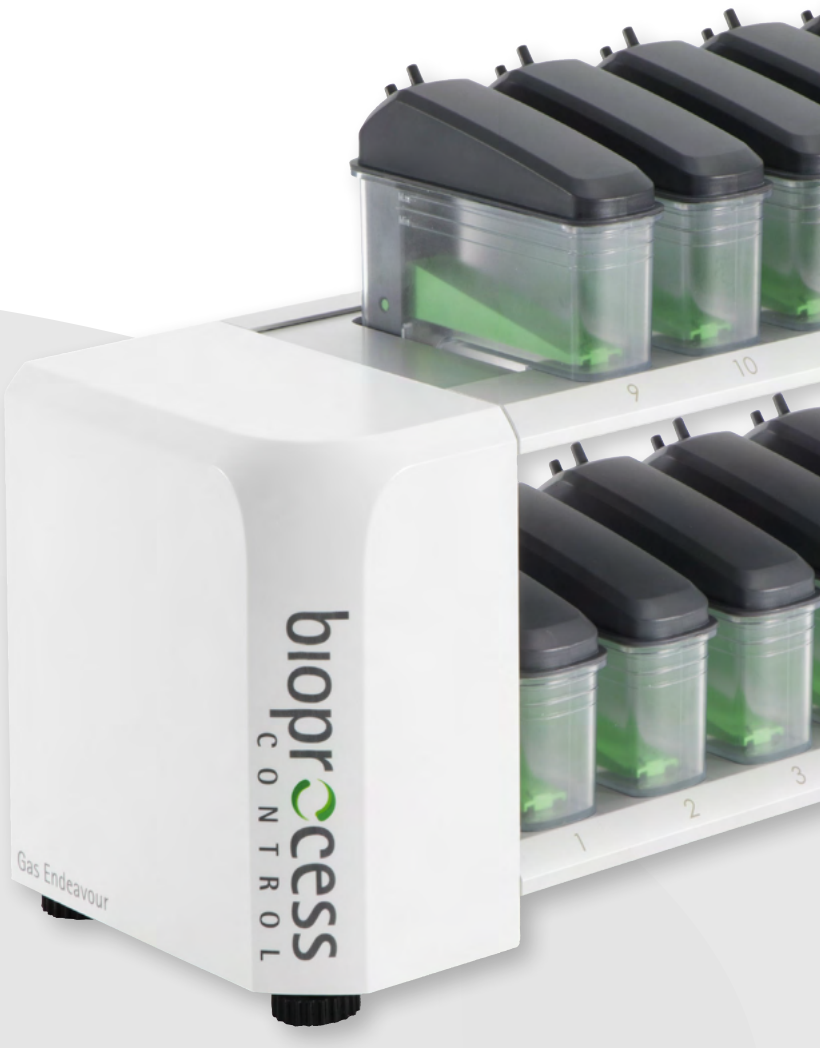
Biodegradability and compostability assays made easier

Gas Endeavour



BPC INSTRUMENTS

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Automated respirometer for aerobic and **anaerobic biodegradability assays**

The degradation of biodegradable polymers and plastics crucially depends on the environment they may end up in, such as soil, aqueous system or marine environment, landfill or composting site. Owing to the great variations in natural conditions, several tests are needed to determine the fate of a polymer material in real life and to study its biodegradability in different environments. In aerobic environments, the biodegradability is usually determined by measuring oxygen demand in a closed respirometer or the amount of carbon dioxide evolution over time. When oxygen is not available, the measurement of released biogas (a mixture of methane and carbon dioxide) is the method for evaluating anaerobic biodegradability. Biodegradability test can be performed according to “certification” or “screening” methods. Certification method is required in cases where the result is intended to be used for certification and/or making public claims on compostable product, whereas screening methods are suggested for internal research purposes and evaluating the biodegradation of a material closed to actual environment such as various aerobic conditions in soil, slurry, aqueous system, seawater, marine sediment or anaerobic conditions in aqueous, controlled slurry and high-solid digestion environments.

