BPC INSTRUMENTS

OPERATION AND
MAINTENANCE MANUAL

BPC® Blue

Analytical Platform for Biodegradability Analysis

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GENERAL INFORMATION

Before operating the BPC Blue (hereafter referred to as “the instrument”, “the system” or “the equipment” interchangeably) from BPC Instruments AB (hereafter referred to as “BPC Instruments”, “BPC”, “Bioprocess Control” or “BPC Instruments AB” interchangeably), carefully read this operator manual for the instrument, any separate instructions for other equipment used together or in conjunction with the instrument, as well as the safety instructions for any and all chemicals used in the process of utilising the instrument.

Safety Information

When performing experiments with the instrument, always use protective eyewear, gloves, and lab coat. Always make sure there is adequate ventilation and take proper precautions when handling electrical devices near water or explosive gases. Make sure to tie back any hanging objects, such as hair and clothing, when working near rotating or other moving parts.

Do not modify the instrument without the prior consent of the manufacturer. BPC Instruments AB do not assume responsibility for any errors due to equipment modification.

Do not clean or service the instrument while it is running.

Do not expose the instrument to mechanical vibrations or high frequency radio transmissions.

Never operate the instrument in a way it was not intended.

Never operate the instrument or let anyone else operate it without proper training.

Never use the instrument outside or in environments with parameters outside of the instruments recommended range.

Never connect additional electrical equipment not supplied by BPC Instruments AB for the express purpose of using with the instrument. This is true even if the connections can mate.

Always back-up important data to an external device.

Always keep the instrument level and on a flat and stable surface. Failing to do so can, among other things, generate an erroneous gas reading.

Always make sure all safety guards are in place and working before operating the instrument.

Always make sure that all parts are functioning properly immediately after start-up.

Always keep the instrument clean.

Always make sure to have access to relevant chemicals before starting an experiment.

Always dispose of parts and chemicals according to applicable rules in the country of usage.

Periodic maintenance of the instrument and its various accessories is essential. Always make sure they are in working condition. If service or spare parts are required, please visit https://webshop.bpcinstruments.com or contact BPC Instruments AB directly or one of its representatives.

Always make sure to connect the power supply so that it is easy to remove from the mains power outlet and so it doesn’t risk becoming damaged.

Always make sure that the gas outlet of the Flow Cell Unit (FCU) is able to release pressure in the event of pressure build-up inside of the instrument. Do not obstruct or block it.

Always wait 60 seconds between powering the system on and off. This will allow for the operating system to shut down properly and for the capacitators to properly cycle.

Always use deionized water to minimise the risk of residue or rust forming on the inside of the FCU.

Limited Warranty

The product warranty provided with the instrument corresponds to the stipulations in Orgalime S 2012, unless otherwise agreed upon with BPC Instruments AB. BPC Instruments AB reserves the right to correct any possible errors, mistakes, changes, updates, technical data or otherwise relevant information in this manual or any other documents, where applicable by law.

Electrical Safety

Compliance is required with respect to voltage, frequency and current requirements indicated on relevant parts. Improper operation, damage to the equipment, fire or otherwise undesired effects might be caused by connecting to a different power source. There are no user-serviceable parts in the equipment, unless otherwise agreed upon with BPC Instruments AB.

Before Getting Started

Read this manual before installing and using the instrument. In addition, keep this instruction manual for future reference and make sure it is easily available for people who regularly use the system.

Contact Information

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Chapter 01: Overview

Biodegradability of plastics refers to the process by which microorganisms break down the organic material (polymer) to its basic elemental components (water, biomass and gas). It is a complex biological process reliant on several critical factors, including the chemical and physical properties of the test material (e.g., polymer chain length and strength of interactions, surface area, etc.), environment (e.g., soil, compost, water, presence of microorganisms, etc.) and conditions (e.g., temperature, humidity, dynamic or static incubation, etc.).

The central focus of biodegradability studies is determining the degree and rate to which a given polymer can biodegrade. In laboratory settings, this question can be answered by evaluating the biodegradation properties of the tested material considering a specific type of environment under a well-defined set of conditions.

BPC Blue platform represents the next generation of our analytical tools for conducting biodegradability analyses under anaerobic and aerobic conditions. This system delivers precise and accurate gas measurements, enabling the determination of biodegradation rate and real-time kinetic information of the biodegradation process of any plastic materials.

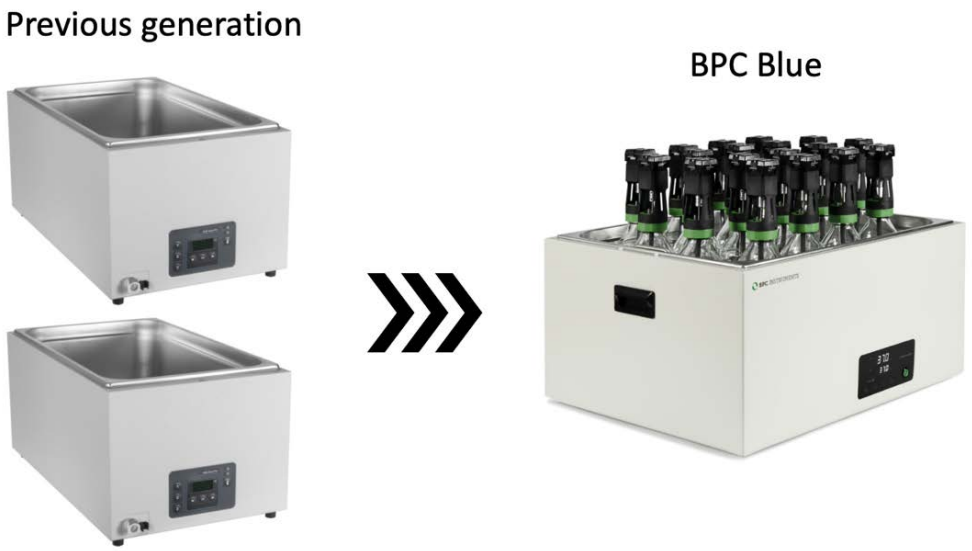
BPC Blue system has been specifically designed to implement and control a wide range of standard laboratory conditions in accordance with several international protocols, providing a thorough and reproducible evaluation of the biodegradation properties of polymers. Its advanced capabilities offer fundamental insights into the biodegradability of a given material, enabling users to conduct comprehensive analyses of the biodegradation process and its underlying mechanisms.

Compared to the previous instrument offered by BPC Instruments for biodegradability studies, Gas Endeavour, BPC blue retains the following key features:

- Fully automated setup for sampling, recording, data analysis and report generation.
- Standalone instrument with embedded data acquisition and web server for remote access (no need for software installation).
- The measuring cell is pre-calibrated by the factory.
- The software can be accessed locally or remotely from any device with a web browser (preferably Google Chrome). System log for operational diagnosis.
- Option for real-time automatic compensation for atmospheric pressure, environmental temperature and moisture content changes to normalise the data to standard conditions.
- Reliable operation and easy maintenance where most of the components can be easily exchanged without special requirements.

The following are the main new features of BPC Blue:

- Default setup with 18 channels.
- New software dedicated to biodegradability analysis.
- New configurations for anaerobic and aerobic tests (Light, DUO and Premium).
- New electronic hardware with significantly improved performance and additional functionalities.
- 150 higher volume detection capacity compared to the previous version.
- New thermostatic water bath with capacity for 18 (1 L) reactors or 9 (2 L) reactors.



- New detection unit (BPC Core Unit) with OLED screen to easy access the status and IP address of the instrument, USB port for software upgrade and power button.
- More robust and less gas permeable tubing.
- Various accessories for better tube management and easier operation.
- New Gas Absorption Attachment (GAA) material more resistant at high temperatures (aerobic tests).

2.1 Anaerobic Biodegradability Analysis

Under anaerobic conditions (absence of oxygen), biodegradable materials are converted into methane (CH_4), carbon dioxide (CO_2), water (H_2O) and biomass:

$$C_{polymer} \longrightarrow \boxed{CH_4 + CO_2} + H_2O + C_{biomass}$$

Anaerobic biodegradability analysis is based on biogas ($CH_4 + CO_2$) measurements considering different types of environment, such as aqueous medium, controlled slurry digestion system and high solid digestion conditions. In this case, the biodegradation rate of plastic materials is measured by a combination of evolved carbon dioxide and methane gases as percentage of the conversation of carbon in the plastic sample to carbon in the gaseous form.

The first step in calculating the biodegradation rate of the investigated material under anaerobic conditions, is to determine the amount of gaseous carbon (C_g) evolved from each reactor. Using the ideal-gas equation, the volumes of CH_4 and CO_2 are converted to volumes at standard conditions of temperature (273 K) and pressure (1 013,25 hPa):

$$\frac{pV}{T} = \text{constant}$$

Where,

p is the pressure in hectopascal (hPa)
V is the volume in L
T is the temperature in Kelvin (K)

The volume of biogas evolved needs to be adjusted to determine the corresponding amount of gaseous carbon released, employing the standard equation: 22,4 mL of biogas at standard conditions = 12 mg of C_g.

The recorded volumes are also adjusted to account for variations in water vapor pressure and atmospheric pressure that may have occurred during the test.

To calculate the average net amount, in grams, of gaseous carbon released during the anaerobic biodegradation of the test material, subtract the average amount, in grams, of gaseous carbon evolved in the three replicates of the test material from the average amount, in grams, of C_g evolved in the blank samples (three replicates). The biodegradation rate can be calculated using the following equation:

$$\% \text{ biodegradation} = \frac{m_{C,g}(\text{test}) - m_{C,g}(\text{blank})}{m_{C,i}} \times 100$$

Where,

$m_{C,g}$ is the amount of gaseous carbon evolved, in grams.
$M_{C,i}$ is the amount of carbon initially in the test material, in grams.

BPC Blue Anaerobic is suitable to perform tests in accordance with various standard protocols (**Table 1**):

Table 1. Examples of standard protocols that can be performed using BPC Blue Anaerobic System.

Protocols	Description	Environment
ISO 11734	Water quality — Evaluation of the "ultimate" anaerobic biodegradability of organic compounds in digested sludge — Method by measurement of the biogas production.	Slurry digestion
ISO 13975	Plastics — Determination of the ultimate anaerobic biodegradation of plastic materials in controlled slurry digestion systems — Method by measurement of biogas production.	Slurry digestion
ISO 14853	Plastics — Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system — Method by measurement of biogas production.	Aqueous medium
ISO 15985	Plastics — Determination of the ultimate anaerobic biodegradation and disintegration under high-solids anaerobic-digestion conditions — Method by analysis of released biogas.	High solid digestion
ASTM D5210	Standard test method for determining the anaerobic biodegradation of plastic materials in the presence of municipal sewage sludge.	Slurry digestion
ASTM D5511	Standard test method for determining anaerobic biodegradation of plastic materials under high-solids anaerobic-digestion conditions.	High solid digestion
ASTM D5526	Standard test method for determining anaerobic biodegradation of plastic materials under accelerated landfill conditions.	High solid digestion
OECD 311	Anaerobic biodegradability of organic compounds in digested sludge: By measurement of gas production.	Slurry digestion

2.1.1 BPC Blue Anaerobic (Default System)

The default configuration of the BPC Blue Anaerobic System (**Figure 1**) includes all the necessary components to conduct biodegradability studies under anaerobic conditions. The components are listed below:

Figure 1. BPC Blue Anaerobic Complete System.

