WASTE 4 GENERATION
THE SOLUTION FOR FUTURE GENERATIONS

CASE STUDY 1

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A 5MW anaerobic digestion site based in Northern England, utilising predominantly food waste.

Originally we were brought in due to the high consumable usage (and costs), in addition to the plant struggling to thrive and achieve production targets.

Key achievements:

- Maximum production achieved and on a regular basis (Even throughout the pandemic).
- Implementation of new acceptance procedures and feeding and loading schedule.
- Achieved optimum biological conditions and health within the digesters.
- Optimisation of consumables reducing operational costs and process issues.

Started February 2019 – December 2020
Initial Investigation

Excessive Ferric Usage

- Excessive ferric chloride dosing was used in an effort to reduce H_2S levels, which resulted in a drastic increase in consumable costs and inhibition of the biology.

- It was found that a process design fault led to levels of H_2S up to 20,000 ppm and beyond within the process, which could not be managed by either ferric chloride dosing or the sites' biological treatment facility.

  The above issues were found to be a major contributing factor in restricting electrical production to approximately 50% of the targeted production.

  The unrestrained and detrimental ferric chloride usage resulted in both operational and biological issues, as well as the financial impact of the consumable usage.

  Other issues caused or identified due to the excessive ferric chloride dosing:

  - Pump & pipework failures on the ferric chloride dosing system
  - Inhibition of the biology within the digester (high levels of chlorides as well as heavy metals)
  - Thousand's of £'s of consumables used that was neither budgeted, nor required including activated carbon.
  - Design fault of the process, which lead to H_2S and sulphates being concentrated up and being re-introduced back into the process and biogas.
  - Damage to the CHP engines
  - Biogas monitoring & treatment errors / faulty specification.
  - Bad practices & plant failures leading to crusting and foaming, which was exacerbating the H_2S issues, as the ferric was being dosed on to the crust, preventing it from binding up the H_2S.

- W4G was able to provide the following solutions and optimisation:

  - Resolved the process issues that led to the re-introduction and the concentration of the H_2S back into the process.
  - Providing both a temporary and permanent solution, which would have had a payback period of months, however we were able to demonstrate that it should be covered under warranty.
  - Demonstrated the need for a new ferric dosing system, which was covered under warranty. Optimised ferric usage to improve biology and costs.
  - Improved production with reduced consumable costs. The site achieving maximum production led to hundred of thousands (£) of increased revenue and savings in consumables (ferric and activated carbon).
  - Protected the CHP engine
  - Improved gas monitoring and O_2 dosing issues.
  - Remedied crusting and provided foaming action plans.

Undesirable Feedstock

- Like many plants, there is intense competition for feedstock, especially in regions overpopulated with AD plants, which not only limits the available feedstock, but also drives up the price per tonne (£/tonne) of the feedstock/waste.
- Plants require both volume of feedstock (HRT) and quality of feedstock (OLR) to optimise production, too much either way produces poor results.
- By assessing each individual feedstock, it's frequency as well as its characterisation, allowed us to remove any feedstocks which were detrimental to the blend, and allowed us to improve digester health.

Highly Inhibited Digesters

- As shown on the graphs following, an initial analysis undertaken on the digesters found the digesters to be highly inhibited.
- This was due to the excessive ferric chloride dosing, undesirable feedstocks and the complete absence of acceptance testing.
- There was also a lack of awareness to the inhibitory characteristics of a number of feedstocks.
- For each inhibitor identified, we established baseline levels in each feedstock, to generate a feedstock blend moving forwards that would drive the concentrations down, and eventually maintain them within healthy levels.

Unable to Reach Production Targets

- Along with H_2S, we reviewed and amended the loading and feeding rates, retention time and the composition of the feed to the digesters.
- This included optimising mixing, reducing inhibition & supplementing nutritional deficiencies, which all contributed to achieving maximum production targets.