The Gas Endeavour® is a novel respirometer and analytical platform for both anaerobic and aerobic biodegradation analyses. For anaerobic biodegradability test, the Gas Endeavour® provides efficient and accurate measurement of released biogas in any aqueous medium, controlled slurry digestion system and high-solids digestion conditions. In the case of aerobic biodegradability test, the Gas Endeavour® is used together with our patented *in-situ* carbon dioxide absorption kit to function as a closed respirometer system for measuring oxygen demand. With the help of *in-situ* carbon dioxide absorption kit, the Gas Endeavour® becomes a powerful tool and analytical platform for both anaerobic and aerobic biodegradability analyses in various environmental conditions and supports most of ISO and other worldwide standards for biodegradability evaluation.

,

15
test lines

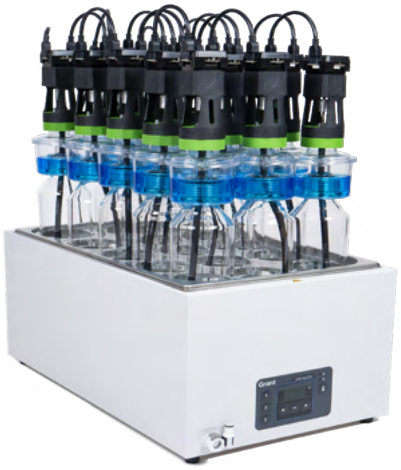
2
measuring resolutions

applicable to

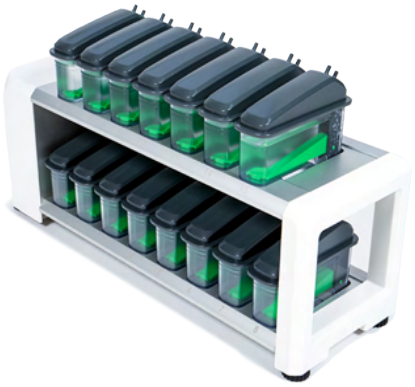
2*
measuring principles

*
1. Biogas measurement for anaerobic biodegradability tests
2. O_2 demand measurement for aerobic biodegradability tests

Standard configuration as a closed respirometer for oxygen demand measurement



Incubation unit with *in-situ* CO_2 absorption kit and mechanical agitation



Gas volume & flow meter array and DAQ unit

Flexible test platform for aerobic and anaerobic biodegradability assays

Modular design for easy replacement and maintenance

Continuous monitoring of O_2 consumption, or biogas production

Highly precise and accurate data

The Gas Endeavour® gives you a better understanding of the degradation kinetics of biodegradable polymers. The precision and accuracy of measurement and data calculations have been validated with the highest quality and standards by scientists.

Standardised measurement procedures, data interpretations and reports

Real-time temperature and pressure compensations minimise the impact of possible variation in measurement conditions and standardise data presentation satisfying the highest scientific demands for data accuracy and precision. An nonlinear mathematical model is also implemented in the latest released Gas Endeavour® to achieve an outstanding high linearity for oxygen demand, carbon dioxide evolution and biogas production in all measurement ranges.

The instrument provides advantages in the standardisation of measurement procedures, data interpretation and reporting. This allows for data from different laboratories around the world to be easily compared.

Significantly reduce labour demands

The instrument allows fully automated analytical procedures, extendable testing capacity and full control of experiments with remote access. The Gas Endeavour significantly reduces the time and labour requirement for performing both aerobic and anaerobic biodegradability analyses and makes the test being less skill dependent for precise and accurate data.

Compact and modular design

The modular approach enables flexible system set-up, easy upgrading options and simple maintenance. The test capacity of Gas Endeavour® can easily be further expanded by connecting multiple instruments with a network switch in order to satisfy different demands and shorten development time.

User-friendly operations with remote access

The instrument is simple to use and easy to operate. The web-based software application makes setting up and monitoring experiments very easy. The Gas Endeavour® also allows easy access from a remote location using anycomputer, smartphone or tablet.

