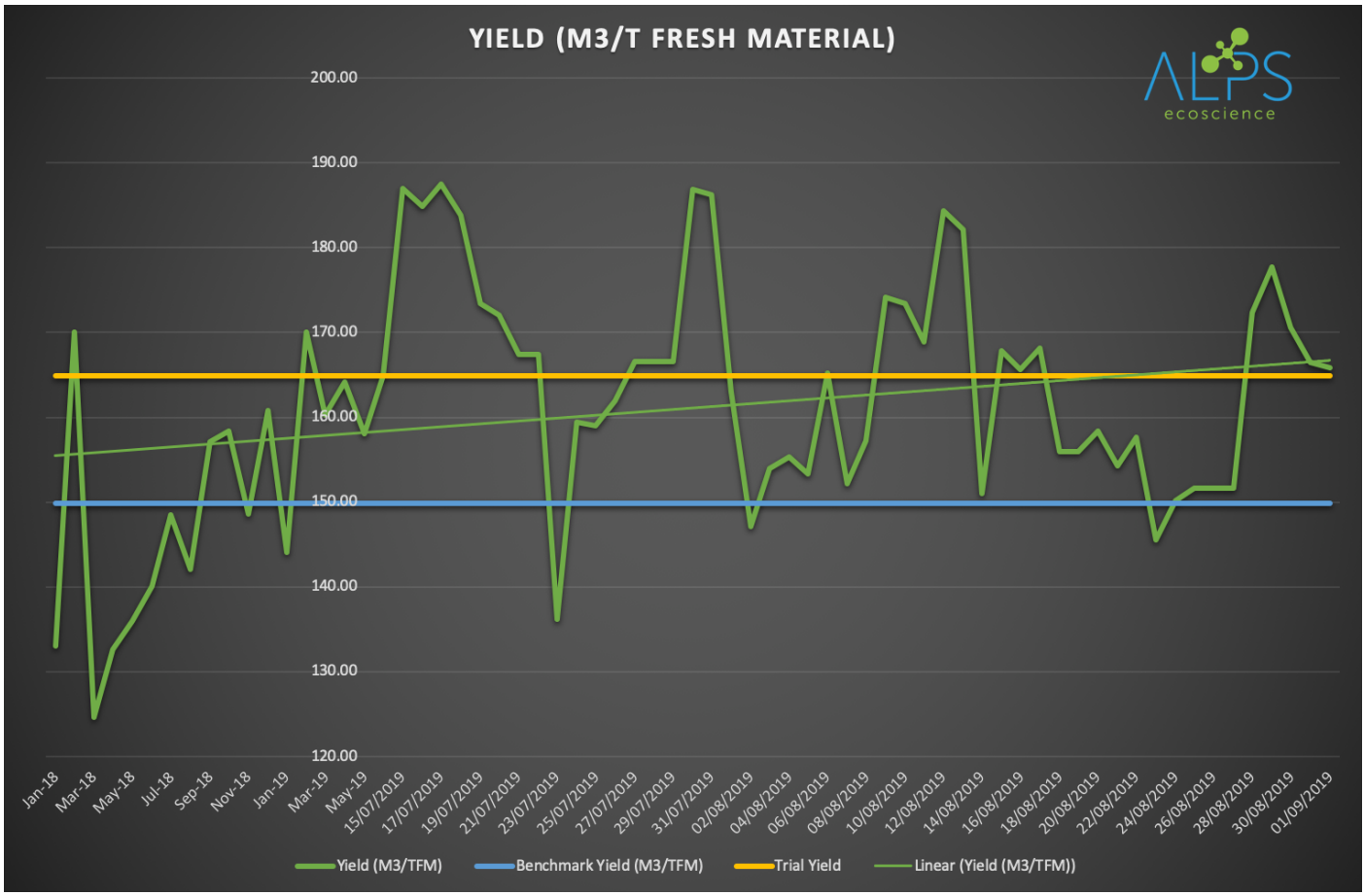


Figure 4 Yield performance data in the trial, average based on 18-month historical average.

