



Boosting Value from AD

Optimisation Strategies to improve ROI of
your AD Plant

DR FRANK WAYMAN, ALPHEUS TECHNICAL & INNOVATION MANAGER

About Alpheus

part of the Anglian Water Group

For over 30 years the Alpheus team have been helping customers to deliver operational efficiencies, extend asset lifecycle, achieve compliance and increase resource reuse for a sustainable future.

Our Expertise

WATER TREATMENT

WASTEWATER TREATMENT

ANAEROBIC DIGESTION (AD)

WATER RECYCLING & REUSE

Our Services

OPERATIONS & MAINTENANCE

ENGINEERING & DESIGN

CONSTRUCTION & DELIVERY

LIQUID WASTE RECYCLING



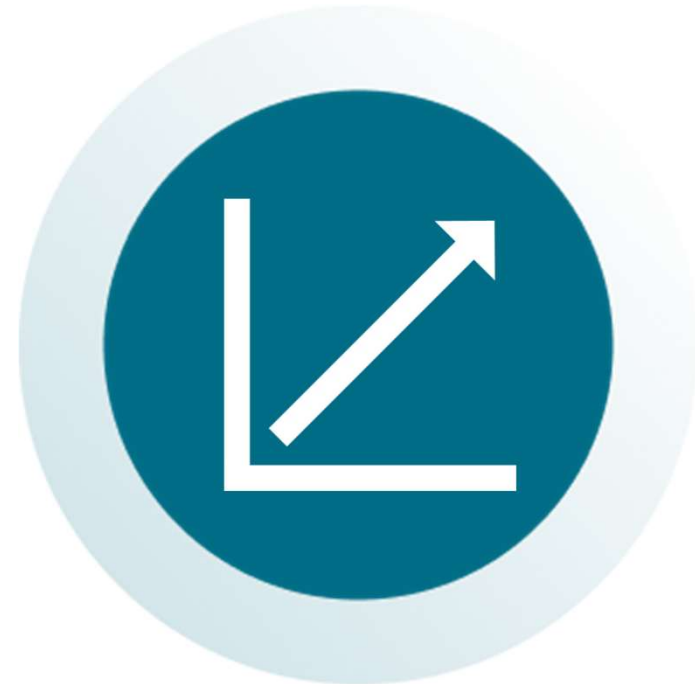
Let's start with you...

What brings you to the session today?