Design Issues & Site Procedures

- Initially fundamental design faults of the facility and the process were identified and reviewed, and solutions were implemented to achieve maximum production including
- Implemented batch feeding regime due to capacity issues
- Feedstock management
- KPI adjustments
- H_2S treatment & management
- Acceptance procedures, new sampling & analysis procedures and management

Initially production was approx. 2.2MW but could not be sustained where full output of 5MW had not ever been achieved

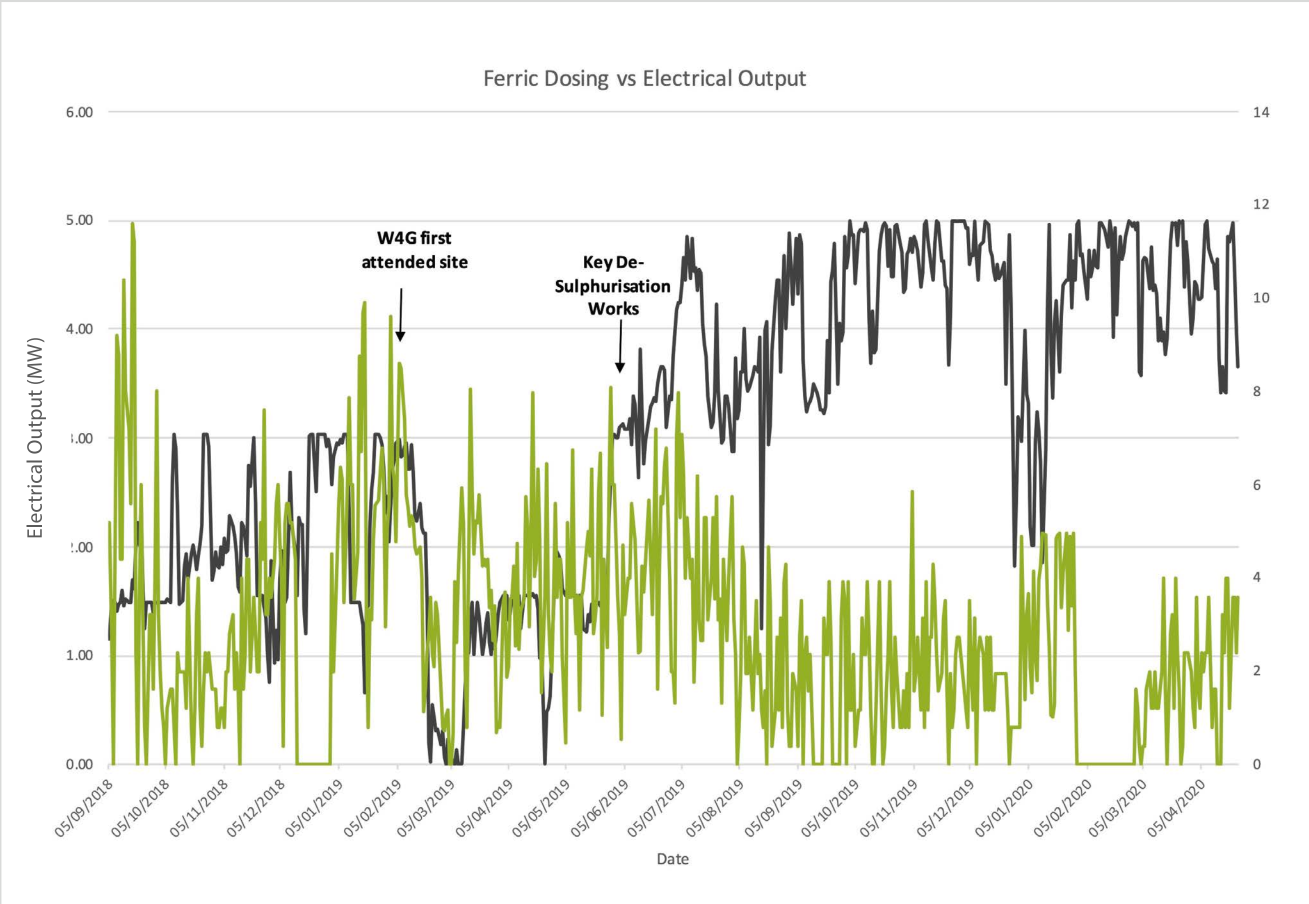
• Over-use of ferric saw over 20 tonnes a week being used, poisoning the digesters, let alone the sheer cost associated with this usage.

• Since then we have introduced a reduction in ferric chloride usage, in small part supplemented by the addition of iron hydroxide dosing.

• Maintaining safe digester temperatures prevent a re-occurrence of a previous incident prior to our arrival where the digesters were in excess of 45 degrees Celsius, and this destroyed the bacterial colony (not thermophilic).

• Guided the operator through key maintenance work which would have typically meant a plant shut-down and considerable loss of revenue, maintained maximum throughput of gas, and electrical production for the plant's reduced capabilities.

• Resolving biological and operational issues to achieve maximum electrical production for the site.