Unit A – Incubation Unit

18 glass reactors (1 L)	1 motor controller signal cable	1 MCU power adapter
18 brushless DC motors 1 motor power splitter	18 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
19 brushless DC motor cables 250 mm (15 units) 500 mm (3 units) 1500 mm (1 unit)	18 stirrers GL 45 (1 L) standard	1 thermostatic water bath lid for 18 reactors (1 L)
	1 motor controller unit (MCU)	18 push-in valves 6 mm

Unit B – BPC Core Unit

1 BPC Core	36 check valves	1 main unit power adapter
18 flow cell units (FCUs)	1 plastic syringe	1 ethernet cable

Additional Components

1 Festo tubing 50 m	36 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	12 soft binders 7/180 mm	FCU volume sheet
18 tubing stoppers	36 multi-coloured marker clamps	

2.1.2 BPC Blue Anaerobic Light

The light version of BPC Blue Anaerobic has the same features and functionalities as the default system, but with a reduced number of channels and different size of reactors. BPC Blue Anaerobic Light (**Figure 2**) comes with 9 channels and 2 L reactors.

Figure 2. BPC Blue Anaerobic Light Complete System.

Unit A – Incubation Unit

9 glass reactors (2 L)	1 motor controller signal cable	1 MCU power adapter
9 brushless DC motors 1 motor power splitter	9 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
10 brushless DC motor cables 250 mm (6 units) 500 mm (3 units) 1500 mm (1 unit)	9 stirrers GL 45 (2 L) standard	1 thermostatic water bath lid for 9 reactors (2 L)
	1 motor controller unit (MCU)	9 push-in valves 6 mm

Unit B – BPC Core Light Unit

1 BPC Core	18 check valves	1 main unit power adapter
9 flow cell units (FCUs)	1 plastic syringe	1 ethernet cable

Additional components

1 Festo tubing 50 m	18 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	6 soft binders 7/180 mm	FCU volume sheet
9 tubing stoppers	18 multi-coloured marker clamps	

Both systems operate on a mechanism that is based on biogas measurements (**Figure 3**):

Figure 3. BPC Blue Anaerobic measures biogas produced by the biodegradation of plastic materials.

The FCU has 2 possible resolutions, 9 mL and 2 mL for low and ultra-low gas measurements. ***The operational principle is based on liquid displacement and buoyance***. When a certain gas volume enters the flow cell unit, the force of buoyancy leads the flow cell to open and releases the entrapped gas (**Figure 4**). The system counts each flow cell opening and registers the temperature and pressure for automatic compensation to normalise the flow rate and volume to standard conditions.

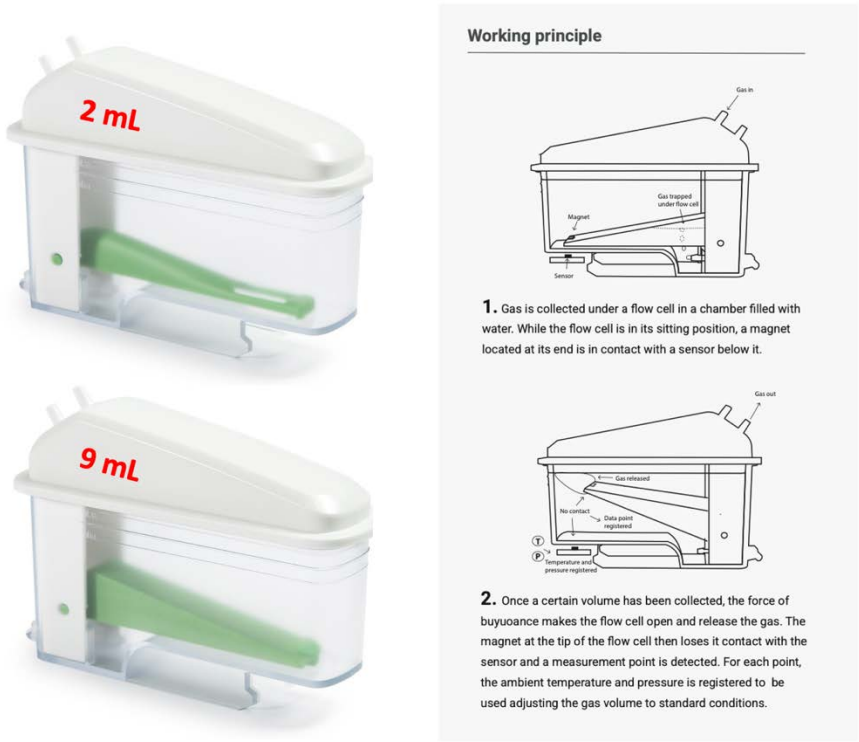


Figure 4. 2 and 9 mL FCUs and working principle.

2.1.3 BPC Blue Anaerobic DUO

This configuration consists of two BPC Core Units, where users can measure the total gas (e.g., $CH_4 + CO_2$) and a gas component (e.g., CH_4) from 18 samples simultaneously (**Figure 5**).

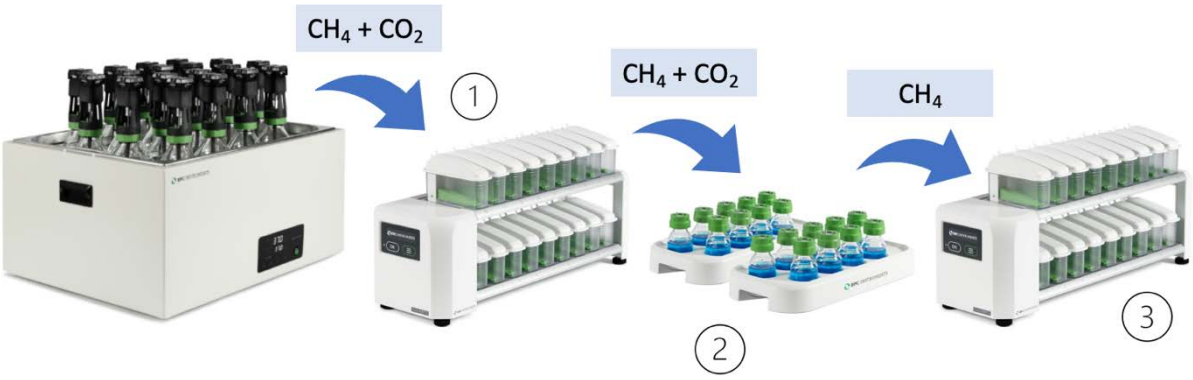


Figure 5. BPC Blue Anaerobic DUO operation divided in three stages.

The system operates based on three different stages:

- **Stage** ①: The accumulated gas volume and flow rate generated by the anaerobic digestion process (CH_4 + CO_2) is continuously measured by the first BPC Core Unit.
- **Stage** ②: Carbon dioxide is removed using a 3 mol/L NaOH solution (selective absorption). In this case, only a single gas component will be measured by the second detection unit.
- **Stage** ③: CH_4 is collected and measured by the second BPC Core Unit.

The average gas composition can be backcalculated and plotted at any time during the test.

Additionally, different measurement resolutions (2 and 9 mL) can be combined in this configuration depending on the application and requirements of the test. For instance, the first detection unit can have 9 mL FCUs and the second one 2 mL FCUs.

Unit A – Incubation Unit

18 glass reactors (1 L)	1 motor controller signal cable	1 MCU power adapter
18 brushless DC motors 1 motor power splitter	18 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
19 brushless DC motor cables 250 mm (15 units) 500 mm (3 units) 1500 mm (1 unit)	18 stirrers GL 45 (1 L) standard	1 thermostatic water bath lid for 18 reactors (1 L)
	1 motor controller unit (MCU)	18 push-in valves 6 mm

Unit B – CO_2-absorption Unit

2 bottle holders 9 x 250 mL	18 bottle nuts GL 45
18 glass bottles (250 mL)	18 lids GL 45

Unit C – BPC Core Unit

2 BPC Core	72 check valves	2 main unit power adapters
36 flow cell units (FCUs)	1 plastic syringe	2 ethernet cables

Additional Components

1 Festo tubing 50 m	72 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	12 soft binders 7/180 mm	FCU volume sheet
18 tubing stoppers	36 multi-coloured marker clamps	

2.1.4 BPC Blue Anaerobic Light DUO

For BPC Blue Anaerobic Light DUO, the same process described above can be done with nine samples using 2 L reactors. The package comes with one BPC Core Unit with 18 active channels for both total and single gas measurements (**Figure 6**).

Figure 6. BPC Blue Anaerobic Light DUO complete system.

Unit A – Incubation Unit

9 glass reactors (2 L)	1 motor controller signal cable	1 MCU power adapter
9 brushless DC motors 1 motor power splitter	9 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
10 brushless DC motor cables 250 mm (6 units) 500 mm (3 units) 1500 mm (1 unit)	9 stirrers GL 45 (2 L) standard	1 thermostatic water bath lid for 9 reactors (2 L)
	1 motor controller unit (MCU)	9 push-in valves 6 mm

Unit B – CO_2-absorption Unit

1 bottle holders 9 x 250 mL	9 bottle nuts GL 45
9 glass bottles (250 mL)	9 lids GL 45

Unit C – BPC Core Light Unit

1 BPC Core	36 check valves	1 main unit power adapter
18 flow cell units (FCUs)	1 plastic syringe	1 ethernet cable

Additional components

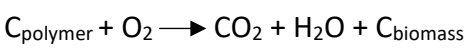
1 Festo tubing 50 m	36 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	6 soft binders 7/180 mm	FCU volume sheet
18 tubing stoppers	18 multi-coloured marker clamps	

The following items are **NOT** provided in the packages above:

- Flushing gas to obtain anaerobic conditions inside the reactors during the sample preparation phase.
- 3 mol/L sodium hydroxide (NaOH) solution.
- pH indicator (Thymolphthalein) and ethanol.
- Additional wall socket adapters (plugs/contacts). The ones supplied are according to European, US or UK standards, depending on the country where the instrument will be operated.
- Gas sampling units and gas bags for off-line gas composition analysis.