PERFORMANCE



CAPACITY

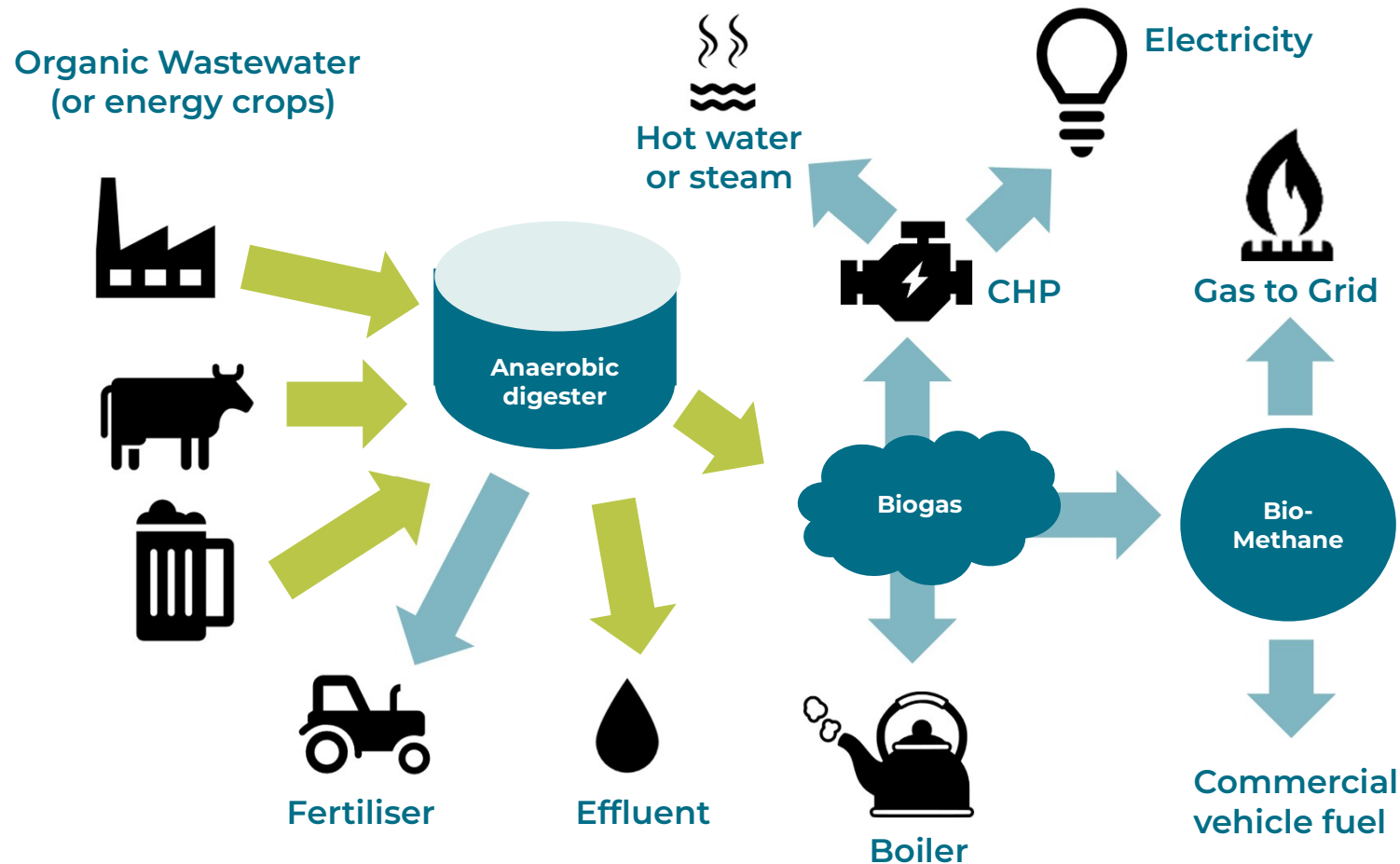


You'll leave with

1. An understanding of the science behind AD.
2. Key areas and tactics to improve value delivered from AD plant.
3. Where investment or operational changes could deliver value.
4. Real-life examples of optimisation in action, and the value it has added.
5. Some bullet points to aid your performance investigation



Anaerobic Treatment of Waste

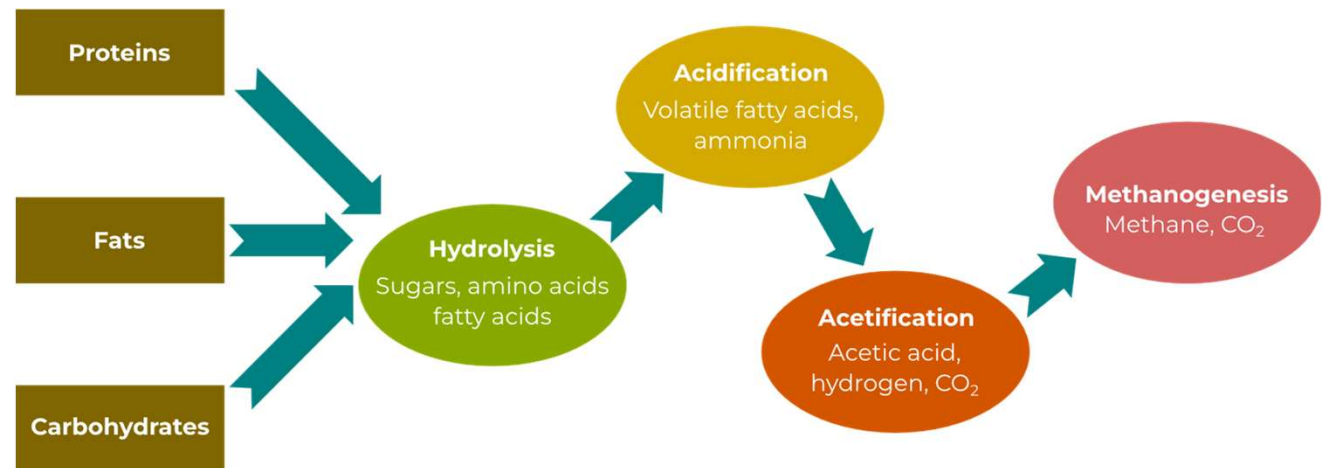


Opportunity: Understanding your technology, gas production capacity and site needs can identify additional value.

