CASE STUDY

MICROBIAL MATRIX

Understanding the biological needs and limitations of microbial populations within anaerobic digestion to boost performance.

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2024

DIGESTER DOC
Simplifying Anaerobic Digestion.

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MICROBIAL MATRIX

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Project **Background**

Analyzing the microbial populations to diagnose issues and recommend strategies for the digester's recovery.

Digester Doc was engaged to evaluate the microbial community in a collapsed anaerobic digestion (AD) influent sample. Typically, effluent is used to test the health of a digester. The primary objective of this study was to analyze the microbial populations to diagnose issues and recommend strategies for the digester's recovery. The assessment employed next-generation sequencing (NGS) to profile the microbial DNA present in the sample, revealing key insights into the microbial dynamics within the digester.

STUDY CONDUCTED 2024

Conducted by:
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Amy R. Hall, MS, Director of Sciences | Digester Doc

By understanding the specific microbial species in an anaerobic digester, process parameters can be tailored to promote the growth of beneficial microorganisms and potentially suppress inhibitory species.

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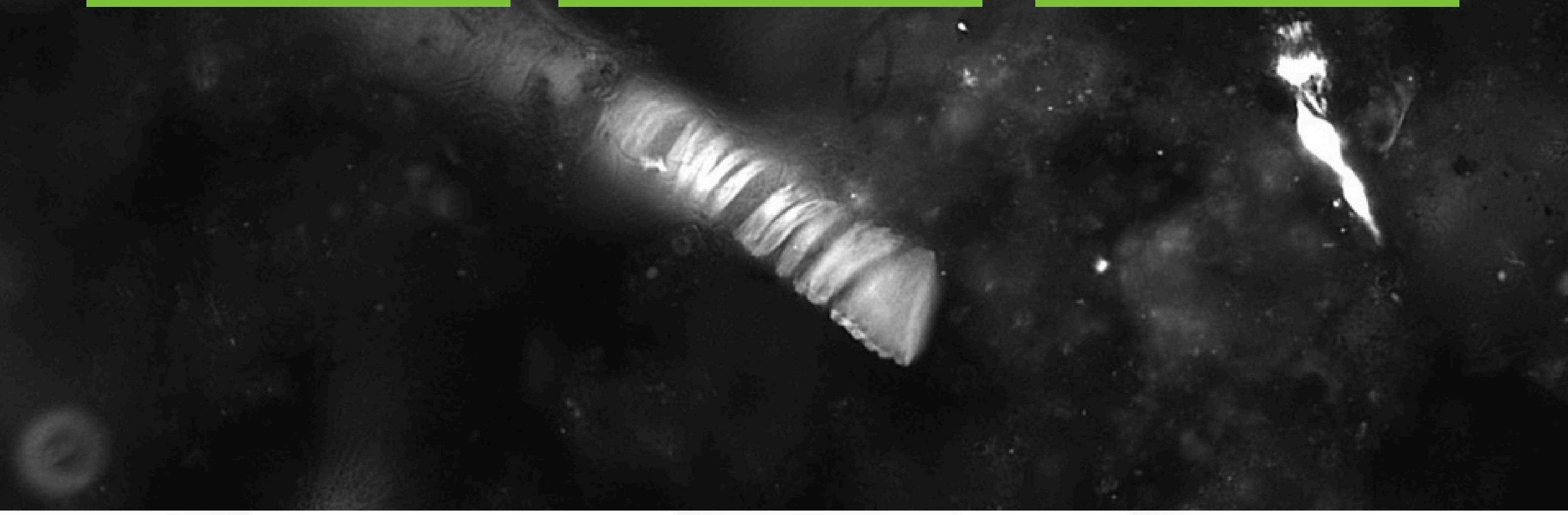
Problem

A balanced microbial ecosystem is critical for stable digester operation. Imbalances can lead to issues such as reduced biogas production or the accumulation of harmful byproducts like hydrogen sulfide (H_2S). Our analysis of the collapsed digester revealed a significant imbalance in its microbial ecosystem, primarily characterized by an excess of acid and H_2-producing bacteria and a shortage of methanogens.