2.2 Aerobic Biodegradability Analysis

The biodegradation process of plastic materials under aerobic conditions can be summarized by the following reaction:



$$C_{polymer} + O_2 \longrightarrow CO_2 + H_2O + C_{biomass}$$

The basic driving force of biodegradation is the action of microorganisms, in the presence of oxygen, using the carbon (C) bound in the polymer as a feedstock, breaking down the organic matter into simpler compounds, such as carbon dioxide, water, mineral salts and new microbial cellular constituents (biomass). The biodegradation rate can be determined by directly measuring the amount of CO_2 evolved as a function of time. However, there are several challenges/issues regarding the analytical apparatus related to this procedure, as described below:

- Complex and expensive instrumentation. The system requires a pressurized-air setup that provides CO_2-free, H_2O-satured air to each reactor at accurate flow rates high enough to create truly aerobic conditions through the test. Additionally, suitable devices for measuring CO_2 and O_2 concentrations, such as continuous infrared analyzer or gas chromatograph, are needed.
- Depending on the analytical instrument applied (e.g., gas chromatograph), it may be necessary to add a cooling unit to remove water from the air.
- Oxygen levels must be closely monitored and controlled during the test, especially if adjustments of the air-flow rate are made.
- Usually, taking into consideration the limit of quantification of CO_2 sensors, a high concentration of test material is required in order to yield enough carbon dioxide for the determination. In this way, big reactors are required for the test, which affect the size and properties of the incubation unit which is used for temperature control.

Alternatively, BPC Blue Aerobic System provides a simple, efficient, precise and accurate method for determining the biodegradation rate of polymers under aerobic conditions. This volumetric respirometer continuously measures oxygen consumption resulting from CO_2 production throughout the entire experiment, providing real-time information on the dynamics of the biodegradation process, including kinetic information and degradation profile.

This system requires a small amount of test material and aerobic inoculum (e.g., 1 g test material per 100 g inoculum), where dynamic or static incubation (with and without mixing) can be applied depending on the type of fermentation medium considered for the test. BPC Blue Aerobic operates based on the mechanism illustrated below (**Figure 7**):

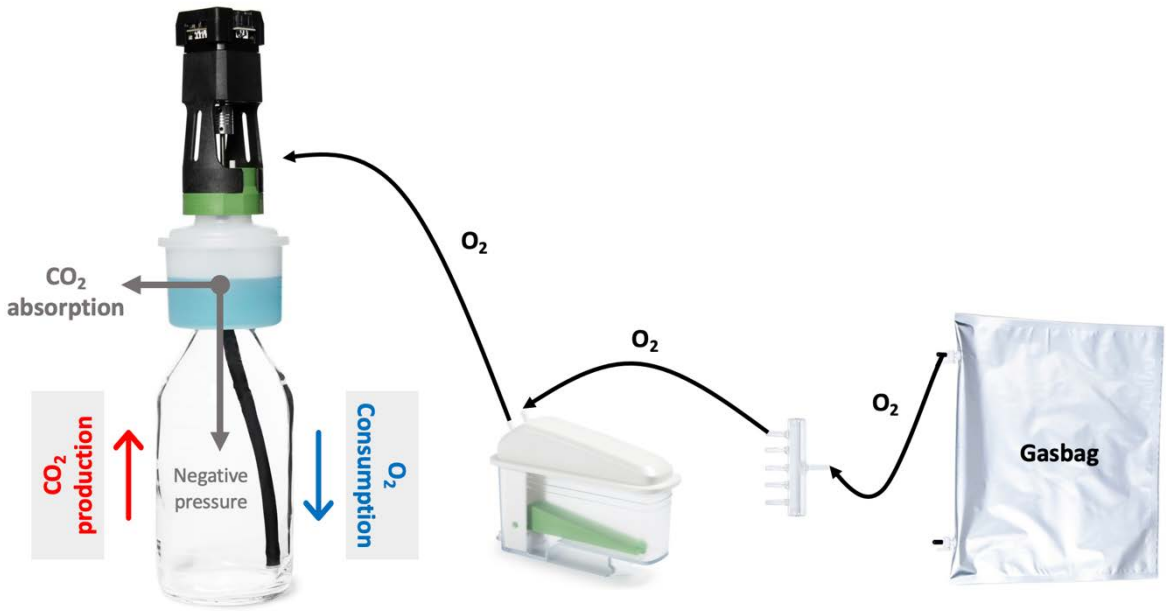


Figure 7. Operating mechanism of BPC Blue Aerobic System.

In the presence of oxygen, the biodegradation of the tested material initiates and carbon dioxide is continuously produced. The CO_2 generated is absorbed by a 3 mol/L sodium hydroxide solution placed in the GAA unit attached to the reactor. Carbon dioxide reacts with sodium hydroxide in an acid-base reaction to generate sodium carbonate and sodium bicarbonate:

$$2\,NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$
$$Na_2CO_3 + CO_2 + H_2O \rightarrow 2NaHCO_3$$

This process creates a small negative pressure inside the reactor, which become the driving force for a flow of oxygen from the gasbag to the reactor in order to re-equilibrate the pressure. In this manner, the system precisely quantifies the gas volume accumulated over time and calculates the biodegradability. The biodegradation rate (D_t) is determined by comparing the Specific Biochemical Oxygen Demand (BODs), measured by the instrument, with the Theoretical Oxygen Demand (ThOD), which can be calculated if the chemical composition of the investigated material is known or it can be determined by elemental analysis.

$$\text{BODs} = \frac{B_t - B_{bt}}{C_T} \qquad D_t = \frac{BODs}{ThOD} \times 100$$

Where,

B_t is the BOD of the reactors containing the test material at time t.
B_{bt} is the BOD of the blank at time t.
C_T is the concentration of the test material in the reaction mixture.

The amount of oxygen demand/consumed during the test is proportional to the amount of carbon dioxide generated by the biodegradation process. Based on this mechanism, BPC Blue Aerobic System does not require CO_2 and O_2 sensors and a pressurized-air unit and its associated components, since the instrument is a closed system which directly measures the consumed oxygen by the aerobic respiration of microorganisms, as result of biodegradation of the polymer sample. Furthermore, since each reactor has a carbon dioxide-trapping apparatus (GAA unit), the final concentration of CO_2 can be determined by titration at the end of the test.

BPC Blue Aerobic is an ideal analytical platform for conducting biodegradability tests in accordance with various international standard protocols (**Table 2**). The system provides a proper setup to easily create standardised procedures required for laboratory-based biodegradability tests performed under well-controlled conditions. With BPC Blue Aerobic System, users have a high degree of control over temperature, humidity, mixing, testing period, and level of contact between the test material and microorganisms, which are key factors that define the rate of biodegradation of plastic materials.

Table 2. Examples of standard protocols that can be followed using BPC Blue Aerobic System.

Protocols	Description	Environment
ISO 14851	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium – Method by measuring the oxygen demand in a closed respirometer.	Aqueous medium
ISO 17556	Plastics — Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved.	Soil
ISO 18830	Plastics — Determination of aerobic biodegradation of non-floating plastic materials in a seawater/sandy sediment interface — Method by measuring the oxygen demand in closed respirometer.	Seawater/sandy sediment
ISO 23977-2	Plastics — Determination of the aerobic biodegradation of plastic materials exposed to seawater — Part 2: Method by measuring the oxygen demand in closed respirometer.	Seawater
ASTM D5929	Standard test method for determining biodegradability of materials exposed to source-separated organic municipal solid waste mesophilic composting conditions by respirometry.	Compost
ASTM D5988	Standard test method for determining aerobic biodegradation of plastic materials in soil.	Soil
OECD 301	Ready biodegradability – Screening of chemicals for ready biodegradability in an aerobic aqueous medium.	Aqueous medium

2.2.1 BPC Blue Aerobic (Default System)

BPC Blue Aerobic (**Figure 8)**, the default package, is provided with the following components described below:

Figure 8. BPC Blue Aerobic Complete System.

Unit A – Incubation Unit

18 glass reactors (1 L)	1 motor controller signal cable	1 MCU power adapter 1 motor controller unit (MCU)
18 brushless DC motors 1 motor power splitter	18 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
19 brushless DC motor cables 250 mm (15 units) 500 mm (3 units) 1500 mm (1 unit)	18 stirrers GL 45 (1 L) GAA 18 push-in valves 6 mm	1 thermostatic water bath lid for 18 reactors (1 L)

Unit B – CO_2-absorption Unit

18 Gas Absorption attachment (GAA) units	18 funnels for GAA

Unit C – BPC Core Unit

1 BPC Core	36 check valves	1 main unit power adapter
18 flow cell units (FCUs)	1 plastic syringe	1 ethernet cable

Additional components

1 Festo tubing 50 m	36 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	6 soft binders 7/180 mm	3 gasbags
18 tubing stoppers	18 multi-coloured marker clamps	FCU volume sheet
1 Gas distribution Manifold 3 Mk 2	3 Gas distribution Manifolds 6 Mk 2	

2.2.2 BPC Blue Aerobic Light

Compared to the default package, BPC Blue Aerobic Light (**Figure 9**) is equipped with bigger reactors (2 L) and reduced number of channels (9 channels). The complete setup is listed below:

Figure 9. BPC Blue Aerobic Light Complete System.

Unit A – Incubation Unit

9 glass reactors (2 L)	1 motor controller signal cable	1 MCU power adapter 1 motor controller unit (MCU)
9 brushless DC motors 1 motor power splitter	9 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
10 brushless DC motor cables 250 mm (6 units) 500 mm (3 units) 1500 mm (1 unit)	9 stirrers GL 45 (1 L) GAA 9 push-in valves 6 mm	1 thermostatic water bath lid for 9 reactors (2 L)

Unit B – CO_2-absorption Unit

9 Gas Absorption attachment (GAA) units	9 funnels for GAA

Unit C – BPC Core Unit

1 BPC Core	18 check valves	1 main unit power adapter
9 flow cell units (FCUs)	1 plastic syringe	1 ethernet cable

Additional components

1 Festo tubing 50 m	18 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	3 soft binders 7/180 mm	3 gasbags
9 tubing stoppers	9 multi-coloured marker clamps	FCU volume sheet 4 Gas distribution Manifolds 3 Mk 2

2.3 BPC Blue Premium

The BPC Blue Premium configuration is specifically designed to perform tests under both anaerobic and aerobic conditions. In this way, this versatile system allows users to measure oxygen consumption or biogas/biomethane production as a function of time. The *Ex-situ* CO_2-absorption unit is also provided for single gas measurements (e.g., CH_4) under anaerobic conditions.

2.3.1 BPC Blue Premium (Default System)

The default package corresponds to BPC Blue Aerobic System with additional 18 stirrers to convert the setup from aerobic (**Figure 10 – A**) to anaerobic configuration (**Figure 10 – B**). In addition, this system comes 36 flow cell units, 9 mL FCUs (18 units) and 2 mL FCUs (18 units).

Figure 10. Reactor configuration for (A) aerobic and (B) anaerobic tests.