Anaerobic metabolism

Anaerobic digestion (AD):

The conversion of organic material by micro-organisms to methane and CO₂, in the absence of oxygen.

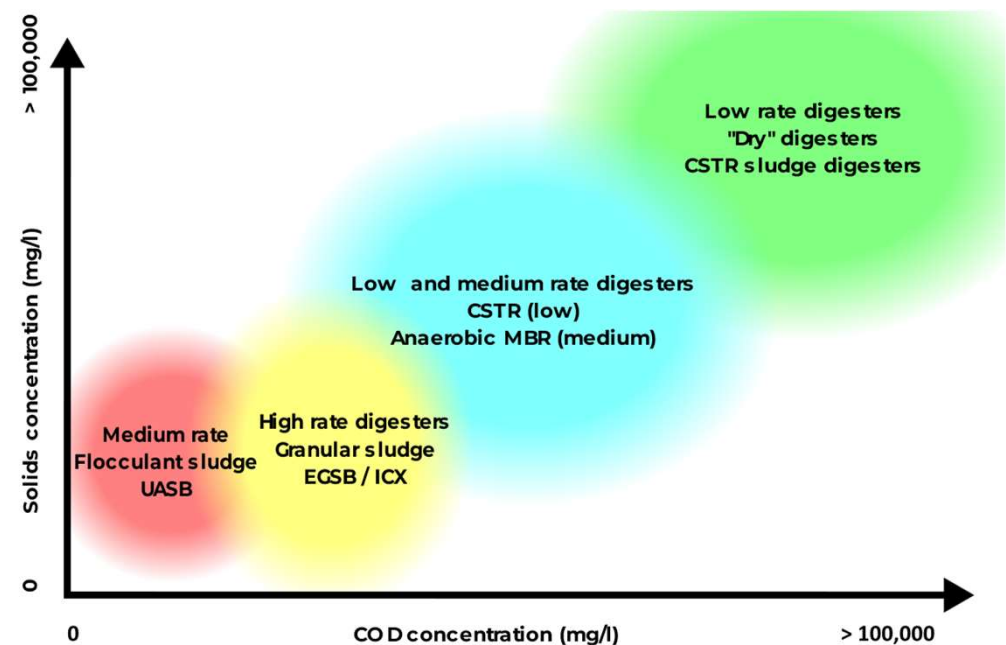


Anaerobic Technologies

Every site is different, and the potential improvements and outputs will vary, due to factors such as:

- Wastewater composition
- Production volumes
- Reactor type
- Energy and consumables required
- Operational resource

The optimisation opportunity will depend on your plant type, and in some circumstances, changing to a different technology can vastly improve ROI.



Optimal Effluent Quality = Optimal Performance

Optimising what you have

Daily checks and monitoring of operational parameters and analysis of the output to maintain health and optimise system performance:

- Wastewater analysis: Influent and effluent – through each stage of the treatment process
- Equipment and instrumentation
- Energy use
- Biogas output/quality
- Feed selection

IMPORTANT

- ✓ Good communication between the waste producer and the treatment plant operators.
- ✓ The knowledge and experience from a specialist to support optimisation and improvements can add significant value, due to the complex nature of AD systems.



Wastewater & Lab Analysis

These are critical process controls that directly impact the health, efficiency, and ROI of AD plants.

Feedstocks will always vary due to production issues, seasonal changes, and cleaning schedules. These require dynamic operational adjustments.

Laboratory strategies for maximising AD performance

- Tailored Wastewater Analysis
- Feedstock Profiling
- FOS/TAC Ratio Monitoring
- Micronutrients

Over-measurement is a waste of money, but under-measuring can hit profits too.



VFA / Alkalinity (FOS/TAC) ratio

A simple measure that tells you if everything is okay

- Exact figure depends on plant specifics
- Generally speaking, a value of 0.3 or less is healthy, and 0.4 or more is stressed

The equipment is cheap to buy and operate and provides valuable information.