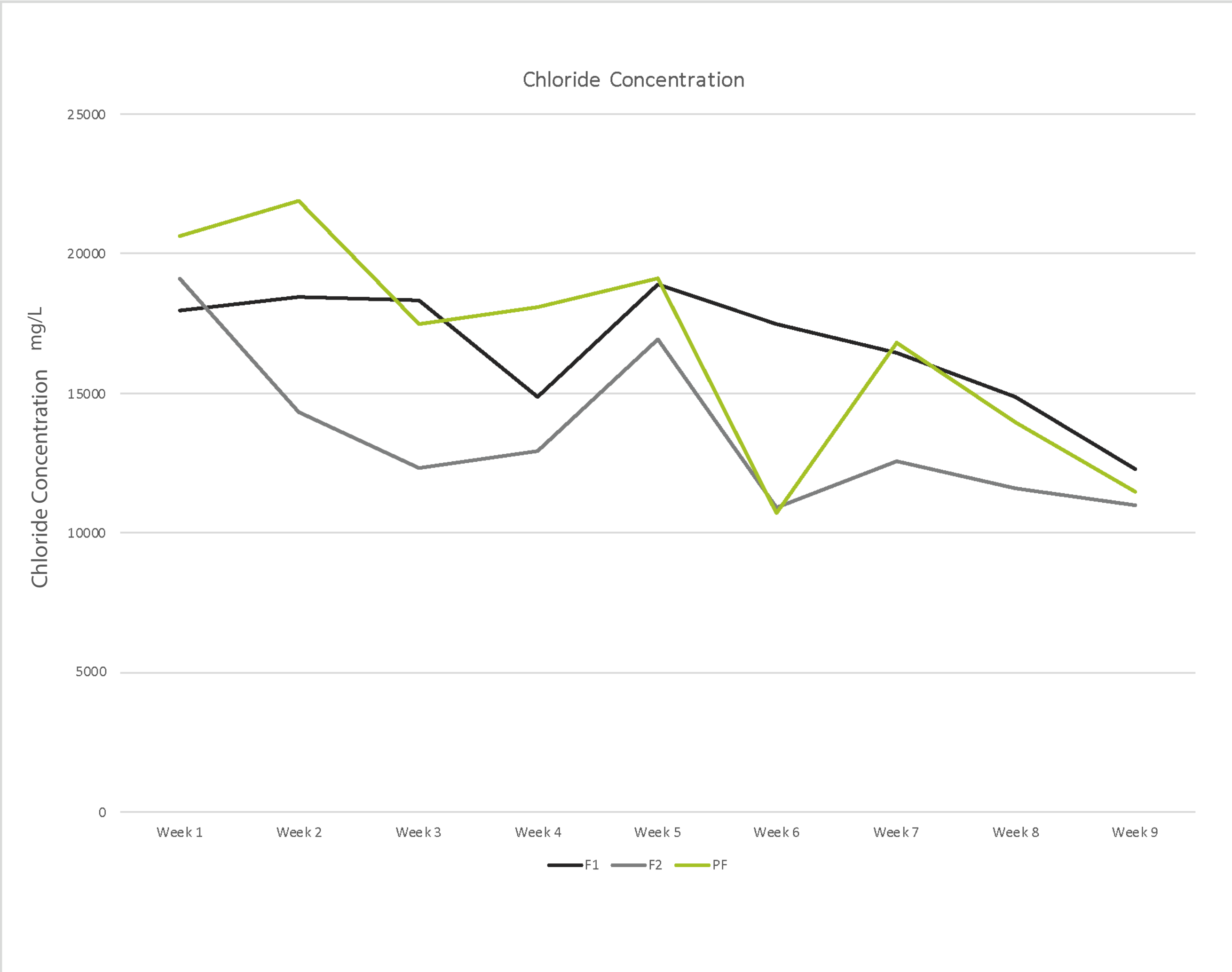


Significantly reduced ferric dosing whilst increasing plant loading and electrical production output.

Output began increasing as remedial work to the H_2S treatment system were completed, and as the concentration of inhibitors present within the digesters were reduced.

We progressively reduced the ferric chloride dosed to the system, both reducing the chemical costs and inhibition of the process, optimising H_2S treatment via ferric chloride and hydroxide, optimising the O_2 dosing and the biological treatment of the H_2S.