The default package (**Figure 11**) is specifically equipped with the following items:

Figure 11. BPC Blue Premium Complete System.

Unit A – Incubation Unit

18 glass reactors (1 L)	1 motor controller signal cable	1 MCU power adapter 1 motor controller unit (MCU)
18 brushless DC motors 1 motor power splitter	18 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
19 brushless DC motor cables 250 mm (15 units) 500 mm (3 units) 1500 mm (1 unit)	18 stirrers GL 45 (1 L) GAA 18 stirrers GL 45 (1 L) Standard 18 push-in valves 6 mm	1 thermostatic water bath lid for 18 reactors (1 L)

Unit B – CO_2-absorption Unit

18 Gas Absorption attachment (GAA) units	18 funnels for GAA
2 bottle holders 9 x 250 mL	18 bottle nuts GL 45
18 glass bottles (250 mL)	18 lids GL 45

Unit C – BPC Core Unit

1 BPC Core	36 check valves	1 main unit power adapter
18 flow cell units (9 mL) 18 flow cell units (2 mL)	1 plastic syringe	1 ethernet cable

Additional components

2 Festo tubing 50 m	36 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	12 soft binders 7/180 mm	3 gasbags
18 tubing stoppers	36 multi-coloured marker clamps	FCU volume sheet
1 Gas distribution Manifold 3 Mk 2	3 Gas distribution Manifolds 6 Mk 2	

2.3.2 BPC Blue Premium Light

In line with the structure described in the manual for the light versions, the BPC Premium Light variant is outfitted with 9 reactors, each with a capacity of 2 L. The components included in this configuration (**Figure 12**) are listed below:

Figure 12. BPC Blue Premium Light Complete System.

Unit A – Incubation Unit

9 glass reactors (2 L)	1 motor controller signal cable	1 MCU power adapter 1 motor controller unit (MCU)
9 brushless DC motors 1 motor power splitter	9 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
10 brushless DC motor cables 250 mm (6 units) 500 mm (3 units) 1500 mm (1 unit)	9 stirrers GL 45 (2 L) GAA 9 stirrers GL 45 (2 L) Standard 9 push-in valves 6 mm	1 thermostatic water bath lid for 9 reactors (2 L)

Unit B – CO_2-absorption Unit

9 Gas Absorption attachment (GAA) units	9 funnels for GAA
1 bottle holder 9 x 250 mL	9 bottle nuts GL 45
9 glass bottles (250 mL)	9 lids GL 45

Unit C – BPC Core Light Unit

1 BPC Core	18 check valves	1 main unit power adapter
9 flow cell units (9 mL) 9 flow cell units (2 mL)	1 plastic syringe	1 ethernet cable

Additional components

1 Festo tubing 50 m	9 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	3 soft binders 7/180 mm	3 gasbags
9 tubing stoppers	9 multi-coloured marker clamps	FCU volume sheet 4 Gas distribution Manifolds 3 Mk 2

2.3.3 BPC Blue Premium DUO

BPC Blue Premium DUO provides enhanced analysis capacity for tests specifically designed to determine gas composition, under anaerobic conditions. Additionally, it incorporates all the necessary components required for aerobic biodegradability assays (**Figure 13**):

Figure 13. BPC Blue Premium DUO Configuration.

Unit A – Incubation Unit

18 glass reactors (1 L)	1 motor controller signal cable	1 MCU power adapter 1 motor controller unit (MCU)
18 brushless DC motors 1 motor power splitter	18 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
19 brushless DC motor cables 250 mm (15 units) 500 mm (3 units) 1500 mm (1 unit)	18 stirrers GL 45 (1 L) GAA 18 stirrers GL 45 (1 L) Standard 18 push-in valves 6 mm	1 thermostatic water bath lid for 18 reactors (1 L)

Unit B – CO_2-absorption Unit

18 Gas Absorption attachment (GAA) units	18 funnels for GAA
2 bottle holders 9 x 250 mL	18 bottle nuts GL 45
18 glass bottles (250 mL)	18 lids GL 45

Unit C – BPC Core Unit

2 BPC Core	72 check valves	2 main unit power adapters
36 flow cell units (9 mL) 36 flow cell units (2 mL)	1 plastic syringe	2 ethernet cables

Additional components

2 Festo tubing 50 m	72 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	12 soft binders 7/180 mm	3 gasbags
18 tubing stoppers	36 multi-coloured marker clamps	FCU volume sheet
1 Gas distribution Manifold 3 Mk 2	3 Gas distribution Manifolds 6 Mk 2	

2.3.4 BPC Blue Premium Light DUO

Figure 14. BPC Blue Premium Light DUO System.

Unit A – Incubation Unit

9 glass reactors (2 L)	1 motor controller signal cable	1 MCU power adapter 1 motor controller unit (MCU)
9 brushless DC motors 1 motor power splitter	9 axis couplings for brushless DC motors	1 thermostatic water bath 1 base tray
10 brushless DC motor cables 250 mm (6 units) 500 mm (3 units) 1500 mm (1 unit)	9 stirrers GL 45 (2 L) GAA 9 stirrers GL 45 (2 L) Standard 9 push-in valves 6 mm	1 thermostatic water bath lid for 9 reactors (2 L)

Unit B – CO_2-absorption Unit

9 Gas Absorption attachment (GAA) units	9 funnels for GAA
1 bottle holder 9 x 250 mL	9 bottle nuts GL 45
9 glass bottles (250 mL)	9 lids GL 45

Unit C – BPC Core Light Unit

1 BPC Core	36 check valves	1 main unit power adapter
18 flow cell units (9 mL) 18 flow cell units (2 mL)	1 plastic syringe	1 ethernet cable

Additional components

1 Festo tubing 50 m	18 push-in connectors 6 mm	1 bottle/tube opening tool
1 funnel	6 soft binders 7/180 mm	3 gasbags
9 tubing stoppers	18 multi-coloured marker clamps	FCU volume sheet 4 Gas distribution Manifolds 3 Mk 2

In comparison with BPC Blue Premium Light, the DUO version (**Figure 14**) is equipped with 18 channels with additional related components (e.g., check valves, flow cell units and push-in connectors).

Chapter 03: Equipment Description – Installation and Operation

3.1 BPC Blue Anaerobic Systems

BPC Blue Anaerobic delivers precise and efficient data analysis of biogas release resulting from the biodegradation of organic materials in the absence of oxygen.

3.1.1 Equipment Description

BPC Blue Anaerobic configurations consist mainly of two parts: Incubation Unit and BPC Core Unit (also called gas volume measuring device).

1) **<u>Incubation Unit (Unit A)</u>**: Here is where the fermentation process takes place (**Figure 15**). 18 (0.5 or 1 L) or 9 (2 L) reactors are placed inside a thermostatic water bath (68 x 56 x 33 cm), which is used for temperature control (up to 60° C, precision of 0.2° C). The thermostatic water bath is provided with a lid for 18 or 9 reactors to minimise water loss and ensure that the temperature set point is rapidly reached. The incubation system provides a well-controlled environment in regard to temperature, pH, and relative humidity for biogas production.

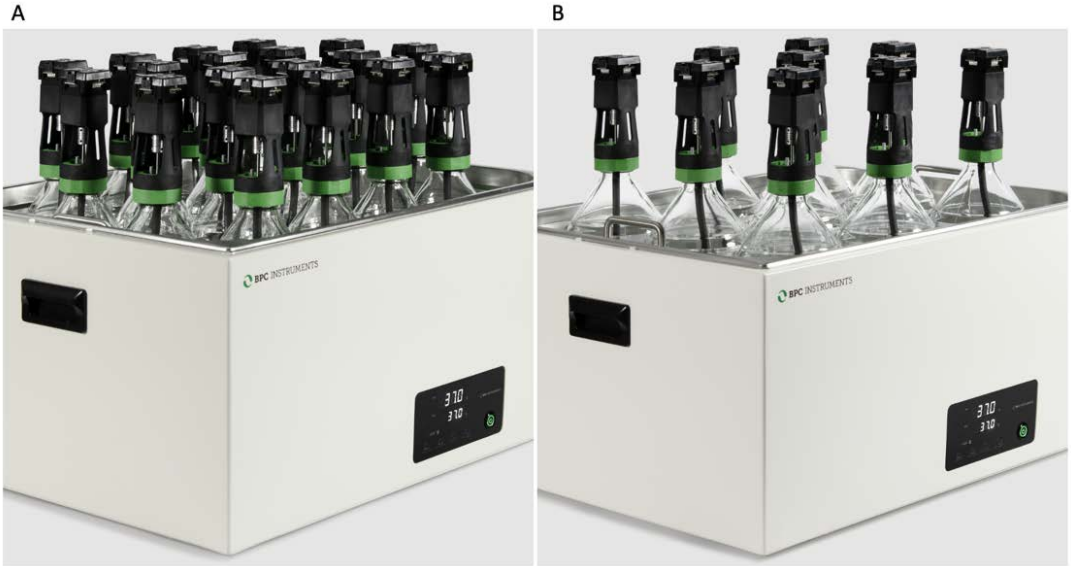


Figure 15. (A) Incubation Unit for BPC Blue Anaerobic (Default Package) and (B) BPC Blue Anaerobic Light.

Each reactor is connected to a brushless DC motor that ensures a well-mixed content through a strong, reliable, and multifunctional agitation system (**Figure 16**). A motor controller provides the power via motor cables, where all the motors receive the same information. **The MCU needs to be turned off and unplugged from the power source when any cables are connected or disconnected from the motors.**

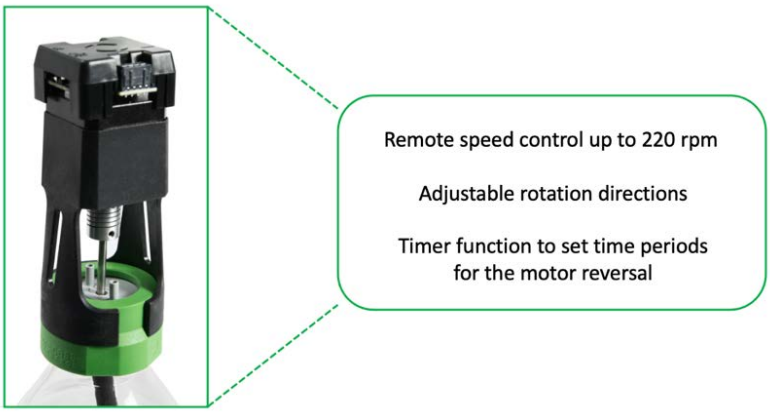


Figure 16. Main features of the agitation system.