3,150,900
FERMENTERS
Measured: 42%
Healthy Range: 45%

3,660,940
ACID PRODUCERS
Measured: 49%
Healthy Range: 30%

700,500
METHANOGENS
Measured: 9%
Healthy Range: 25%



Pinpointing **Innefficiencies.**

What exactly do these microbial community imbalances mean for operations?

HIGH LEVELS OF ACID PRODUCERS

This excess can lead to an accumulation of organic acids, which can **destabilize the digester if not adequately metabolized.**

INSUFFICIENT METHANOGENS

This deficiency limits the conversion of methane precursors into methane, **leading to lower biogas production.**

ELEVATED H_2S-PRODUCING BACTERIA

H_2S is a corrosive compound that can **damage equipment, inhibit methanogenesis, and pose toxicity risks.**

Key Insights

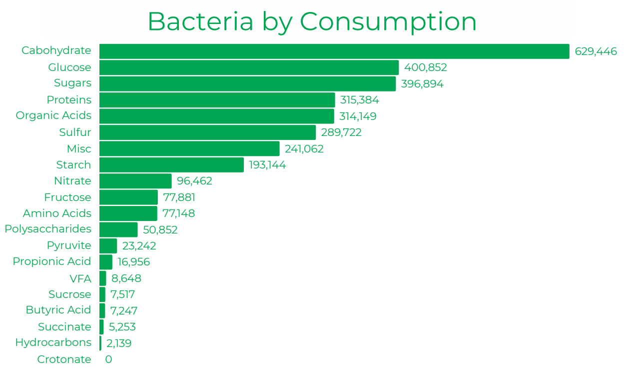


Table 1: Organisms broken down by the molecules they consume.

A DEEPER DIVE

The microbial analysis revealed a substantial presence of carbohydrate- and sugar-consuming bacteria, indicating a feedstock rich in sugars, such as glucose and fructose (Table 1). This sugar-rich environment has promoted the proliferation of acid-producing organisms, leading to the significant production of organic acids, including succinate, propionate, and acetate (Table 2).

TIPPING THE SCALE

The accumulation of these organic acids suggests an imbalance, as the digester lacks sufficient bacterial and archaeal populations to metabolize these compounds further, which can destabilize the system or delay its initiation. Notably, the microbial community includes a high concentration of hydrogen gas (H_2)-producing bacteria, indicating a plentiful hydrogen supply in the feedstock. Conversely, there is an elevated presence of H_2S-forming bacteria, resulting in high levels of hydrogen sulfide (H_2S) (Table 2)

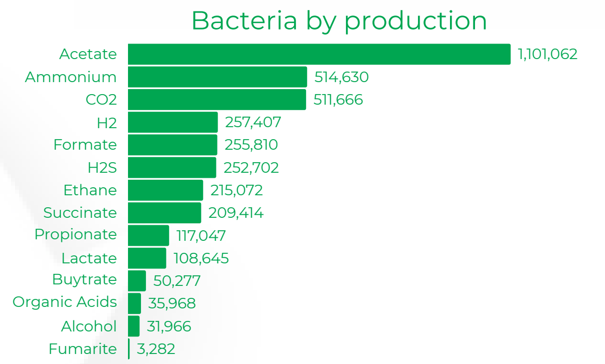
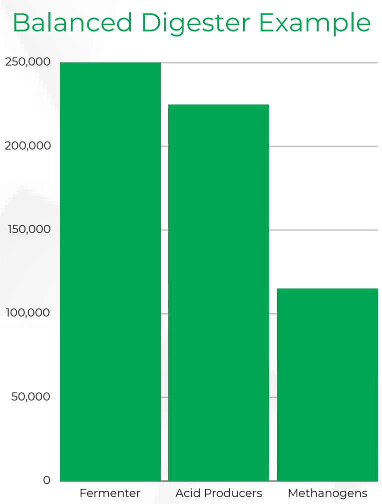
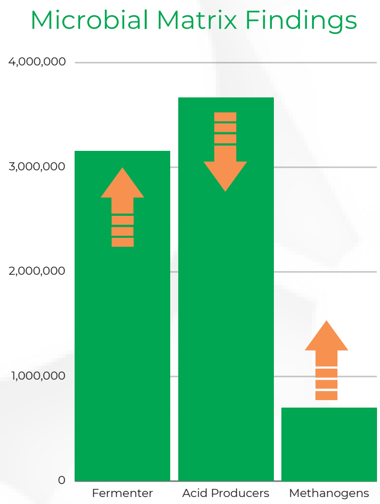