It should be used at least daily, possibly twice a day for high-rate processes.



Metalloproteins and micronutrients

Methanogens are *Archaea*, not bacteria. They date from the time of the earliest life on earth, when there was no oxygen in the atmosphere.

They have a metabolism quite unlike aerobic life forms and have special combinations of metals and peptides bound together to catalyse biochemical reactions.

- **Molybdenum** and/or **tungsten**, alongside sulphur are vital for release of methane from coenzyme M.

H																		He
Li	Be												B	C	N	O	F	Ne
Na	Mg												Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	

- **Cobalt** and **selenium** are essential for the metabolism of single-carbon groups.
- Manganese, **nickel**, copper and zinc also have biological function.

These trace metals may not be present in feedstocks derived from animals and plants.

Checking in on AD metabolism

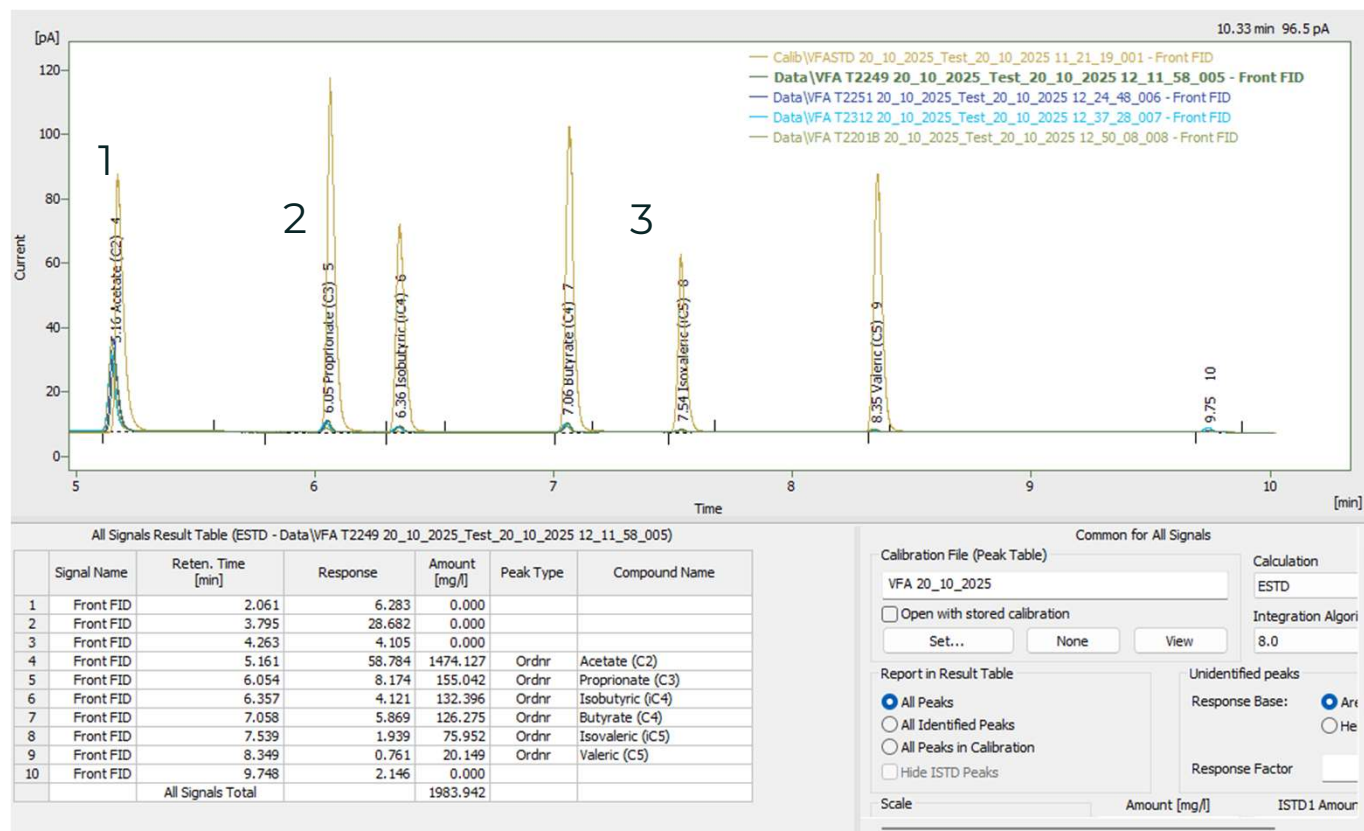
Advanced Fatty Acid Analysis

On-site gas chromatography, though underutilised due to upfront costs, provides low-opex, high-value insights, especially for sites with unusual or complex feedstocks.

