Swedish Biogas INTERNATIONAL

# Evaluation of Biologic® SR2 Solution in a Mono-substrate Anaerobic Continuously Stirred Tank Reactor

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**Abstract:**
The impact of the addition of Biologic® SR2 solution in a lab scale anaerobic continuously stirred tank reactor (CSTR) running on a mono-substrate was investigated. The Biologic® SR2 solution, developed and obtained from Pure Bio-Clean Solutions Inc. and SciCorp International Corp, is a micronutrient supplement of natural biodegradable vitamins and minerals. The mono-substrate CSTR had been in operation for over a year prior to the addition of the Biologic® SR2 solution which occurred daily throughout a six month time period, yielding an increase in specific gas production, decrease in volatile fatty acid (VFA) concentration, and allowed for an increase in organic loading.

## 1. Introduction:

As a mono-substrate, one of the main problems that can arise is reactor instability caused from micronutrient deficiency, which could lead to decrease gas production, increased volatile fatty acid (VFA) concentrations, and eventually even reactor failure Other restrictions that may occur in running a mono-substrate reactor include the need to maintain low organic loading rates and long hydraulic retention times. Due to these concerns it is important to ensure optimum conditions for the microorganisms involved in the anaerobic digestion process.

## 2. Material and Methods:

### 2.1 System

The continuously stirred tank reactor (CSTR) system used in this experiment consisted of a 5 Litre (L) glass tank, feeding tube, stirring shaft and motor, heating mantel, temperature probe, gas outlet three-way valve, condensate trap, and a Ritter MilliGas Counter.

**2.2 CSTR Experiment**

The mono-substrate reactor was originally seeded with digestate from a large scale anaerobic digester, designed and constructed by Swedish Biogas International located in Flint, MI, to a total volume of 4L and kept at mesophilic conditions of 37°C. Throughout experiment several varieties of the same type of substrate were used denoted as substrates A-C.

The experiment started with substrate A being fed at an organic loading rate (OLR) of 0.65 kg VS/($m^3$*day) then increased to an OLR of 2.00 kg VS/($m^3$*day) during a five month period. Substrate B was fed the following month at the same OLR; however, after the sixth month of operation the CSTR failed and had to be reseeded.

Upon the reseeding of the CSTR, a diluted substrate B was fed at an OLR of 0.55 kg VS/($m^3$*day) which was increased to 2.75 kg VS/($m^3$*day) during a period of five months. For the next four month an undiluted substrate B was fed; however, the OLR was decrease to 1.60 kg VS/($m^3$*day) due to an increase in VFA concentrations. A mixture of substrates B and C was fed at the same total OLR; however, again the digester began to fail, so the loading was decreased to 0.45 kg VS/($m^3$*day) and a small amount of sewage sludge was added to stabilize reactor.

Once the reactor stabilized the OLR was increased to 1.65 kg VS/($m^3$*day) during a four month period followed by the addition of the Biologic® SR2 solution. The Biologic® SR2 solution was added to the daily feed at an initial concentration of 200 ppm then increased to a concentration of 2000 ppm. After three months the OLR was increased to 2.00 kg VS/($m^3$*day) for a month then up to 2.50 kg VS/($m^3$*day) for an additional month after which the substrate was changed to substrate C only. Two months following the change in feed the addition of the Biologic® SR2 solution ceased.

**3. Results:**

**3.1 Specific Gas Production**

A noticeable increase in specific gas production **(Figure 1)** occurred after the addition of the Biologic® SR2 solution. The average specific gas production values are given below in **Table 1**.