2) **<u>BPC Core Unit (Unit B):</u>** Here the gas is recorded and processed. The BPC Core Unit consists of 18 or 9 flow cell units for simultaneous gas volume detection from 18 or 9 independently operating reactors (**Figure 17**). Unit B comes with an OLED screen which will display various information, including IP address of the instrument, version of the software, current environmental parameters (temperature and pressure), and alignment indicator. The information can be accessed through two physical buttons located below the screen. The BPC Core Unit is equipped with an USB port for software upgrades and possible new applications and a power button.

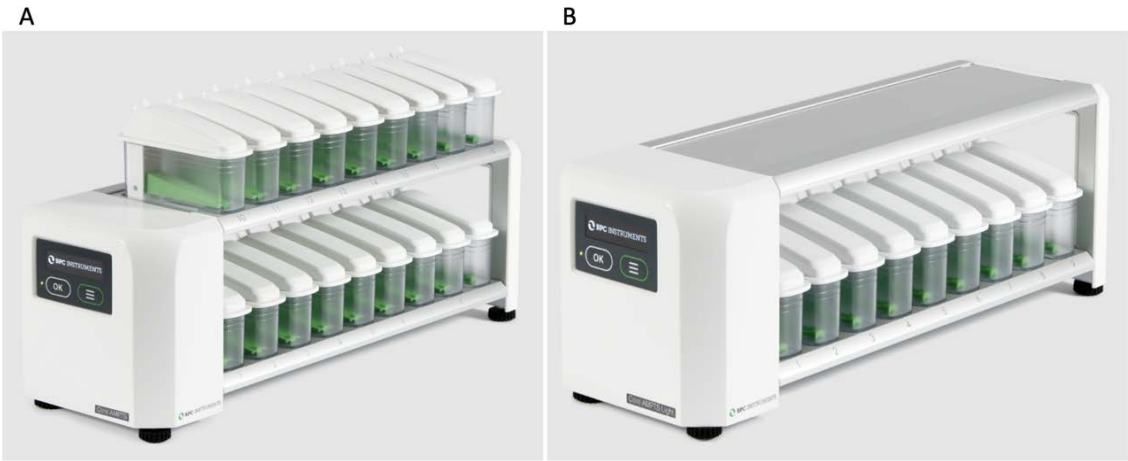


Figure 17. (A) Gas volume measuring device for BPC Blue Anaerobic and (B) BPC Blue Anaerobic Light.

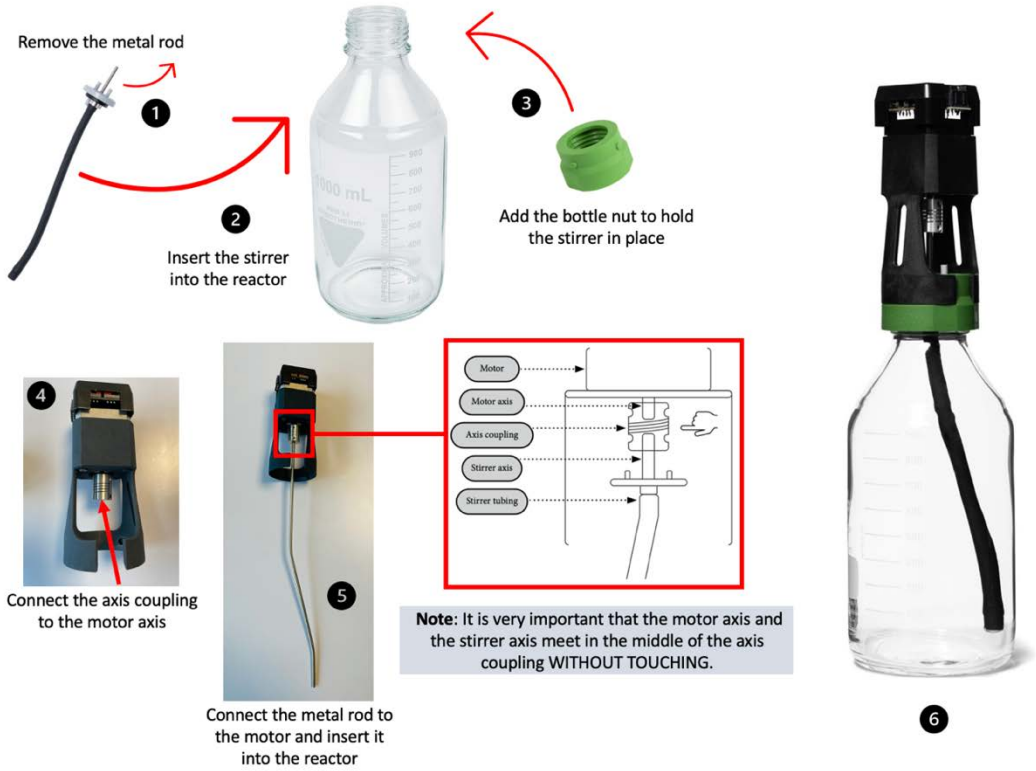
BPC Blue Anaerobic DUO, including the light version, and BPC Blue Premium (all configurations) include the *Ex-situ* CO_2-absorption unit (**Figure 18**), where CO_2 and traces of hydrogen sulphide are removed through a chemical reaction with a 3 mol/L NaOH solution in order to measure biomethane.

Figure 18. *Ex-situ* CO_2-absorption unit for single gas measurements under anaerobic conditions.

3.1.2 Setting up the Instrument

In order to install the system properly, the steps described below need to be followed:

Step 1: Unpack the instrument and place the thermostatic water bath on a flat and stable surface.
Step 2: Remove the blue plastic protection on the thermostatic water bath lid, mount the legs and handles and place the lid on top of the thermostatic water bath.
Step 3: Fix the reactors after adding the samples by following the instructions below:



Step 4: Place the reactors inside the thermostatic water bath. Add a piece of tubing to the push-in valve and attach it to one of the 2 ports on the lid (the other one is the gas outlet).

A funnel is provided with the instrument to facilitate the introduction of solid samples inside the reactor. Once all reactors are in place, distilled/deionised water needs to be added into the thermostatic water bath until the recommended level by using the designated hole on the thermostatic water bath lid.

In the thermostatic water bath, the temperature is controlled by a simple and intuitive digital interface. The instrument contains 2 LED screens: the first one displaying the current temperature (PV) and the second one showing the desired temperature (SV). Press the button ***SET*** to determine SV. The desired temperature can be easily selected by using the shift digit, increase and decrease buttons. When the button ***SET*** is pressed, the last digit of the value displayed in SV blinks, indicating that the respective digit can be changed by pressing the buttons increase (∧) and decrease (∨). If there is a considerable difference between the current and desired temperature in SV, the operator can use the shift digit button (R/S) to select the first digit and quickly go from 30 to 60°C, for example. Once the desired temperature is selected, press the button ***SET*** again to save the value. Once the desired temperature is established, the instrument will heat the water until PV and SV reach the same values. When the light ***HEAT*** is on, it is an indication that the instrument is on heating mode. When the temperature in PV is close to reach the SV, 2° C from SV, the light ***HEAT*** will start blinking until the desired temperature is achieved.

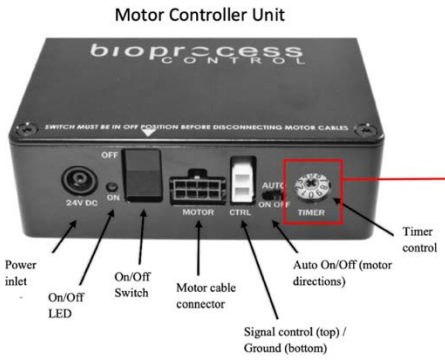
NOTE: Check periodically the water level inside the thermostic water bath.

Step 5: Fixing the agitation system. Connect the short motor cables (250 mm) in series by attaching one short motor cable to each motor (excluding the last motor in the chain), and then connecting the free end of the cable from motor 1 to the free port on motor 2 and so on until motor 9. Repeat the same operation for the remaining nine motors, creating two groups of motors connected to each other through short cables. After that, connect the 500 mm motor cable from the last motor in the chain of each group to the motor power splitter. Finally, use the 1500 mm motor cable to connect the power splitter to the MCU. The last step is to connect the signal cable from the motor controller to the detection unit.

The same procedure described above can be used for BPC Blue Anaerobic Light.

NOTE: Make sure that the power adapter for the motor controller is disconnected from the power supply when inserting or removing the motor cables.

From the motor it is only possible to control the direction of the mixing, clockwise (CW), AUTO and counterclockwise (CCW). If users select AUTO, the motor controller will dictate the change of direction at certain intervals using the timer, if the motor controller's AUTO is ON. Since the signal cable connects the motor controller to the detection unit, the phase (single or double) and speed can be controlled using the software (see pages 38 and 39).



Timer position	Time (s)
0	5
1	15
2	30
3	45
4	60
5	120
6	300
7	600
8	1800
9	3600

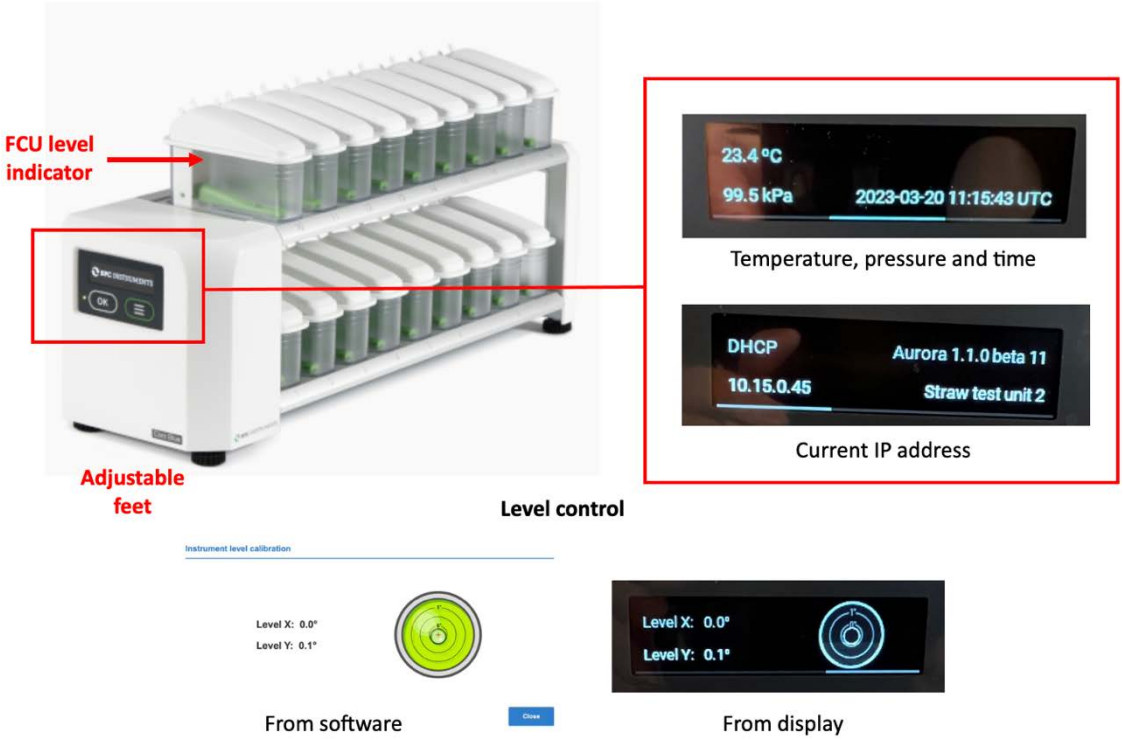
Step 6: Prepare 3 mol/L NaOH solution (***BPC Blue Anaerobic DUO and Premium Configurations***). The 250 mL bottles should be filled with 200 mL of the alkaline solution which makes it necessary to add 3.6 L and 1.8 L of 3 mol/L NaOH for 18 and 9 glass bottles, respectively. After weighing 432 g (for 18 bottles) or 216 g (for 9 bottles) of NaOH pellets, mix it with approximately 3⁄4 of the required total volume of distilled water. The heat generation following dissolution of NaOH in water is high, it is therefore recommended to add small amounts of supplementary water followed by mixing. When the NaOH is completely dissolved, add the remaining amount of water until the total volume (3.6 or 1.8 L) is reached. Prepare 0.4% Thymolphthalein by dissolving 40 mg in 9 mL ethanol followed by 1 mL of water. Mix it with 3 mol/L NaOH solution. After adding 200 mL of 3 mol/L NaOH solution with pH indicator in each bottle, place them on the bottle holder.