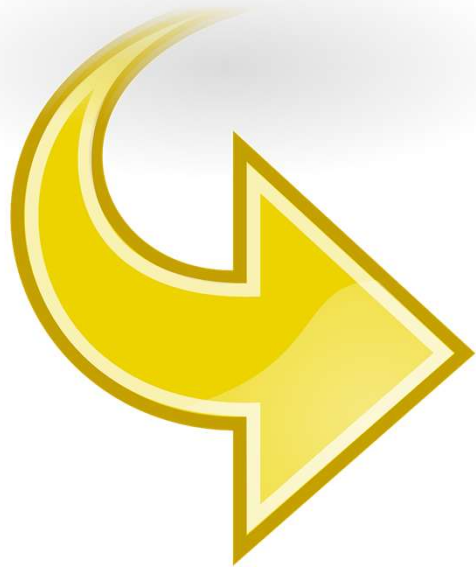


VFA chromatogram

1. **A high C2 peak indicates Mo or W deficiency**, as acetyl groups cannot release carbon as CO_2 .
2. **A high C3 peak indicates Co, Se deficiency**, as propionic acid levels will build up if methyl transfer is blocked
3. **All peaks high indicates another issue**; this could be a deficiency, toxicity, overfeeding or incorrect process conditions.

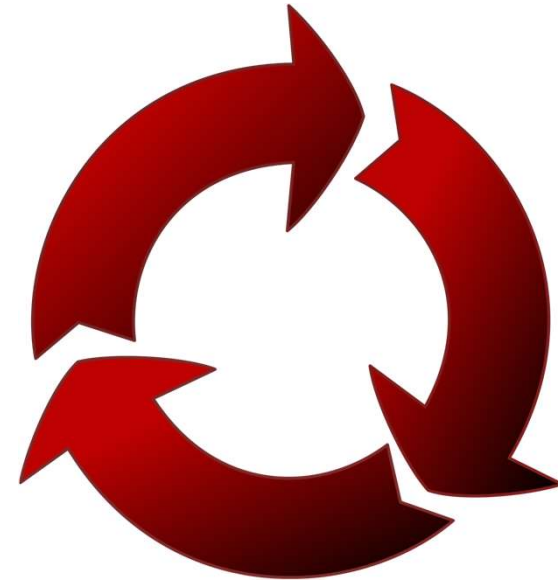


Maximising Efficiency



**Improve inlet
management for better
biogas utilisation**

**Heat incoming
wastewater with waste
heat to save biogas**



Cleaning up the biogas



Reducing H₂S content can improve efficiency, performance and lengthen asset life

! High hydrogen sulphide levels in biogas can damage boilers and CHP units, leading to increased maintenance and reduced lifespan. Very high levels can be toxic to micro-organisms, reducing output.

TREATMENT OPTIONS

Pre-AD Reactor (inlet treatment):

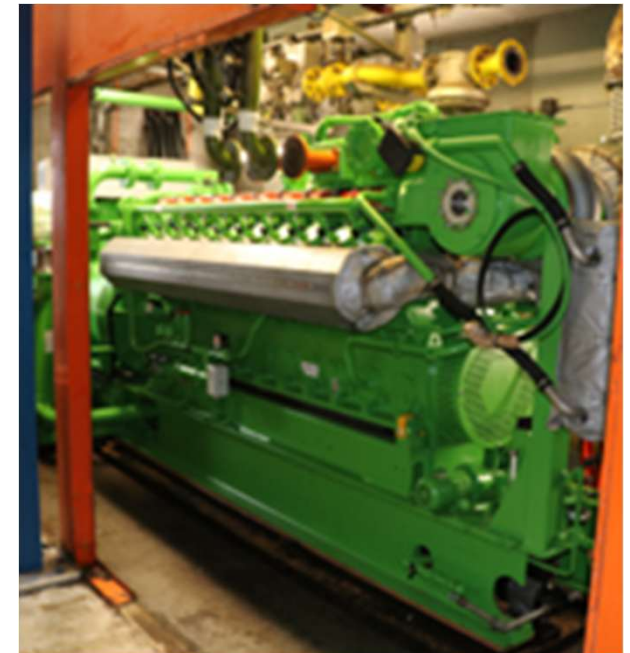
Chemical dosing to reduce hydrogen sulphide formation.