Table 2: Organisms broken down by the molecules they produce.

Our Microbial Matrix study provides a clear understanding of microbial communities, creating a roadmap to enhanced efficiency and output.





OVERCOMING SHORTCOMINGS

These insights illuminate a critical imbalance where excessive fermenters and acid producers far outnumber methanogens. This disproportion can lead to inefficiencies in methane production and overall system performance. By identifying these microbial discrepancies, our Microbial Matrix study provides a clear roadmap to rebalance the microbial community, enhancing the digester's efficiency and output.

Solution

The Microbial Matrix facilitates a deep understanding of the microbial dynamics within anaerobic digestion systems. By revealing specific pathways to correct microbial imbalances and harmful environments, it enables the development of targeted strategies that enhance the consistency and efficiency of anaerobic digestion operations.

1. MICROBIAL SUPPLEMENTATION

Introducing microbial supplements would help shift the metabolic pathways towards more efficient methane production, reducing the accumulation of harmful intermediates.

2. OPTIMIZING FEEDSTOCK COMPOSITION

Adjusting the feedstock composition to reduce the excess sugars and carbohydrates would help balance the microbial community by lowering the population of acid producers.

3. ENHANCING CARBON AVAILABILITY

Increasing the availability of carbon within the digester can provide necessary substrates for the growth of beneficial microbes, particularly methanogens.

4. MONITORING & ADJUSTMENTS

Continuous monitoring of microbial populations and chemical composition would enable timely adjustments to nutrient inputs and operational parameters.

Produce
Enhance methane production

Stabalize
Reduce the risk of instability.

De-Risk
Minimize harmful byproducts

MICROBIAL MATRIX

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Let us **pinpoint and resolve the biological factors within your system** that are holding you back.

Conclusion

This Microbial Matrix Study highlighted critical inefficiencies in the digester's microbial community. The predominant issues—excessive acid and hydrogen gas producers, insufficient methanogens, and elevated levels of H_2S-producing bacteria—underscore the need for targeted interventions to restore equilibrium.

By adopting the recommended strategies, including microbial supplementation, feedstock optimization, and enhanced monitoring, the digester can significantly improve methane production, mitigate the risk of system instability, and minimize the presence of harmful byproducts.

Next Steps

Maintaining a balanced microbial ecosystem within ADs is crucial for efficient waste management and energy production. Regular microbial assessments, as provided by Digester Doc, are essential for identifying and addressing issues that could compromise the system's performance.

Please contact our team to unlock a comprehensive view of your digester's microbial populations. Our expert analysis and tailored recommendations can help you achieve sustainable and efficient biogas production, safeguarding your operations.

EXPERIENCE THE BENEFITS

UNDERSTAND PERFROMANCE

DEVISE STRATEGIES

PINPOINT DEVIATIONS

UNLOCK A HOLISTIC VIEW

OF THE MICROBIAL MATRIX.

OVERCOME INEFFICIENCIES

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Learn how our cutting-edge service might help you **prevent corrosion, toxicity & Instability**

Contact Us!

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