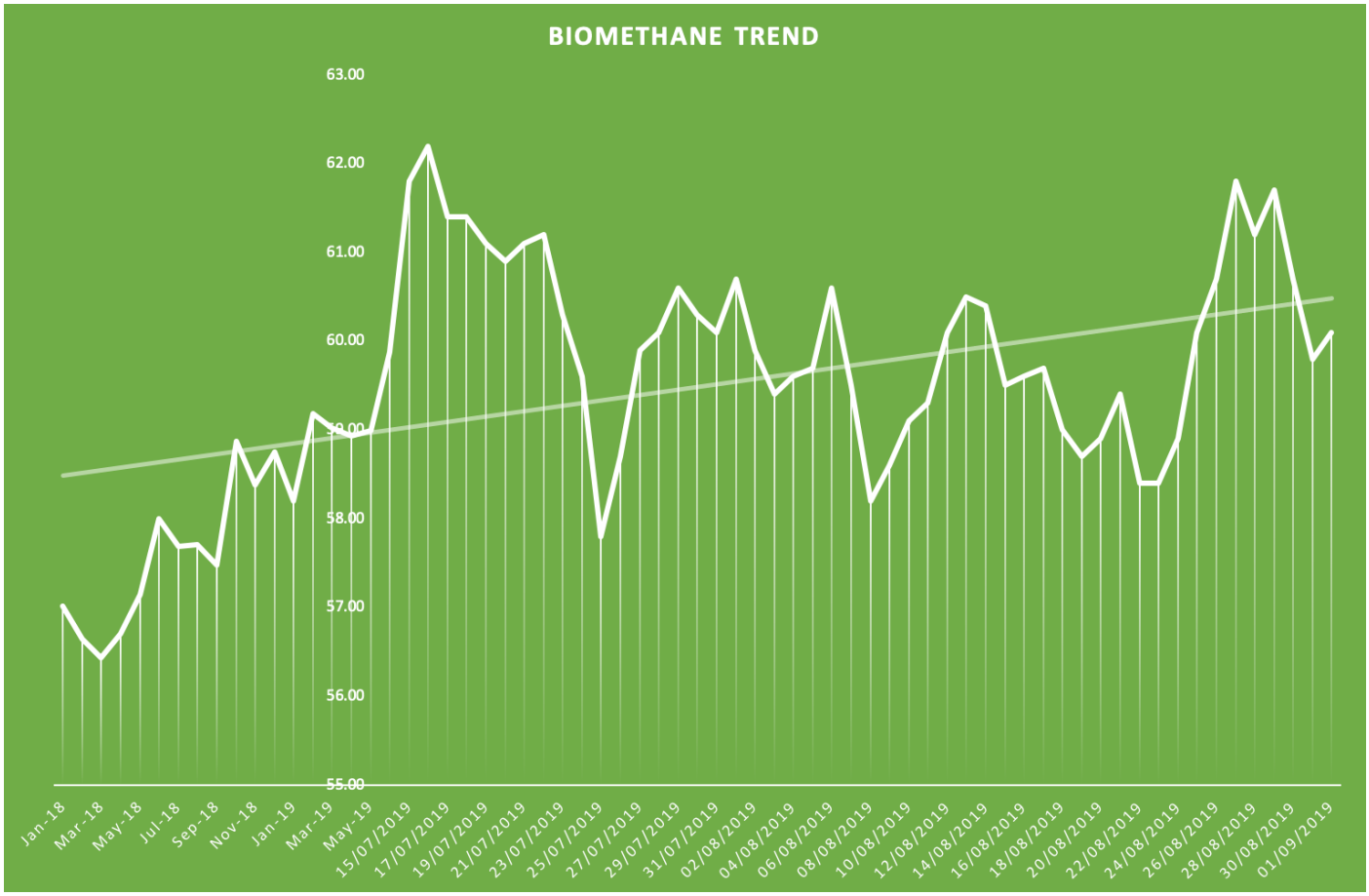


Figure 5 CH4 content in Biogas

6. RECOMMENDATIONS

Commercially the results of the trial show positive possibility. The theoretical financial potential can be summarised as showing a 21% increase in electrical production.

Table 3 Theorical financial potential using trial performance data.

Description	Historical	Trial	Variance	% Variance
Average daily Biogas	21,055.38	24,285.88	3,230.49	15%
Conversion (M^3/kW)	2.03	2.10	0.07	3%
Resultant kW	42,742.43	51,000.34	8,257.91	19%
Average CH4	57.95	60.01	2.06	3.6%
Average Yield	149.89	164.93	15.04	10%
Tarrif	£0.13			
Daily Revenue benefit	£1,073.53			
Treatment (l/day)	16.00			
Unit Cost (£/l)	£12.50			
Treatment Cost	£200.00			
Net Profit after Treat	£873.53			
ROI (Treatment)	5			

Table 3 illustrates potential financial gains with the use of the BOC and suggests a 7:1 ROI. The continued use of the BOC will continue to show commercial relevance as well as biological robustness and over time will balance the digestion process removing and or reducing any digester upsets.