Post-AD Reactor (biogas treatment):

Biological or chemical scrubbing to clean biogas before use.

Benefits of process review & optimisation:

- ✓ Enhanced efficiency of boilers/CHPs.
- ✓ Reduced operational and maintenance costs.
- ✓ Potential for delivery of cost savings and improved ROI.



Secondary Revenue Streams



Import (more) waste for treatment

From other sites or third-party sites.



Export biomass for resale

This can be sold as a starter for similar systems.



Biogas / utilities export

These can be sold back to the grid or to a 3rd party.

System upgrades for improved ROI

Whilst the majority of plants are built with extra capacity for growth (normally 10%), upgrades may become beneficial over time:

- Ageing assets or poor performance
- Production increases and changes in wastewater composition
- Waste and byproduct reuse
- Opportunities identified through analysis and monitoring



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Case Studies

Hain Celestial

Previous issues:

- Poor treatment performance with high Mogden TE costs
- Underused CHP
- Need for capacity increase

Following a feasibility study, we proposed:

- An ICX reactor (granular sludge AD) for the treatment of the totality of the wastewater with a 20% allowance for flow and load expansion
- The installation of a gas buffer to optimise gas flow control before the existing CHP
- A sugar extraction system from the existing waste jam stream

Other minor system upgrades, such as:

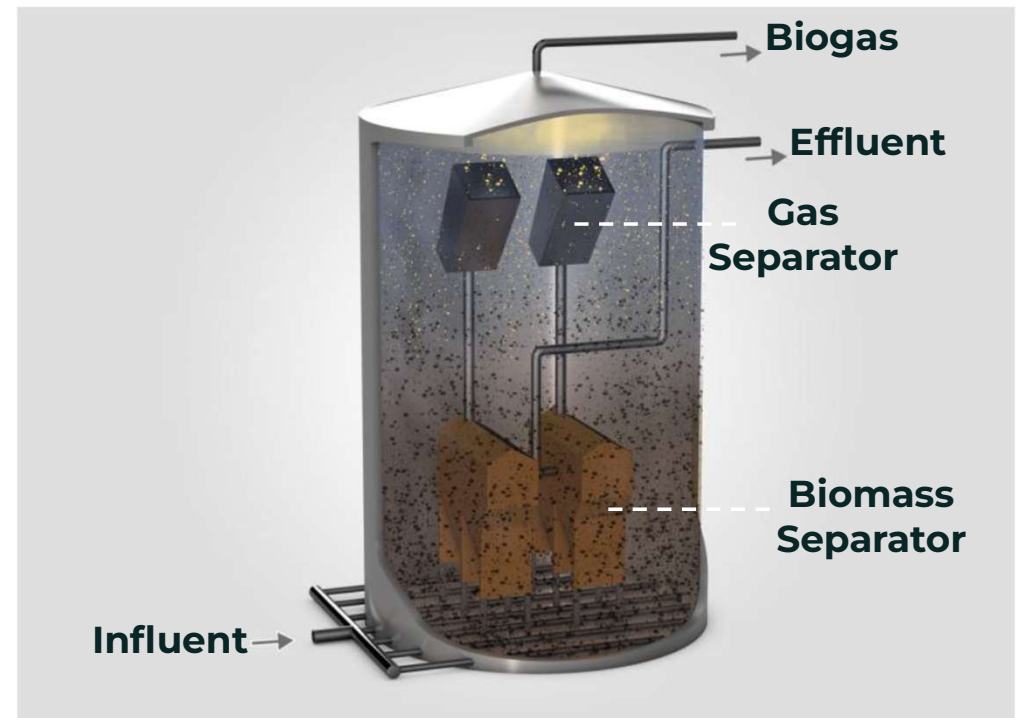
- Balance tank mixers
- Micronutrient dosing