Software for **Gas Endeavour**

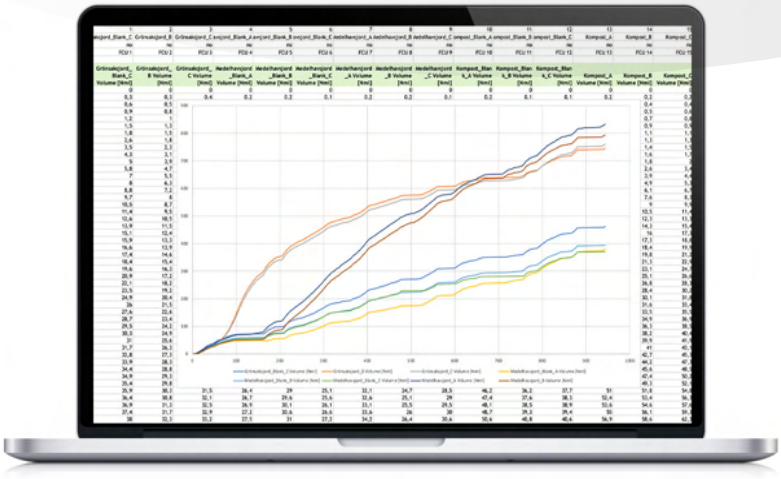
A simple and intuitive software application

The Gas Endeavour® software application has been specifically designed for a wide range of batch tests including biodegradability assays where gas volume or gas flow needs to be measured with high accuracy and precision. This software, which is easy to understand and navigate, allows users to set up an experiment, monitor its progress, and download results with little effort. Moreover, all data is in a standard format that allows for easy comparison with historical data or with results from other laboratories. The software application is simply a natural extension of the Gas Endeavour® hardware that has been designed for carrying out various batch tests where gas flow, volume and composition measurements are important.

Total control throughout an experiment

The control feature of the Gas Endeavour® software application allows users to control the status of each batch test in real-time during an experiment. For the system with our multifunctional agitation system, users can control the interval, speed, rotation directions, and on/off time of the reactor agitation. This ensures each reactor to be operated under optimum mass transfer conditions. Users can also easily start, pause, and stop data acquisition of an ongoing experiment at any time by means of a simple to use control feature, which also indicates the status of each test line at all times.

Overall, this allows users to have optimal control of all test vessels and batch experiments at all times with the simple click of a virtual button from the software user



interface. The graph feature of the Gas Endeavour® software and embedded web server allows users to access their experiment in real-time and from any location. Users can easily monitor the accumulated gas volume and flow rate of each reactor in real-time by selecting and viewing only the one they wish to follow.

Moreover, all values displayed are already adjusted for gas volumes normalised to 1 atmospheric pressure, 0 °C, and zero moisture content.

If a flush gas with a different gas composition from the produced gas is used to establish initial headspace gas conditions, the impact of the flush gas is also taken into consideration for automatical data correction by the Gas Endeavour® software.

This control features allow Gas Endeavour® users to fully control the experiment status, as well as keep an eye on the data being produced.

Total control over your experiment at any time and place

Analyse more and more professionally

Applications

Anaerobic biodegradability

The Gas Endeavour® allows for continuous and on-line monitoring of released biogas in any aqueous medium, controlled slurry digestion systems and high-solids anaerobioc digestion conditions. The instrument can be used to perform anaerobic biodegradability analyses according to anaerobic biodegradability norms including but not limited to ISO 14853, ISO 13975, ISO 15985, ISO 11734, ASTM D5511, ASTM D5210, ASTM D5526 and OECD 311.

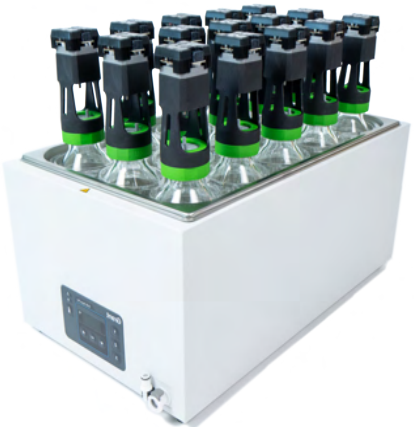
Aerobic biodegradability

Determination of aerobic biodegradability in soil, aqueous medium and marine sediment can be performed by either measuring the oxygen demand in a closed respirometer or analyzing evolved carbon dioxide. Together with the *in-situ* carbondioxide absorption kit, the Gas Endeavour® works as a volumetric respirometer and allows for continuous and on-line measurement of oxygen consumption or depletion caused by aerobic respiration of microorganisms. The instrument can therefore be used to perform aerobic biodegradability analyses according to following norms: ISO 14851, ISO 17556, ISO 23977-2, ISO 18830, OECD 301.

