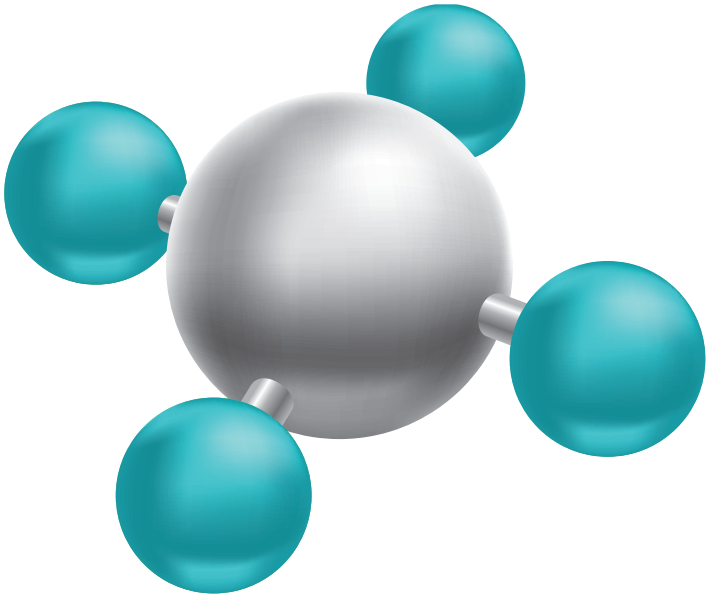
AQUAFIX INC
WASTEWATER LABORATORIES

Impact of BioGas1 on Methane Production

TESTING FROM 5 MANURE DIGESTERS AND 1 MEAT PROCESSING FACILITY



REPORT PREPARED BY:

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Digester Doc

Abstract

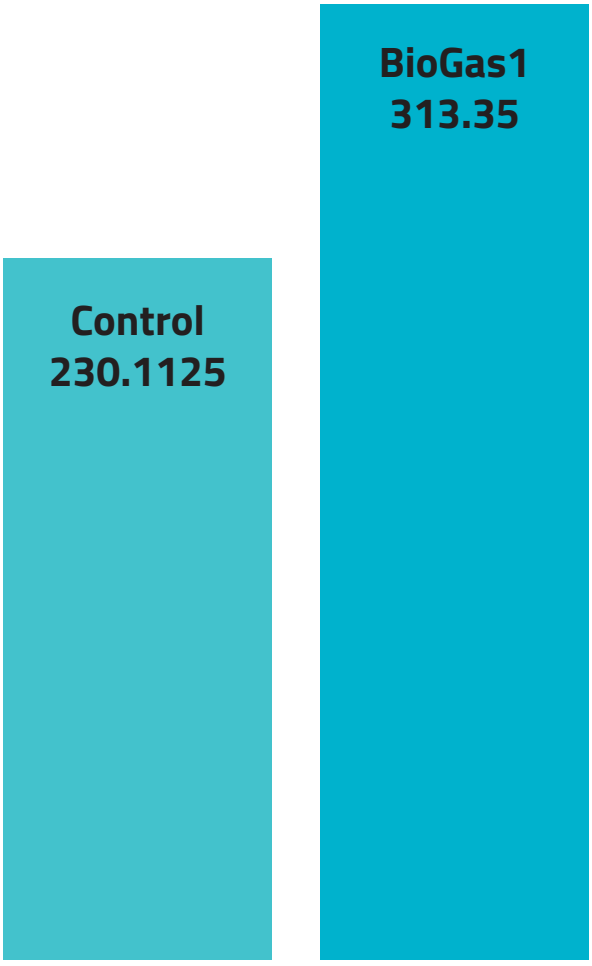
This report was derived from 6 separate studies utilizing BG1 in combination with other additives as compared to the control setting, looking for the pathway(s) to the highest gas production. Samples were derived from various feedstocks, predominantly manure, but also wastewater from a meat processing facility, to determine the most effective additives to increase gas production.

Anaerobic digestion (AD) is a biological process where organic substrates are broken down into methane and CO2, which can then be upgraded to produce renewable natural gas as well as food/beverage grade Carbon dioxide. BioGas 1 (BG1) is a product designed to supplement the microbial nutrient needs of an AD system, providing 10 essential micronutrients including Cobalt, Nickel, and Iron. The reactors with BG1, either by itself or supplemented with additional needed bacteria, showed significant gas yield increases.

All testing was performed by Digester Doc.

BioGas1 produced an average of

36% More Methane



Average Methane Production (mL CH_4/g VS)

Purpose

AD at manure and other agricultural processing facilities has been accelerating recently at an exponential rate. The purpose of this study was to derive solutions for these providers of valuable renewable natural gas and what may exponentially increase their production rates.