Step 7: Add distilled water inside the FCU and place them on the detection unit.

Each FCU has an inlet and outlet for the gas. Use the syringe to introduce water through the inlet of the FCU

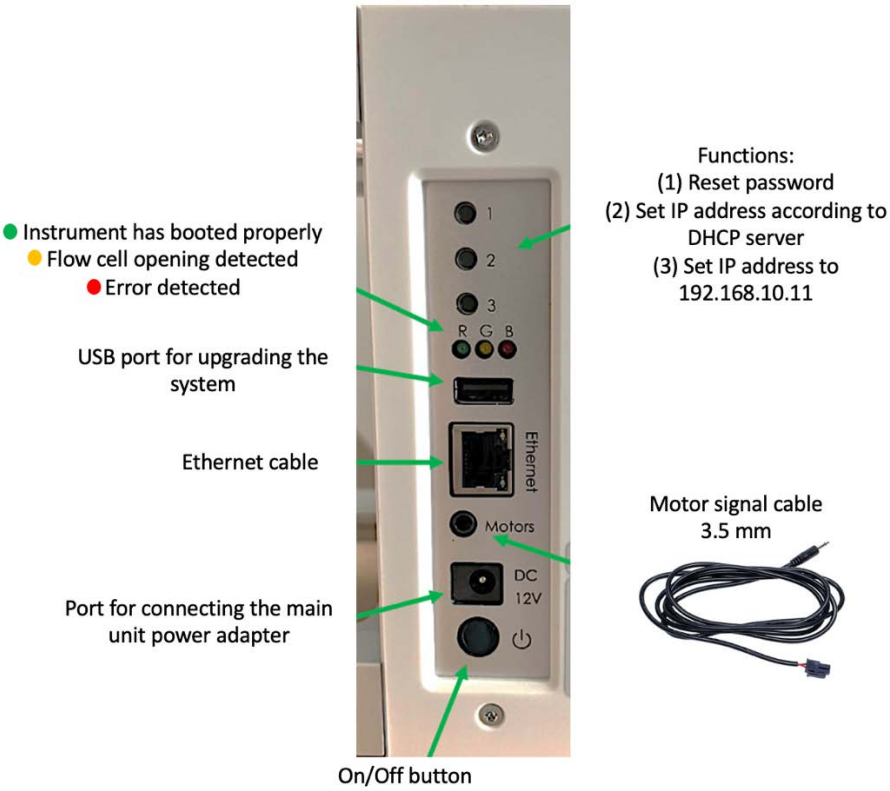
The water should be added until the recommended level

Make sure that each FCU is perfectly seated (horizontally levelled) on the BPC Core Unit. It can be easily observed by checking the **FCU level indicator** and the level control from the software or the OLED screen as shown below. **Adjustable feet** are used to level the instrument.



The BPC Core Unit is equipped with an OLED screen that provides information regarding the status of the instrument (environmental conditions, time, current IP address used by the instrument and alignment indicator). This can be accessed through two physical buttons located below the screen.

Backside of the BPC Core Unit:



Step 8: Cut 36 (BPC Blue Anaerobic) or 18 (BPC Blue Anaerobic Light) pieces of Festo tubing sufficient in length to connect the gas outlet of each reactor to the corresponding FCU. In order to simplify this procedure, use push-in connectors (two per channel) provided with the instrument. To avoid water flowing back from Unit B to Unit A, check valves can be inserted close to the inlet of each FCU in order to the target substance flow in one direction only.

NOTE: If the user wants to flush the reactors to create the anaerobic environment, disconnect the tubing from the BPC Core Unit before to eliminate the risk of damaging the external check valves (if used) by the high-pressure gas flow.

Step 9: Use the softer binder to group tubing of channels that are related to each other. If the test is conducted in triplicate, it is possible to put together six groups with three channels (tubing) each based on the content of the reactors. In order to easily identify each channel, add the multi-coloured marker clamps (two per channel) provided in different colors. Mark each channel by writing the proper description using a ballpoint pen, water-based pen, marker, etc. After the experiment, users can wipe the label off with a wet tissue and reuse them.

Soft binder 7/180 mm

Multi-coloured marker clamps

Step 10: In order to start the test, access the software following the instructions in Chapter 4 of this manual. Add the parameters required for the test and make sure that the status of each channel is classified as **ready** before starting the gas measurements. ***If the status of the channel says "detached", it means that the instrument is not able to detect a FCU in place.*** When using the instrument for the first time, the cell volume of each channel needs to be entered on the control page. A calibration sheet is delivered with the equipment, where the serial number of the flow cell unit is listed together with its calibrated volume. It is important to know where each flow cell unit will be placed on the system, so that the calibrated values can be entered in the right position.

NOTE: Testing the detection unit and software. Before starting the experiment, simulate a flow cell opening by manually removing each FCU and put it back in numerical order from 1 to 18 (repeat this procedure three times). Follow the corresponding result of each opening on the plots on the graph page of the software to make sure that both the detection system and data acquisition system function properly.

Step 11: Once the experiment is finished, generate and download a report on the report menu of the software. Turn off the thermostatic water bath and the motors, including the motor controller. Next, unplug the power adapters (for the Motor Controller and the Gas Volume Measuring Device) from the power source. Disconnect the tubing and remove the lids from the reactors and CO_2 removal bottles after the tests. Removing these components after experiments can often pose a challenge due to their tight fit, specially the tubing to the different connectors. BPC Blue Configurations are equipped with a bottle/tube opening tool to easily remove lids and tubing without the risk of damaging them and the connectors.

Bottle/tube opening tool

3.2 BPC Blue Aerobic Systems

3.2.1 Equipment Description

BPC Blue Aerobic Configurations are composed of four essential components: the incubation unit, the CO_2-absorption unit (*in-situ* apparatus), the detection device, and the oxygen supplier bags.

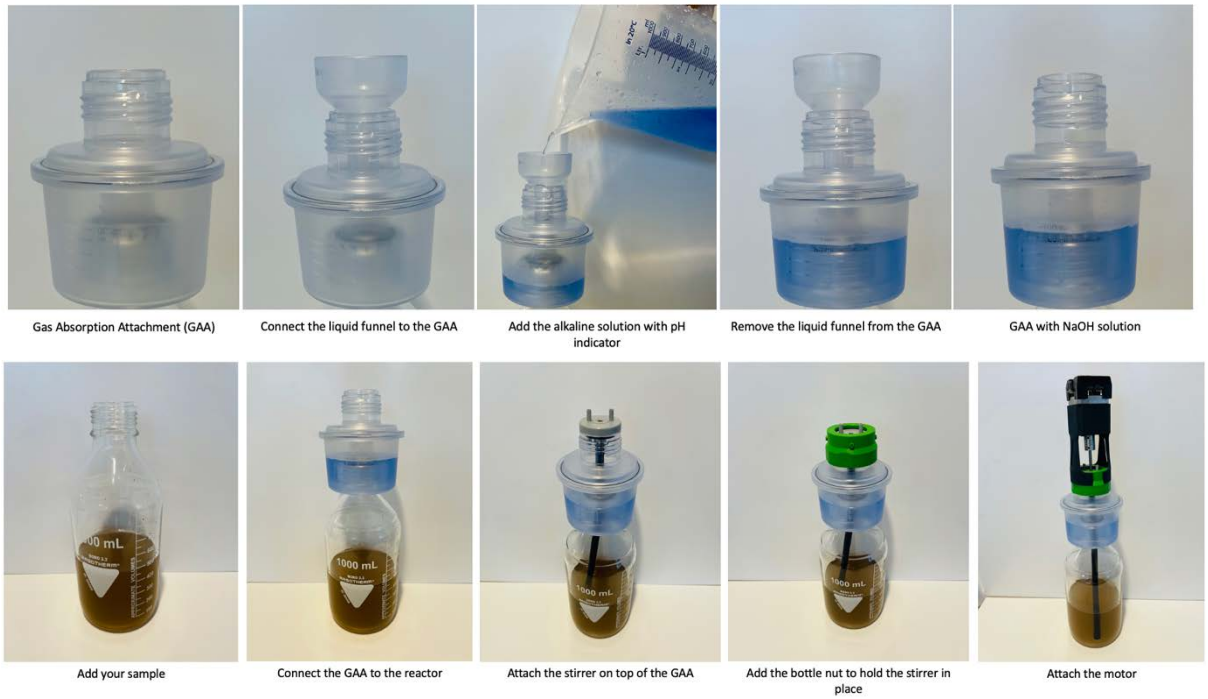
The driving force behind biodegradation is the utilization of carbon present in the polymer as a food source for microorganisms to grow. As the biodegradation process commences, carbon dioxide (CO_2) is generated. In the case, the CO_2 produced during biodegradation is effectively consumed through a chemical reaction with an alkaline solution contained in the GAA. This CO_2 removal results in a negative pressure within the reactor, leading to an inflow of oxygen from the gasbag to the reactor in order to restore equilibrium. Consequently, the instrument continuously measures the accumulated volume of oxygen consumed as a function of time throughout the entire experiment.

The Specific Biochemical Oxygen Demand (BODs) is used to determine the biodegradation rate of the tested material and provide valuable insights regarding the dynamics of the process.