Hain Celestial

ICX REACTOR

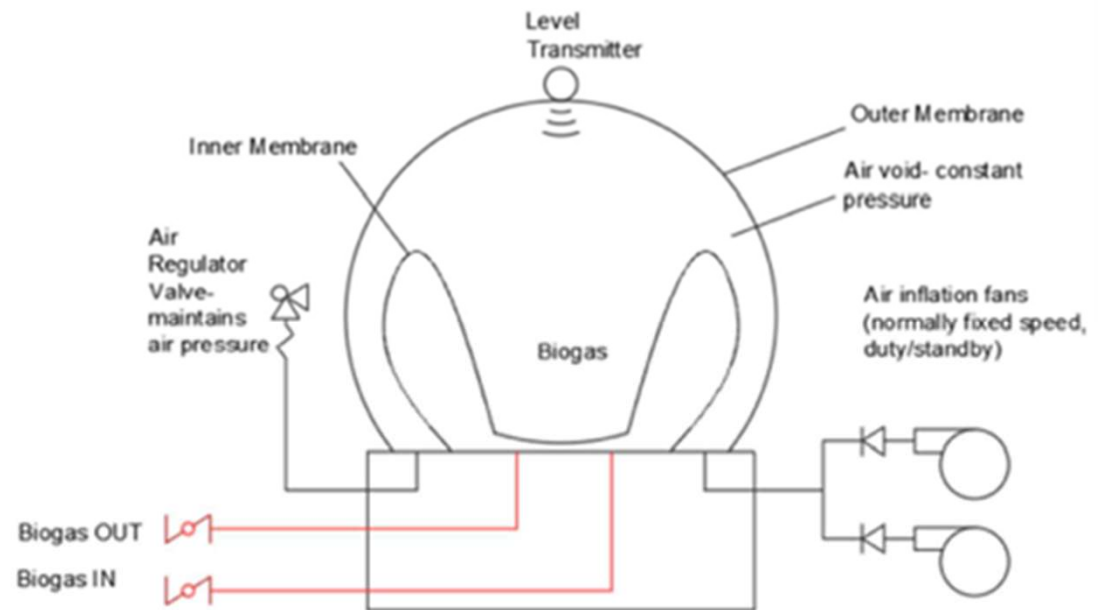
- BAT for the treatment of this type of wastewater (high sugar, low solid content)
- Very low hydraulic retention time that minimises system footprint
- High organic load removal, translating into high biogas yield, and reduced COD discharge.
- Very slow biomass generation, which can be stored and sold for feeding other similar granular-type reactors.



Hain Celestial

GAS BUFFER

- Biogas production is never constant as it depends on the quality of the inlet wastewater
- Previously, any excess biogas that could not be used immediately had to be flared
- Installing a gas buffer gives room for flexibility and allows a constant biogas flow to sites CHP/Boiler systems
- Maximise the biogas utilisation while minimising biogas wastage



Hain Celestial – Jam Injection



... an example of an occasional treat, allowable within a healthy and balanced diet (just like AD!)

JAM INJECTION SYSTEM

- A waste stream was identified by Alpheus as a useful extra feedstock to enhance biogas production.
- The reactor was designed with 20% additional capacity, to accommodate this stream
- A sugar extraction system was installed to extract all the useful part of the stream without keeping the part that will create problems in the system (high solids)
- The extra load is used when the factory production is low. This way the inlet organic load is always maximised.

Performance gains and ROI



- 90% COD removal (vs. 80% target) → improved effluent quality and reduced discharge costs.
- Over 1,250 m³/day biogas generated → 13% of factory energy demand met.
- Energy and discharge cost reductions reduced the payback period from 3.2 to 2.2 years.



Innovation & Value Recovery

Overperformance has made a second CHP viable → further energy savings expected.

The Glenmorangie Company



OPTIMISATION

Glenmorangie's anaerobic MBR was still running under commissioning parameters

- The site needed additional gas as it was a significant cost for running its boilers.
- Chemical usage was high, particularly for scrubbing biogas.
- Distillery shutdowns had a huge impact in the AD plant.
- Maintenance needed to be planned in with minimum production impact.