Methods

In this study, a standard biochemical methane potential test (BMP) was used to measure methane generation comparing a control to a reactor with 2 grams BG1 as a nutrient supplement. Each sample set was run in triplicate in 500mL anaerobic reactors and maintained at 38°C for the duration of the testing. The reactors were set up using 400mL of feed stock representative of the sample sites. Additionally, some samples were also inoculated with Ana-Zyme D (AZD), Ana-Zyme G (AZG), and/or Ana-Zyme P (AZP) for enzymatic supplementation, while one was inoculated with additional bacteria (Bact).

Discussions and Conclusions

Preliminary testing showed that, from 6 dairy manure subject tests and 1 meat processing facility, all case subject facilities were lacking in trace elements that were benefited by the addition of Biogas 1, which supplemented these values sufficiently to encourage increased gas production. The test AD systems saw between 5.9% on the low end to 75.6% increases on the high end over the control sets. In the tests where limited gas yield increases were found, the samples were found to require enzymes to break down large proteins and long chain fatty acids. Enzymatic supplements were added, the experiments were conducted, and the digested feedstock was tested. COD and VFA conversion efficiencies were used to ascertain the biological health and whether additional biology was required. These additions (bacterial and enzymatic) along with the minerals of BG1, resulted in significantly improved efficiency in gas production. Biogas production was recorded in accumulated volumes (NmL) and/or converted to mL of methane produced per gram of volatile solids (mL CH_4/g VS).

Overall, the addition of BioGas1 produced a few distinct results. First, the biological components were naturally balanced and only chemistry modification was required. In these cases, an average increase of 35.5% was observed in dairy manure. Second, in dairy manure where the macronutrients were out of balance, regardless of whether it was in the acidosis or acetogenesis stage, correcting the imbalance with addition of enzymes, in concert with the addition of BG1, an increase of 47.9% gas production was witnessed. Finally, meat processing wastewater is typically unbalanced in all nutrients. However, neither the addition of BG1 alone, nor the addition of only enzymes, provided a significant increase in biogas production. However, balancing the mineral and macronutrient needs of the native microbes produced an increase yield over 100% that of the control. BG1 provided an increase in gas production even in cases where the control produced well above what is expected. (230 - 240 ml CH_4/g VS – based on scientific literature, and industry standards)

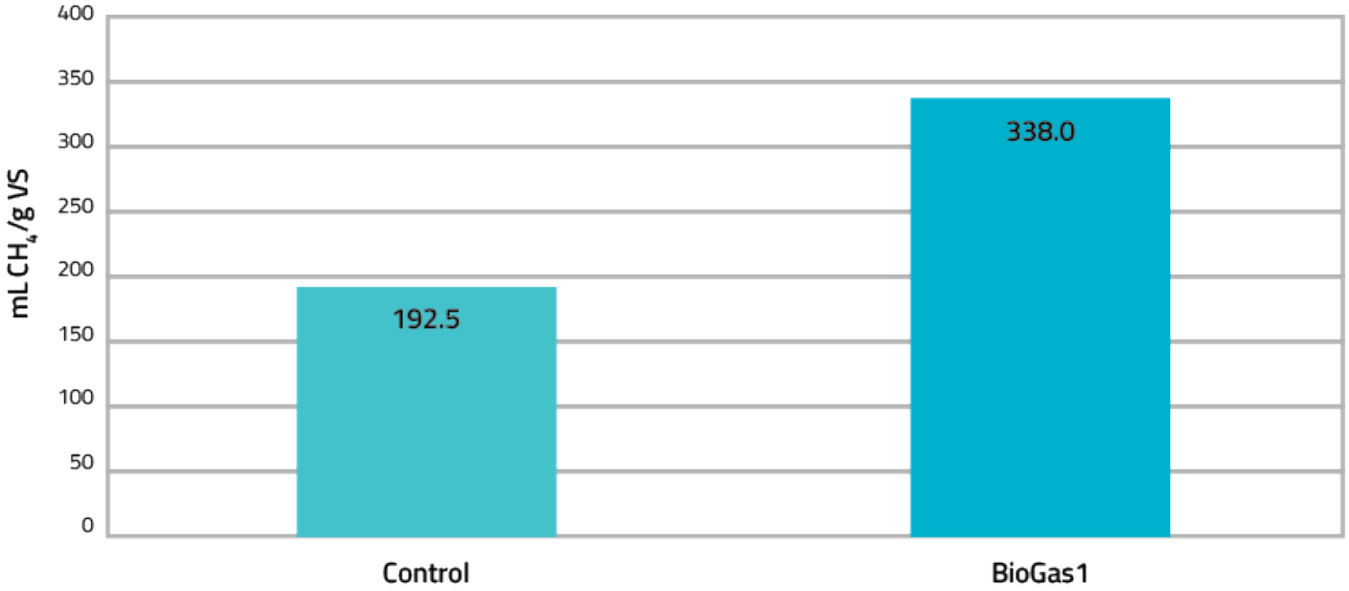
In most cases, the trace elements included within the BG1 formula were sufficient and negated the need for additional supplementation. However, in a few feedstocks, Molybdenum and Selenium need to be added; Aquafix has derived an alternative to provide for those needs, a Biogas product containing Molybdenum and Selenium.