3.2.2 Setting up the Instrument

Following the same procedure described above (topic 3.1.2 – page 27), consider the following adaptations and additional procedures for the aerobic setup:

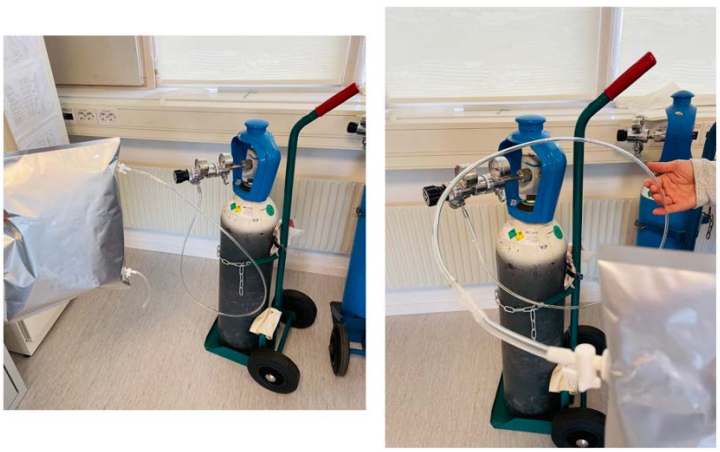
- In **Step 3**, before fixing each reactor according to the illustration provided, attach the Gas Absorption Attachment (GAA) to the reactor and add the NaOH solution with pH indicator as described below*:



* Illustration using the previous GAA unit. Same procedure for the new configuration.

NOTE: Make sure that the GAA is very well attached to the reactor in order to avoid gas leakage.

- Fill up the gas bag using an oxygen cylinder equipped with a pressure regulator.



- Connect the gas distribution manifold (6) to the gas bag. The gas distribution manifold allows one single stream of oxygen to be divided into six different streams. In this case, 3 gas bags are required to get 18 streams of oxygen to be connected to 18 FCUs (similar setup provided for the light version). In order to avoid backflow of water from the FCU to the gas bag, the gas bags should be hanged as illustrated in the picture below*.

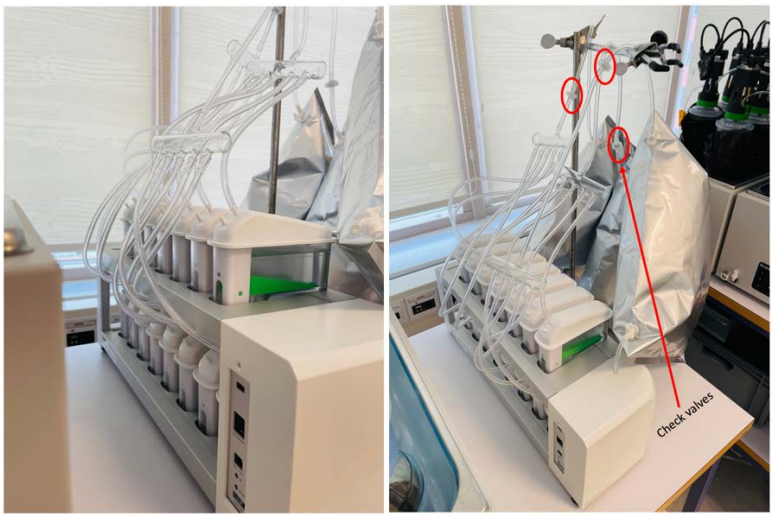
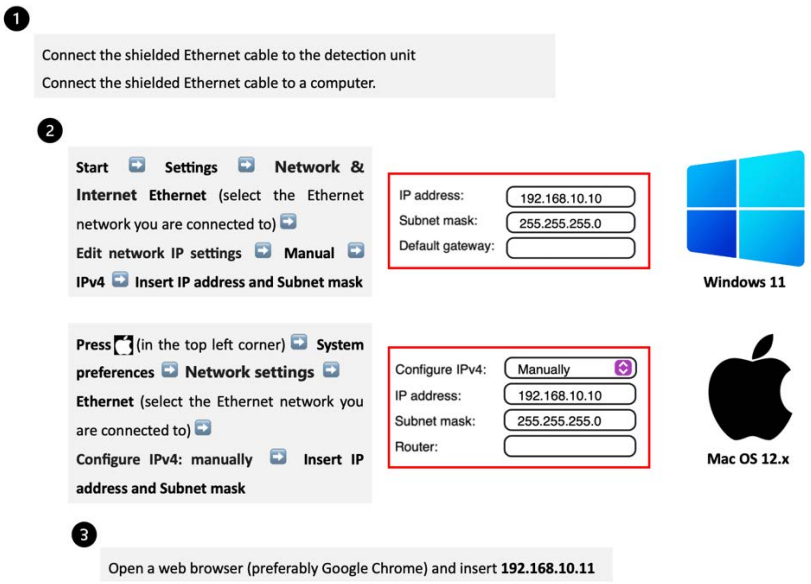


*Illustration using the previous detection unit with 15 channels. Same procedure for the new configuration.

Chapter 04: Web-based Software

4.1 Computer Network Configuration

In order to have access to the web-based software, follow the steps outlined below (this procedure is described considering the most common operating system setups – **Windows 11** and **Mac Os 12.x**):



4.2 Network Quick Guide

	Instrument	Computer
IP address	192.168.10.11	192.168.10.10
Subnet mask	255.255.255.0	255.255.255.0
Default gateway / Router	Leave empty	Leave empty

NOTE: IP address for the computer and the IP address for the BPC Core Unit are different. This is a design requirement of the IP protocol. Care needs to be taken so that the same address is not used in both locations, as it will render the system inaccessible from the designated computer. When using multiple BPC Core Units, make sure that each unit has its own IP address. This can be achieved by changing the last digit of the IP address.

The OLED screen in the detection unit will display whether the instrument uses a manually assigned IP or an automatic IP assigned by a DHCP server as well as what IP address is currently in use and the version of the instrument's software. In this way, it is simple and easy to connect the instrument to a computer or network.

4.3 Aurora™ Software Description

After inserting the default IP address of the instrument, users will have access to the **Log in** page. On the Log in page, the default password **bpc** needs to be added.

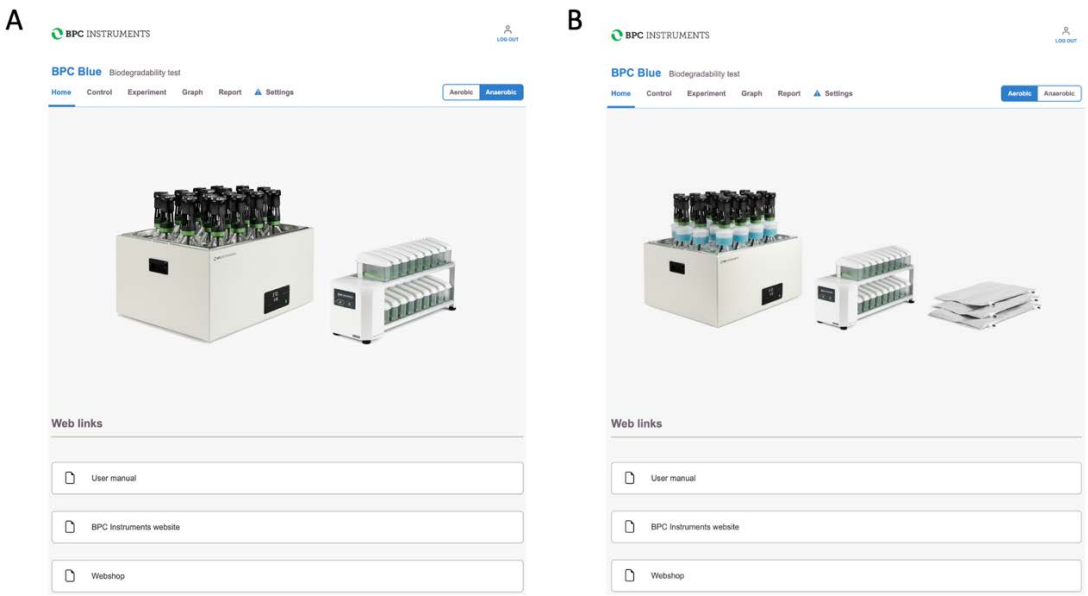


Figure 19. Home page of BPC Blue Software for (A) anaerobic and (B) aerobic tests.

In the Aurora™ software, the type of experiment, anaerobic or aerobic, can be easily selected. The software offers exceptional flexibility to use the instrument and configure different tests.

On the **Home** page, users get an overview of the features of the software, where the topics are ordered according to experimental setup, execution, monitoring and finally documented. In addition, three useful links are provided together with the Log out function (**Figure 19**).

The loading time of this new software is significantly shorter than the previous version. Additionally, several new features were implemented to offer a better user experience.

On the **Control** page (the same description is valid for BPC Blue Light – 9 lines), 18 lines are related to the 18 reactors where each one of them should be properly labelled based on its content. This tab is where direct interaction with the channels and motors are conducted, where users can start and stop all or just selected channels (**Figure 20**). Note that before starting the experiment, it is required to input the FCU volume for each channel.

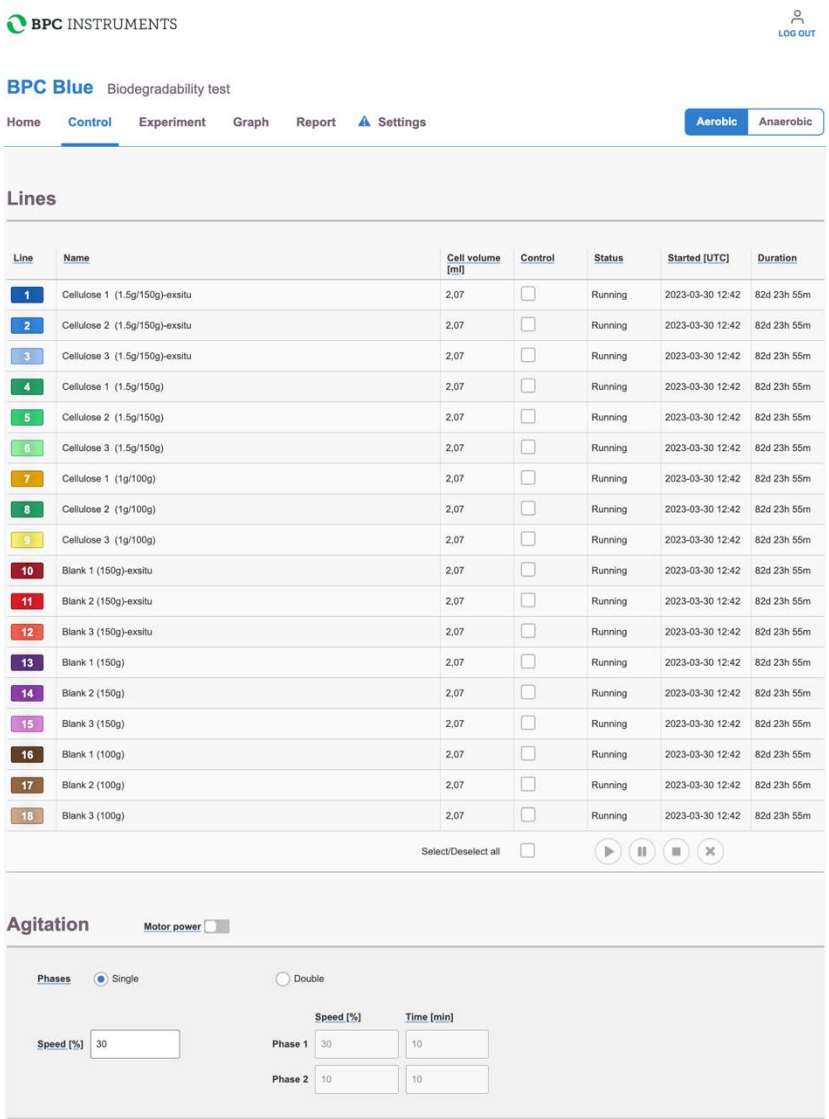


Figure 20. Description of the control page.