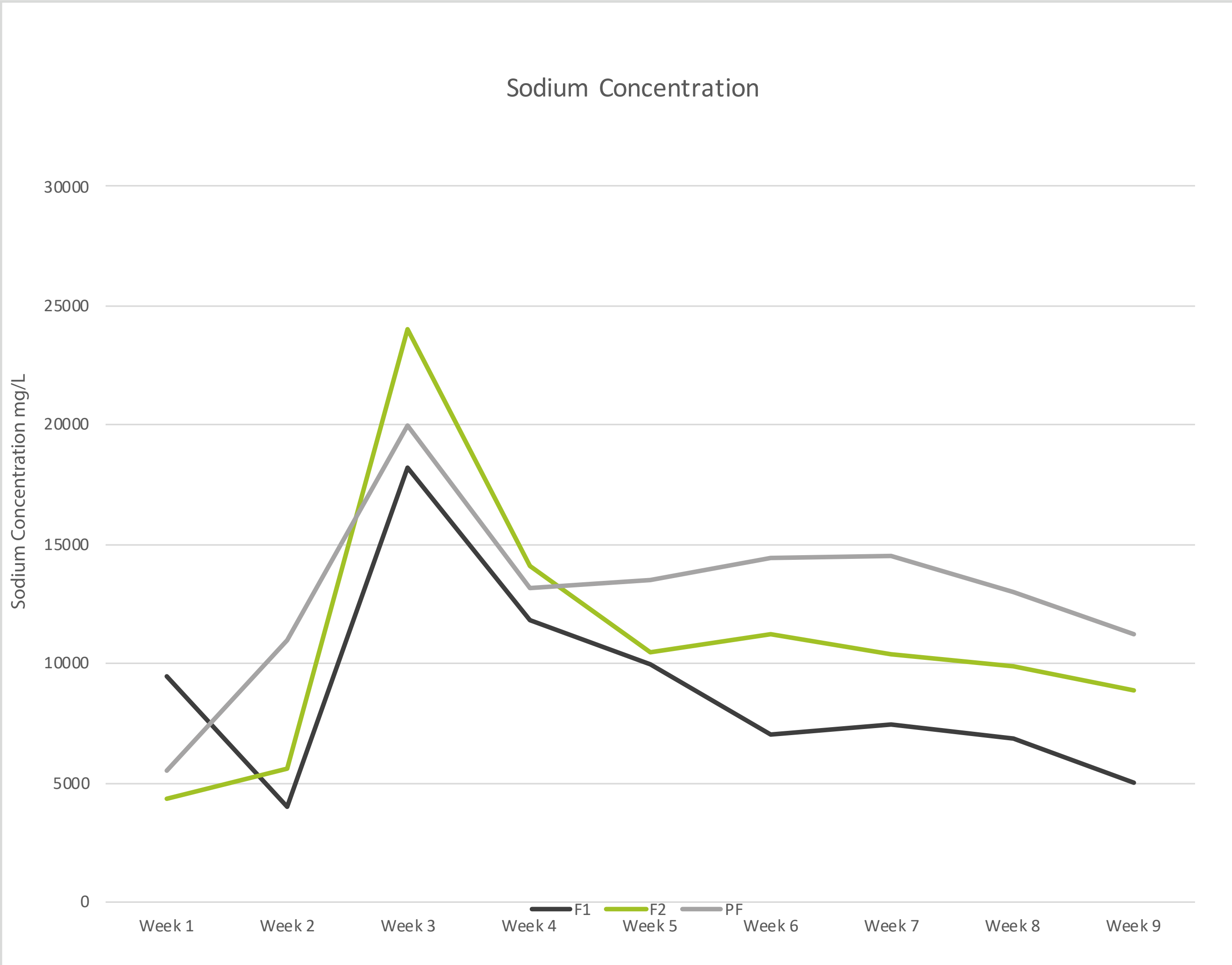
We were able to sustain these reduced levels even whilst we were increasing production, and maintaining reduced H_2S production, as well as reducing consumable costs (and usage), and optimising the biological conditions.



Due to the excessive ferric chloride usage for H_2S control, the chloride concentration within the digesters was extremely high.