RESULTS FROM VARIOUS TESTS INVOLVING BG1 OVER 18 MONTHS

SAMPLE ID	FEEDSTOCK	CH_4 (ml/g VS)	INCREASE OVER CONTROL
Site 1			
Control	Manure	179.95	
BioGas1	Manure	259.62	44%
Site 2			
Control	Manure	192.5	
BioGas1	Manure	338.0	75.6%
Site 3			
Control	Manure	230.1	
BioGas1	Manure	311.9	10.3%
BioGas1 + AZP	Manure	343.9	49.5%
Site 4			
Control	Manure		
BioGas1	Manure		5.9%
BioGas1 + Bact	Manure		86.2%
Site 5			
Control	Manure	317.9	
BioGas1	Manure	343.9	8.2%
Site 6			
Control	MP WW*	222	
BioGas1	MP WW*	256.2	15.4%
BioGas1 + AZD +AZG	MP WW*	465.0	109.5%

**Meat Processing Wastewater*

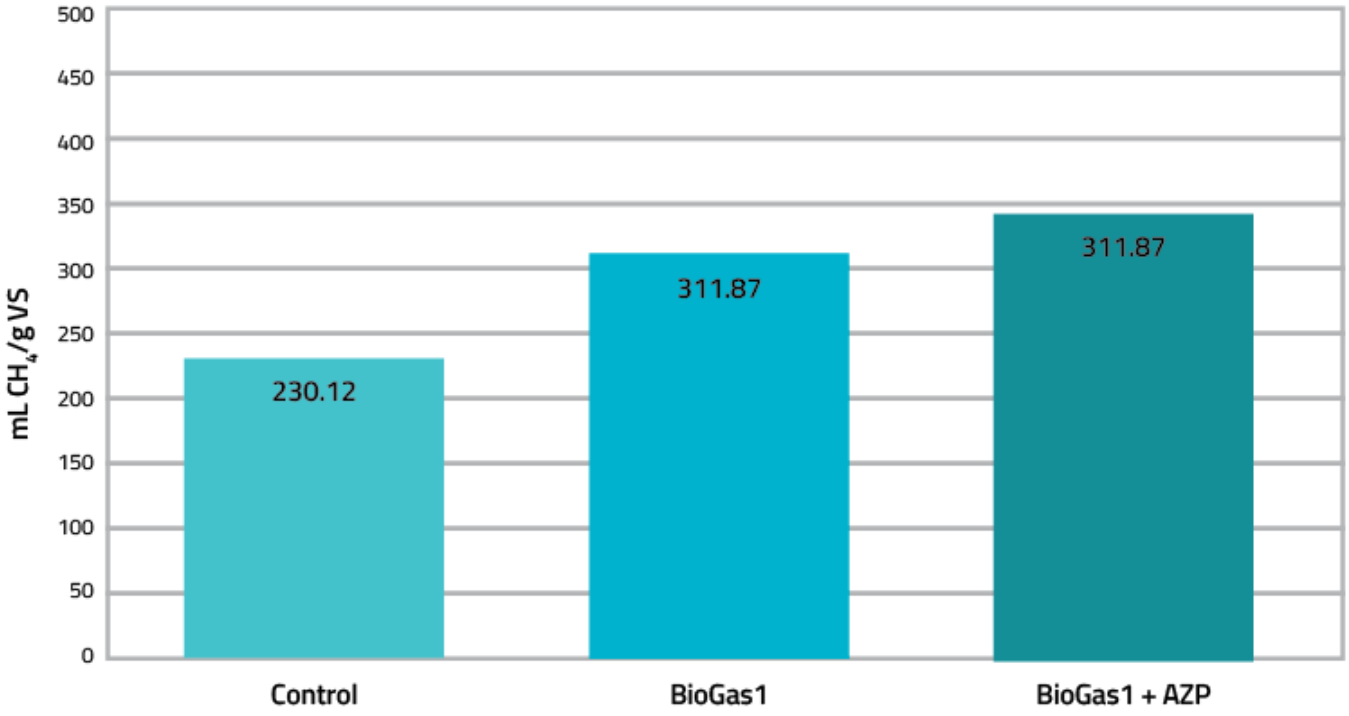
SITE 2: DAIRY MANURE WITH CHEMICAL SUPPLEMENTATION



COMPARISON OF MANURE TESTS WITH BG1 AND A CONTROL SET.