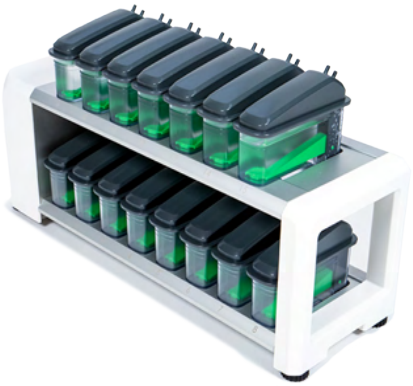
Compostability

The Gas Endeavour® can be configured for home composting analysis according to AS 5810 or ISO 14851. The same configuration may also be utilised to evaluate aerobic biodegradability of polymer samples under the same temperature range of controlled composting conditions using industrial compost as inoculum. This arrangement should be recognised as a simplified method based on measurement of oxygen demand or depletion caused by aerobic respiration of compost microorganisms for internal study or research purposes.

System configuration for anaerobic biodegradability measurement



Incubation unit with mechanical agitation



Gas volume & flow meter and DAQ unit

Technical specifications

Sample incubation unit with mechanical agitation (for biogas measurement)

Maximum number of reactors per system: 15

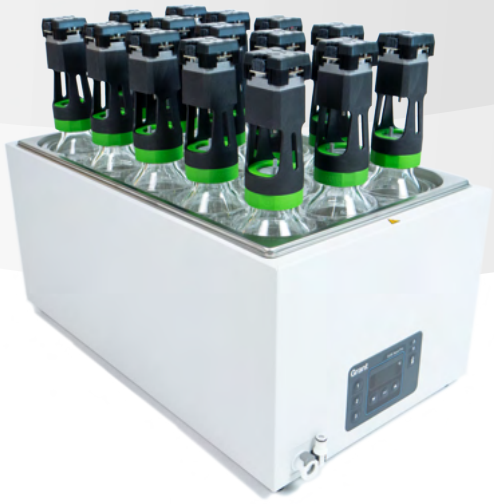
Reactor material: glass

Reactor volume: 500 ml (standard), 1000 ml (optional)

Dimension: 57 x 34 x 27 cm

Temperature control: up to 95 °C (203 °F) (precision of 0.2 °C)

Mixing in the reactor: mechanical agitation (adjustable interval, speed and rotation directions), 10 to 200 rpm



Sample incubation unit with *in-situ* gas absorption and mechanical agitation (for O_2 demand measurement)

Maximum number of reactors per system: 15

Reactor material: glass

Standard reactor volume: 1000 ml (standard), 2000 ml (optional)

Dimension: 57 x 34 x 27 cm

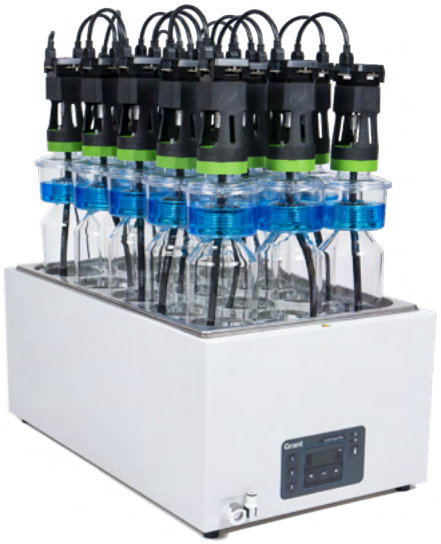
Dimension tray insert: 44 x 26 x 7 cm

Temperature control: up to 95 °C (203 °F) (precision of 0.2 °C)

Volume of *in-situ* gas absorption unit: 100 ml

Absorption liquid for CO_2 removal: 3M NaOH with pH indicator (not included)

Mixing in the reactor: mechanical agitation (adjustable interval, speed and rotation directions), 10 to 200 rpm or shaking water bath, linear shaking motion, 20 to 200 rpm



Gas volume & meter array and DAQ unit

Working principle: Liquid displacement and buoyancy. Up to 15 independent gas flow measurement units and built-in sensors for real-time temperature and pressure compensation.