The Glenmorangie Company



BIOGAS SCRUBBER – ENGINEERING STEP CHANGE

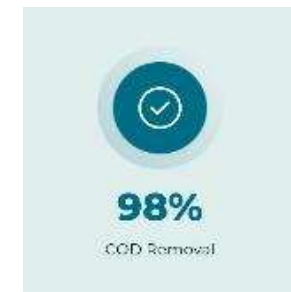
- The biogas quality from the existing reactor is very high in H_2S , making it impossible to inject into the existing boiler.
- The site used a chemical scrubber for its desulphurisation, but caustic soda costs were high.
- Alpheus proposed a biological scrubber with low operating costs, and a lower environmental impact.
- As a result, chemical consumption has been minimised while providing the necessary desulphurisation levels to allow use in the site's boiler.
- Up to £2,200 per week in caustic soda costs have been saved.

The Glenmorangie Company



OPTIMISATIONS INCREASE BIOGAS OUTPUT BY A THIRD

- Implementing a full site review and establishing a continuous improvement cycle for process and asset management increased the percentage of biogas supplied to the boiler by a third - up from 15% to 20% of total site gas demand.
- Ongoing innovation and optimisation as part of our operating philosophy, which included the hibernation and restart of the AD plant in response to the COVID lockdown, which saved the client over £100,000.



Major Pharmaceutical Manufacturer



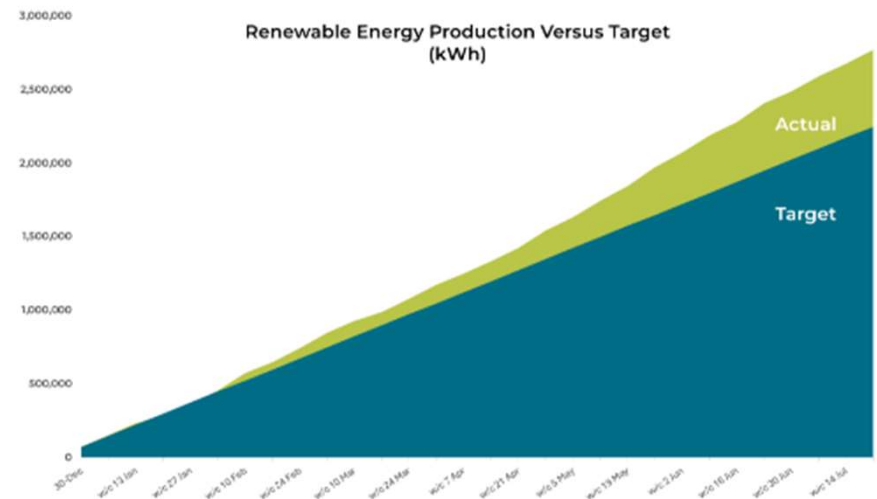
Major Pharmaceutical Manufacturer

Recent optimisations and tank cleans have driven a 23% boost in renewable energy production, exceeding energy targets by over 520,000 kWh.

- Major digester tank maintenance
- Infrastructure upgrades & feed management
- Optimised maintenance scheduling
- Transfer of CHP operations to Alpheus

This boost was achieved despite client production levels being lower than originally planned.

Overall benefit to client - £ 150,000 annually



Feasibility Studies & Design

A Feasibility Study typically incorporates:

- ✓ Project Goals Consideration
- ✓ Assessment of existing infrastructure
- ✓ Analysis of the options (incorporating best available technology).
- ✓ Financial Analysis
- ✓ Recommendations
- ✓ Annexes or appendices (including flow charts or more details diagrams)

The next steps

- ✓ Preliminary Design/Conceptual Design (develop a basis of design, a cost estimate and a project schedule).
- ✓ Detailed Design Study (develop a complete and final design package with an accurate cost and a detailed project execution plan).

Improve ROI of your AD Plant

Operations

- Understand the underlying science
- Measure the right things
- Keep the process conditions optimal
- Put in the right stuff

Design

- Were key components omitted to save costs?
- Identify bottlenecks
- Opportunities
- Increases in size can dilute overheads (within reason)

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Questions?



Get in touch



enquiries@alpheus.co.uk



01234 686100



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