In the first dairy manure test, the control produced 192.5ml CH4/g VS, less than the expected average for dairy manure 230.2ml CH4/g VS found in the scientific literature. After the addition of the Biogas 1 additive, the production in this test sample consistently showed an average production over 330ml CH4/g VS.

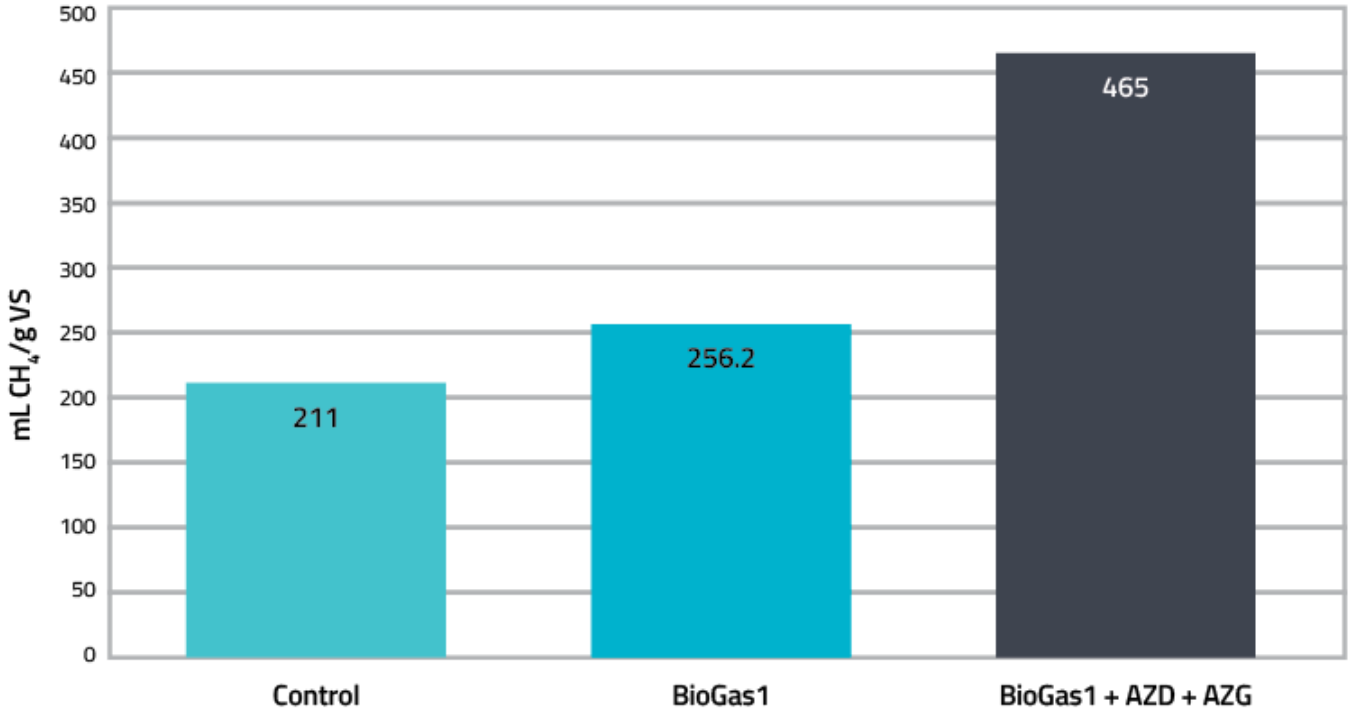
SITE 3: DAIRY MANURE WITH CHEMICAL AND ENZYMATIC SUPPLEMENTATION



EXPERIMENTAL COMPARISON OF BG1 AND BG1 WITH BIOLOGICAL SUPPLEMENTATION IN MANURE TRIALS.

The experiment with the addition of only Biogas 1 product was responsible for 26.6% increased gas yields. The addition of Ana-Zyme P, the production yield increased to 33.1% over the control.

SITE 6 : MEAT PROCESSING WASTEWATER GAS PRODUCTION



EXPERIMENTAL COMPARISON OF BG1 AND BG1 WITH BIOLOGICAL SUPPLEMENTATION IN WASTEWATER TRIALS.

This case study utilizing wastewater revealed that chemistry alone did not increase the production values significantly, but with the addition of Ana-Zyme D (AZD) and Ana-Zyme G (AZG), in combination with the BioGas 1, creating mineral and macro nutrient balance in the substrate, the yields increased by more than twice the gas production of the control.

SIDE BY SIDE COMPARISON OF RESULTS BETWEEN MANURE AND WASTEWATER EXPERIMENTS REQUIRING ADDITIONAL SUPPLEMENTATION.

ADDITIVES	MANURE	WASTEWATER
BioGas1 Only in under performing Systems		
BioGas1	8.08%	15.90%
With Additional Modifications		
BioGas1 + AZP	49.5%	
BioGas1 + AZD +AZG		109.46%

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