Single gas measurement: measurement for 15 test vessels in parallel

Double gas measurement (i.e. total gas and one specific gas component, such as methane): measurement for 7 test vessels in parallel

Measuring resolution: 2 ml or 9 ml

Detection capacity: up to 200 l cumulative gas for each batch test for 2 ml flow cell and up to 900 l cumulative gas for each batch test for 9 ml flow cell

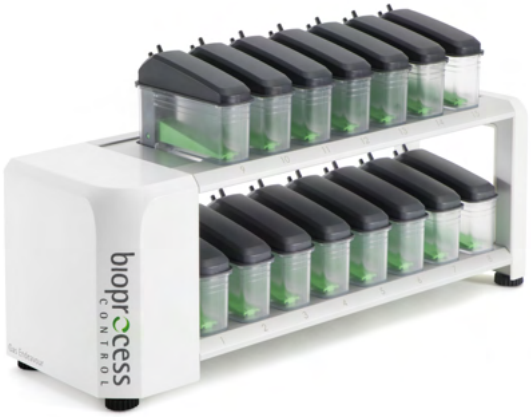
Measuring range: 0.2 to 1500 ml/h* for
2 ml flow cell and 1 to 6000 ml/h* for 9 ml flow cell

Dimension of unit: 51 x 26 x 17 cm

Housing: aluminium and plastic

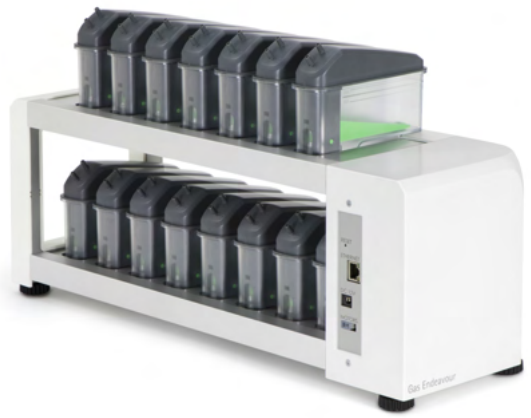
Measuring precision: CV≤ 1%

* Lower range limit refers to measurement of gases with low solubility inn water (e.g. N_2, CH_4, O_2, CH_4, H_2)



Software and System

- User friendly web-based software running on an embedded server, with no need of pre-installation on pc, tablet, or smartphone
- Online real-time gas flow and volume display
- Automatic real-time pressure and temperature compensation
- Extended measurement linearity for high gas flow analysis
- Real-time gas flow and volume normalisation
- Algorithm to avoid over- or underestimation of gas flow and volume that may be introduced by flush gas during experiment setup
- Possibility of multiplexing, allowing for simultaneous batch analysis at different start-up times
- Online system logger for operational diagnosis
- Power supply: 12 V DC / 5 A (Flow cell array and DAQ unit),
- 24 V DC / 2.7 A (mechanical agitation)
- Usage: indoor



BPC Instruments – smart instruments for smart people

BPC Instruments (formerly Bioprocess Control) is a market leader in the area of low gas flow and volume analytical instruments for biotechnology related applications. We invest in innovation and development of smart instruments that allow for more efficient, reliable and higher quality research and analysis, leading to significant reductions in time and labour. We ensure the highest product quality throughout our portfolio, and focus on being service minded and always meeting the needs of our customers.

The company's flagship products, AMPTS® and Gas Endeavour®, have become the preferred analytical instruments around the world for conducting various anaerobic and aerobic batch fermentation tests. BPC's product portfolio offers academic and industrial actors working with biogas, animal feed & nutrition, biodegrable plastics, wastewater, greenhouse gases emissions and other fields exciting products for low gas volume and flow measurements, substrate analyses and process simulations.

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