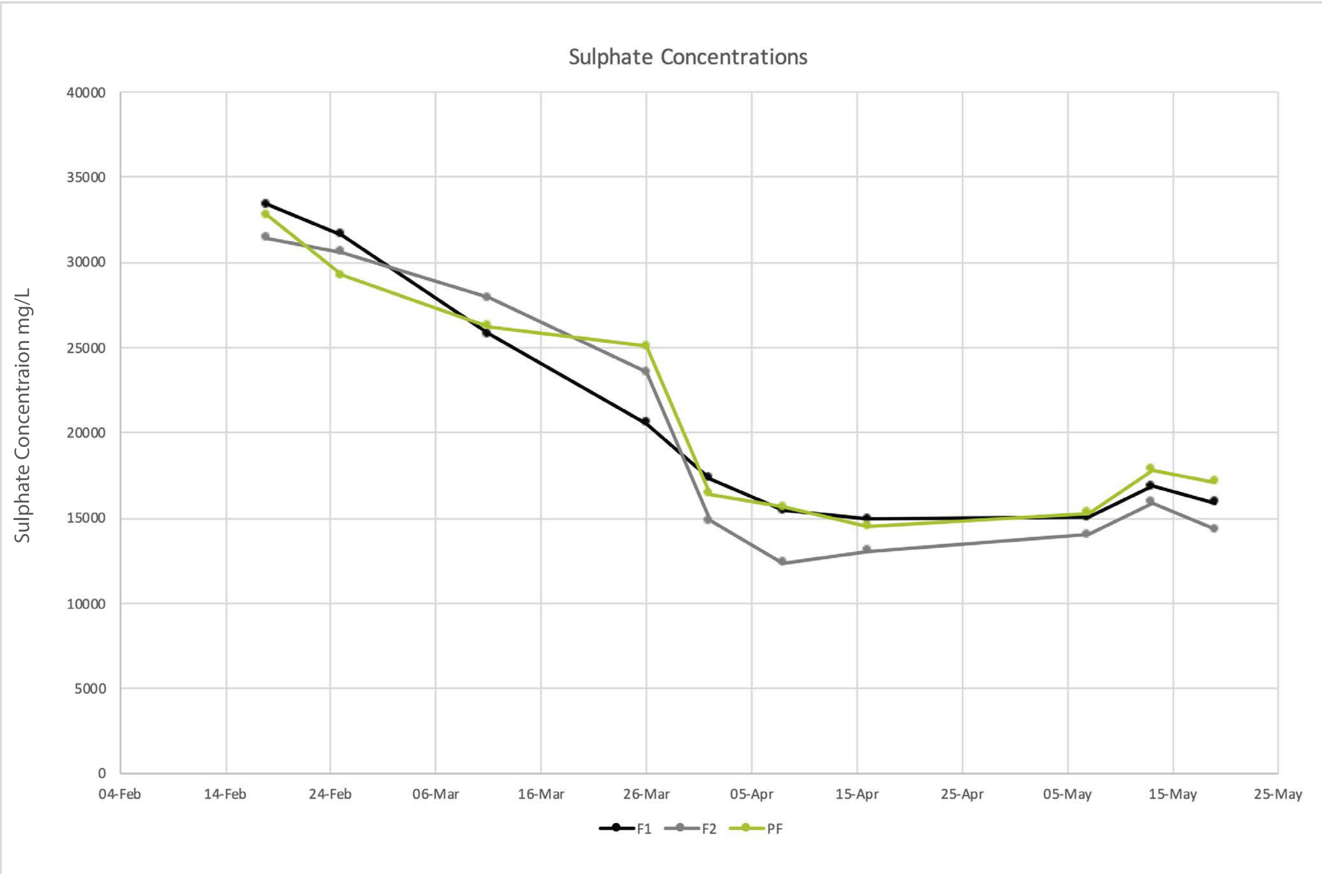
Individual feedstocks were analysed for chloride, and many were found to contain to have high chloride concentrations, many containing excess cleaning chemicals, which were both undesirable and not monitored going on to the plant.

As well as reducing the ferric chloride dosing, we adapted the feedstock recipe to remove harmful waste streams, and produce healthier digesters for the bacteria.



Initially, the sodium concentrations were not excessively high within the digesters. However, within days of us beginning to look into these digesters, the client was offered a high volume of 'good quality feedstock' which needed to be moved quickly.

The client took in a large quantity of waste containing an extremely high concentration of sodium, which was sufficient to raise the concentration of the digesters in the space of a few days. Our next time on site, we identified both the increase within the digesters and also identified the cause, and put the relevant control measures in place to bring the digesters back in line.

