BMP AND BATCH RESEARCH REACTORS

Biomethane Potential (BMP) is a biological test to evaluate the potential methane/biogas volume generated from a substrate. It can also help identify the presence of potentially toxic or inhibitory substances in the feed. An equivalent test, residual biogas potential (RBP), described in WRAP report OFW004-005 is now a UK certified method. The test uses batch reactors where a substrate sample is fed to an AD inoculum. Gas is measured and converted to units of ml/gram VS substrate at STP. The kinetics of biogas generation obtained can provide data on potential sample inhibition, or inoculum degradability. Since the test is a comparison of biogas yield between a control set and sample sets, minimising operational differences between reactors (temperature, mixing) improves the consistency of the results. Through a gearbox (patented) our equipment uses one motor to mix 15x1-litre reactors, assuring equal mixing intensity. By immersion in a water bath with a tight water lid, temperature is maintained constant for all reactors and evaporation minimised even when operating in thermophilic mode.

Figure 1. Biogas potential equipment: BMP Nautilus (top) and Phoenix models (below).

Anaero Technology BMP sets optimise test performance by:

- **Larger reactor volume**. 1-litre reactors allow more sample use, easier to handle and smaller errors. They can be operated with smaller test volumes in the bottle, from 350ml to 900ml.
- **Mixing consistency**. All reactors are mixed at exactly the same speed through stainless/silicone paddles driven by a gearbox. One motor for 15 reactors. Consistent mixing even for high %DS.
- **Low bath water evaporation loss**. Standard water bath with tight-fitting cover that minimises bath water evaporation loss even when operating at thermophilic temperature.
- **Access to reactors during test**. Gas-tight access ports to interior of digesters without affecting gas monitoring (measure pH, redox, VFA, or supplement during test without opening reactors).
- **Real time gas flow measurement** with automatic conversion to standard temperature and pressure and protection of data with built-in battery backup (up to 15h) to **avoid data loss** during power outage.
- **Ease of calibration** (use a simple syringe to confirm the consistency of flow measurements).

Table 1. General parameters of biogas potential sets available from Anaero

Reactors per set	**15**
Reactor volume (l)	1
Materials	HDPE (reactors), 316Stainless steel, polycarbonate (gasflowmeter)
Mixer motors per set	1
Power	110 or 220VAC for bath. 6VDC backup incl. for gasflowmeter
Measurement resolution (ml)	7
Measurement method	Volumetric displacement with real-time temp and pressure sensor
Software	Arduino with automatic conversions and calculation
Dimensions	W570mm XD340mm x H 700mm (reactors); W1000mm X D200mm x H200mm (gasflowmeter)

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- **Bioreactors**. 1litre wide mouth HDPE bottles, allowing for larger samples and inoculums to be processed, which further reduces potential error. Stainlees steel /silicone paddles deliver consitent mixing to all digesters in each set. HPDE is biological innert and remains stable at 100°C. Equal mixing for all reactors is guarantee, allowing the use of kinetic data for rapid evaluation of inhibition or of the effect of feedstock composition on dynamics of biogas production.
- **Water bath**. The temperature of operation is controlled by immersion of reactors in a water bath. A lid that holds the reactors in place has been designed to minimise the loss of bath water by evaporation, facilitating tests at thermophilic temperatures without the common issues of water evaporation when operating water baths at thermophilic temperature.
- **Flexible addition of bespoke ports**. Large diameter cap allows fitting of additional ports.
- **Gasflowmeter**. Gas generation is measured using liquid displacement method. The gas flow meter is a single Perspex block with 15- 0.2l cells and Perspex tumbling buckets of around 7ml gas volume. A spare cell is used for automatic monitoring of temperature. A barometer in the Arduino logger continuously monitors atmospheric pressure for STP correction. The liquid in all cells is interconnected to keep them at exactly the same head, for equal head pressure in all reactors. The liquid can be an acidified or distilled water (total biogas), or caustic solution (CH_4-only). Each cell has a tumbling bucket with active volume of around 7ml (easily calibrated). The smaller measuring volume allows for better recording of the kinetics of the test. To minimise potential errors the diameter of the nozzle orifice where gas enters the measurement cell is machined to 1.5mm, minimising the potential impact of uncounted odd bubbles.

Real-time data collection provides the sensitivity required to differentiate the response of microorganisms in the inoculum to the different components of a substrate. Readily degradable components such as sugars result on rapid production of biogas with fast gas depletion. More complex components, such as protein and fat, can have different stages of high gas production (generally slower at the start) and higher final biogas yields. On the other hand, inhibitory substances will show as –ve values. Often complex samples can have a period of inhibition while the system acclimatises followed by recovery biogas production. On the other hand, toxic substances result in no recovery of biogas production. The availability of this data can be a useful tool to AD operators in fault-finding or for evaluation of the value of potential feedstock.

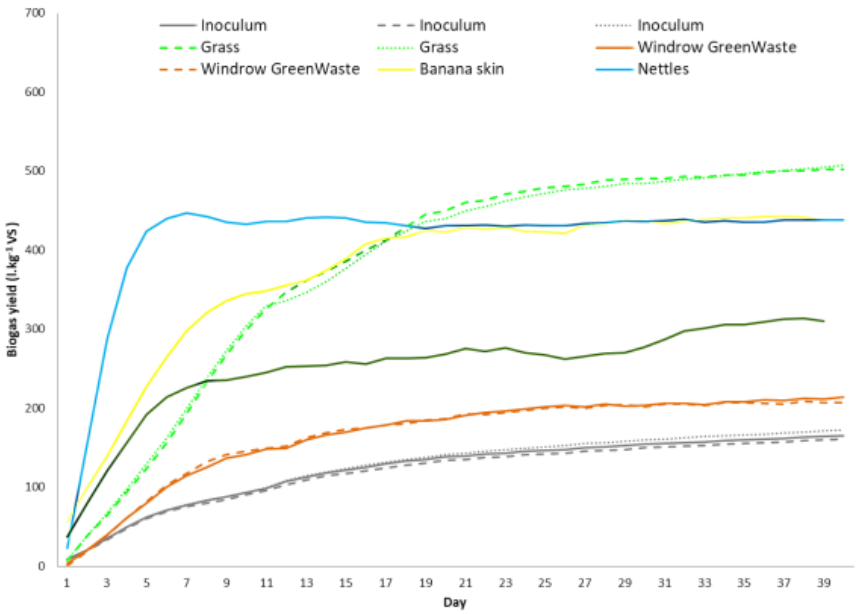
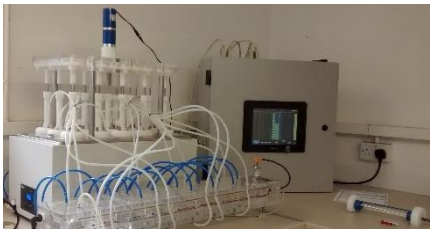
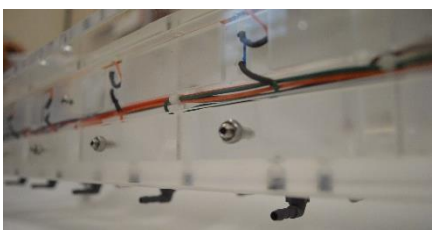


Figure 2. Biogas yield from arable by-products using Anaero Nautilus model





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