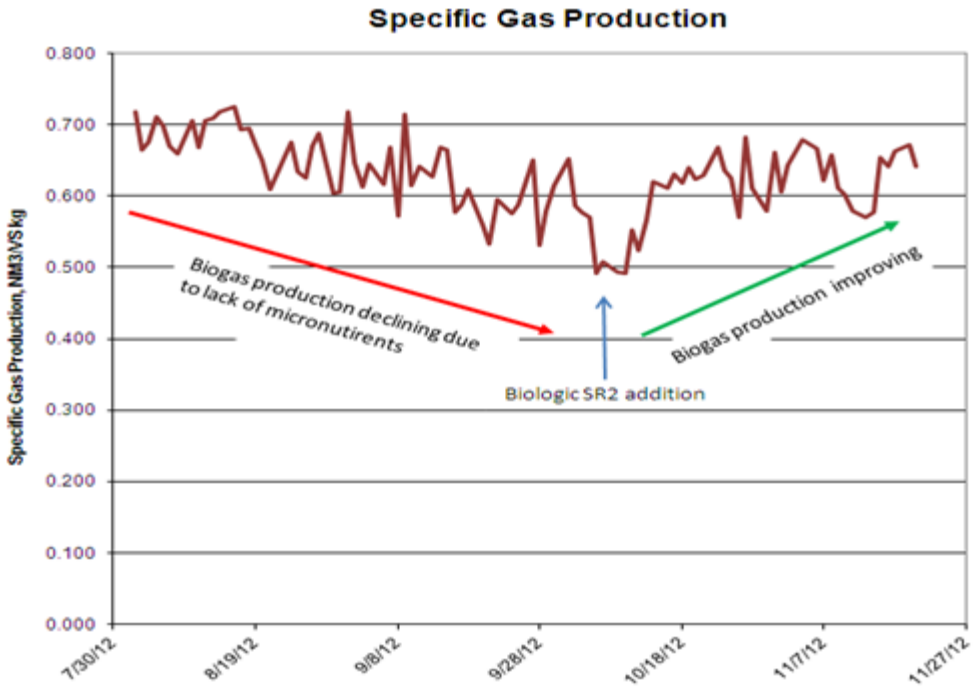


**Figure 1:** Affect of Biologic® SR2 Solution on Gas Production

**Table 1:** Specific Gas Production of Substrate B/C Mixture

| Specific Gas Production ($m^3$/(kg VS *day)) | | Percent Change |
|---|---|---|
| Pre Biologic® SR2 | Post Biologic® SR2 | |
| 0.55 | 0.59 | +7% |

The reactor was maintained for an additional month following the cessation of the Biologic® SR2 solution addition during which the gas production remained stable at the same value **(Table 2)**. With only a month being allowed to pass the affects of the Biologic® SR2 solution would still be expected to be evident as seen with the stable specific gas production.

**Table 2:** Specific Gas Production of Substrate C

| Average Specific Gas Production ($m^3$/(kg VS *day)) | | |
|---|---|---|
| With Biologic® SR2 | Without Biologic SR2 | Percent Change |
| 0.60 | 0.60 | 0% |

### 3.2 Volatile Fatty Acids

The addition of the Biologic® SR2 solution lead to a significant drop in volatile fatty acid concentrations **(Table 3)** indicating improved reactor health. Within a week after the addition of the Biologic® SR2 solution ceased an increase in VFA concentrations occurred **(Table 4)**.

**Table 3:** Total VFA Concentration of Substrates B/C mixture

| Average Concentration (mg/L) | | Percent Change |
|---|---|---|
| Pre Biologic® SR2 | Post Biologic® SR2 | |
| 2404 | 270 | -89% |

**Table 4:** Total VFA Concentration of Substrate C

| Average Concentration (mg/L) | | Percent Change |
|---|---|---|
| With Biologic® SR2 | Without Biologic SR2 | |
| 159 | 530 | +233% |

### 3.3 Organic Loading Rate

Prior to the addition of the Biologic® SR2 solution the OLR of the reactor could not be raised above 2.00 kg VS/($m^3$*day) without reactor failure; however, with the addition of the Biologic® SR2 solution, the OLR was raised and maintained at 2.50 kg VS/($m^3$*day), a 50% increase, without a decrease in reactor health or performance.

### 3.4 Ammonia and Hydrogen Sulfide

Ammonia concentration of the reactor was around 4000 mg/L prior to the Biologic® SR2 solution addition. After the addition of the solution, the ammonia concentrations remained near the same level until further efforts were used to decrease the ammonia concentration to an average of 3000 mg/L. Although the Biologic® SR2 solution did not decrease the already present high ammonia levels, it appeared to prevented the levels from increasing any further.

The affects of the Biologic® SR2 solution on Hydrogen sulfide levels were not investigated during this experiment.

### 4. Conclusions:

Addition of the Biologic® SR2 solution to a mono-substrate anaerobic CSTR yielded beneficial results. The solution improved overall reactor health and performance with a decrease in total VFA concentrations and an increase in specific gas production. The greatest evidence of the benefit of the Biologic® SR2 solution was the decrease in the VFA concentrations. Prior to addition, VFA concentrations would continue to increase causing reactor instability; however,

after the addition the VFAs decreased and remained low until the product was no longer added. The increased reactor stability provided by the Biologic® SR2 solution allowed for a higher loading rate to be achieved. Overall, the Biologic® SR2 solution assisted in maintaining good performance of an anaerobic digester running on the particular mono-substrate.