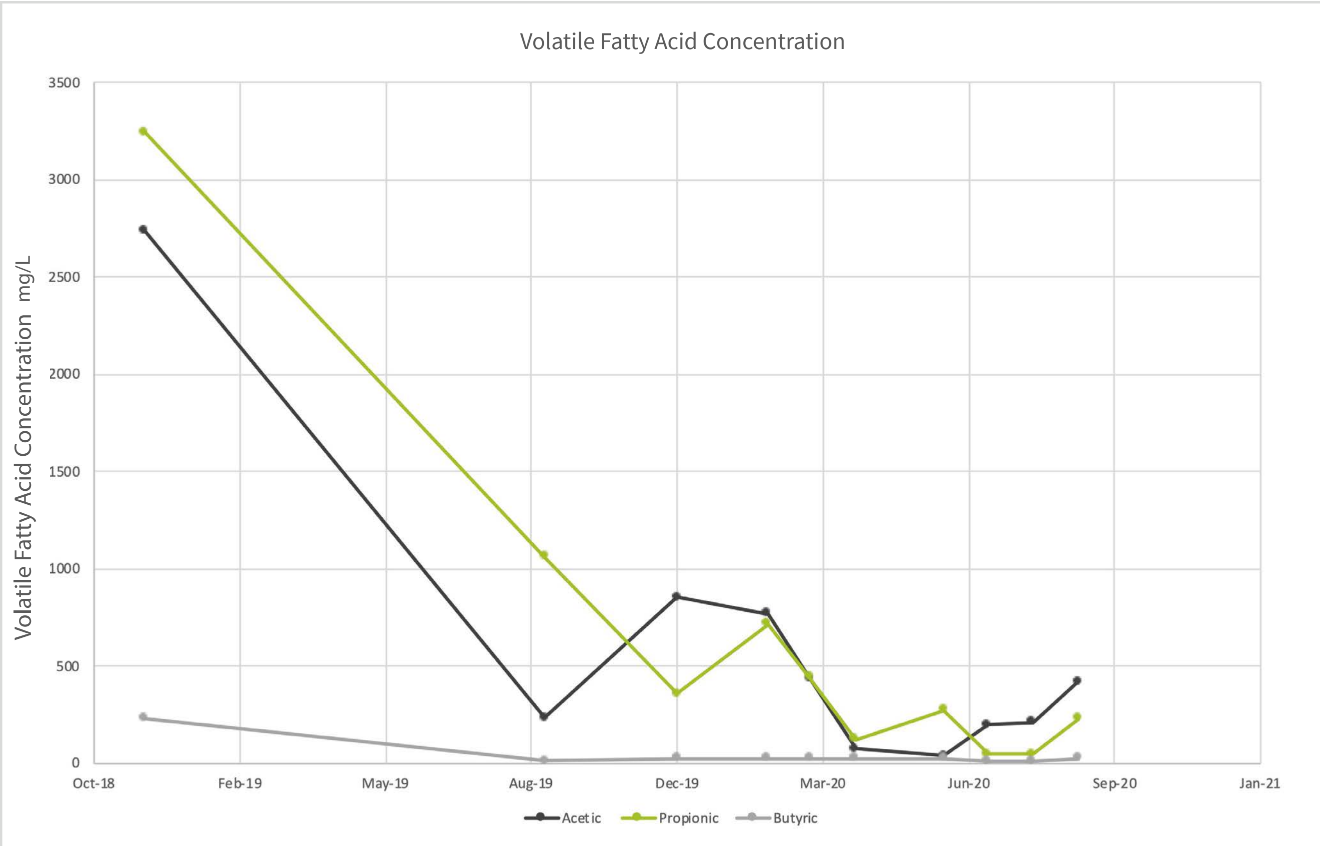


Over the course of 3 months we substantially reduced the sulphate concentrations within the digester.

Less sulphate within the digester means less sulphate available to be converted to H_2S within the digesters.

A significant overhaul and assessment of each feedstock (and their individual benefits), lead to us re-vamping the feedstock recipe to a better suited combination.

Manage conditions within the digesters away from the optimum conditions (for the sulphate reducing bacteria as opposed to the other anaerobic bacteria present) to minimise the conversion of sulphate loading to below 10% (where it had been in excess of 20%) as well as managing the sulphate loading itself.



Every AD digester has a different acid profile, and understanding them is key to improving the plant's production.

At this site, there was a build-up of both acetic acid and propionic acids, indicating inhibition was preventing them from being converted to biogas.

Propionic acid itself is inhibitory at high concentrations within anaerobic digesters, so it is vital to reduce these levels to improve the digester's health.