Located at the bottom right of the lines section is the control panel for the flow cell units. These work as follows:

Start data registration. In order to be able to press this button, the status needs to be ready

Pause data registration. In order to be able to press this button, the status needs to be running

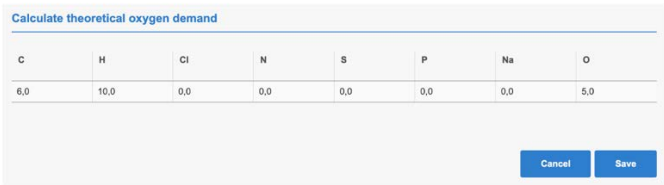
Stop data registration. In order to be able to press this button, the status needs to be paused

Clear all data registrations. In order to be able to press this button, the status needs to be stopped

Regarding the agitation system, the motors can be controlled in *continuous (single) or two-phase (double)* modes. With the two-phase mode, the motors can run intermittently at two different speeds or as ON and OFF.

The **Experiment** page serves as a platform for users to insert relevant values based on the type of test, whether aerobic or anaerobic. For both type of tests, parameters such as total solids (%) and amount of inoculum and sample should be provided. In order to generate the graph biodegradation rate as a function of time for tests conducted under aerobic conditions, it is necessary to input the ThOD (Theoretical Oxygen Demand) value. Similarly, for anaerobic tests, the parameter TOC (Total Organic Carbon) needs to be inserted in order to generate the graph that displays the evolution of biodegradation. In both cases, the software will automatically calculate the ThOD and TOC values once users input the elemental composition of the material being investigated. (**Figure 21**). *Users have the flexibility to directly input ThOD or TOC values without relying on the calculator tool, utilizing the elemental composition.*

A

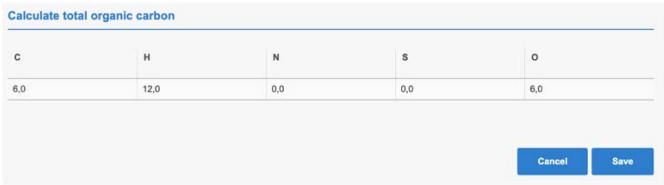


Calculate theoretical oxygen demand

C	H	Cl	N	S	P	Na	O
6,0	10,0	0,0	0,0	0,0	0,0	0,0	5,0

Cancel Save

B



Calculate total organic carbon

C	H	N	S	O
6,0	12,0	0,0	0,0	6,0

Cancel Save

Figure 21. Information regarding elemental composition of the test material.

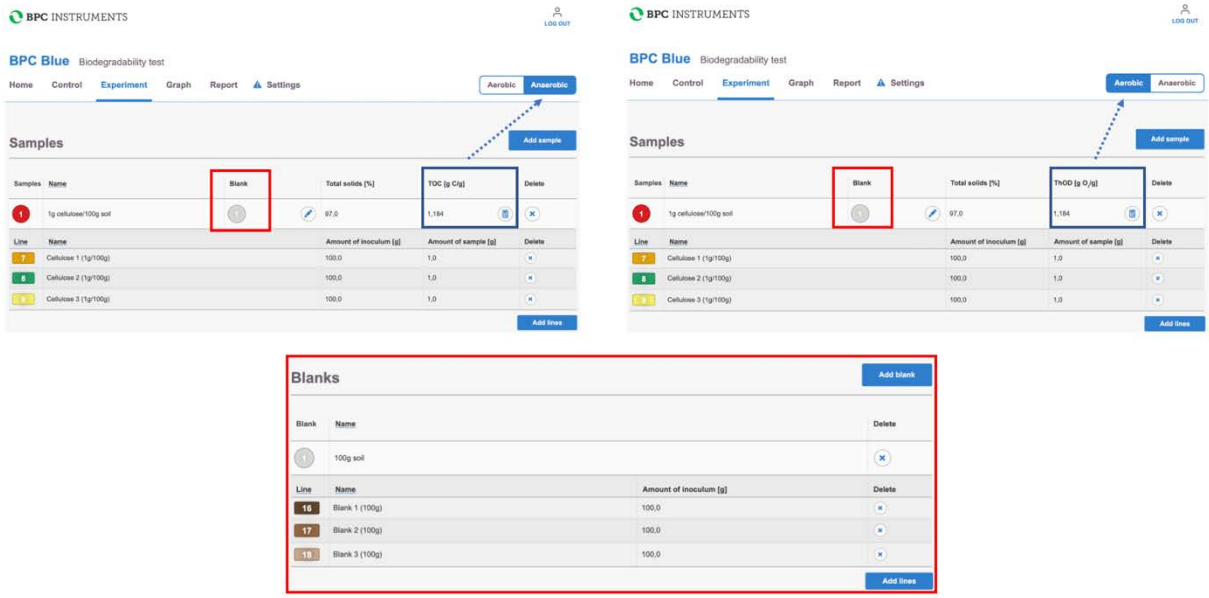


Figure 22. Overview of the experiment page.

Furthermore, the Experiment page offers a convenient feature that allows effective grouping of blank and sample considering the replicates. This proves particularly useful when conducting tests involving samples with varying concentrations or inoculum, where users have the capability to directly associate a specific sample with its corresponding blank, streamlining the analysis process, as highlighted in red in **Figure 22**.

The **Graph** page is divided into three distinct sections: **lines, groups, and biodegradation**. The first two sections present two graphs: **accumulated gas volume as a function of time and flow rate as a function of time**. In the lines section, both graphs display the corresponding data for each individual channel (**Figure 23 – A**). On the other hand, the groups section shows the data for each group defined on the Experiment page (**Figure 23 – B**). The groups section provides a straightforward and convenient method to evaluate and compare the results of the various samples used in the test, facilitating effective analysis. In both sections, different output and rate units are considered.

The biodegradation section presents direct information on the biodegradation rate over time (**Figure 24**). This allows for easy access to the biodegradation degree of the investigated material as the test progresses without the requirement to download a report (no need for manual data processing). Additionally, the software provides direct information concerning Specific Oxygen Consumption (SOC), enabling users to monitor oxygen consumption rates over time. Similarly, for anaerobic tests, the software provides Specific Carbon Production (SCP) data as a function of time, allowing users to track carbon production rates accurately. This feature enhances the user's ability to analyze and interpret aerobic and anaerobic test results effectively. As highlighted in red in **Figure 24 – A**, specific groups or channel can be selected for better analysis.

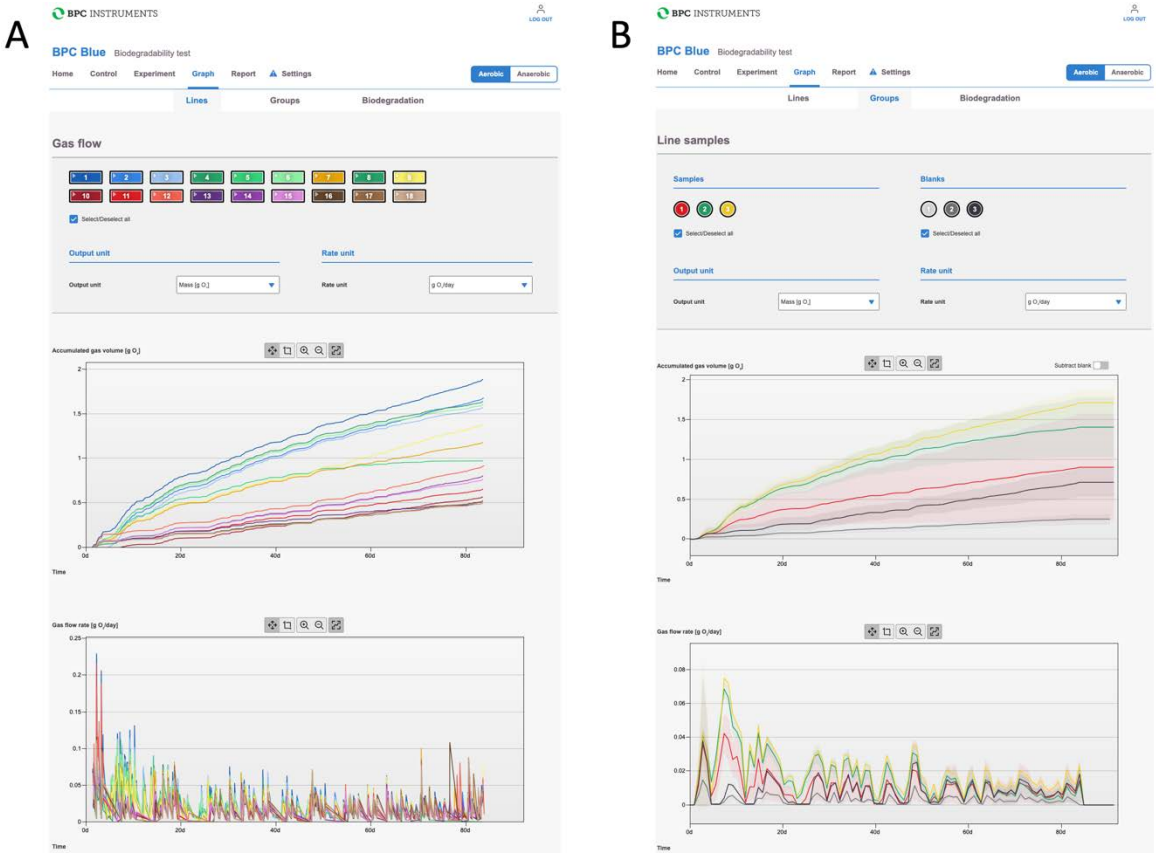


Figure 23. Graph page: (A) lines and (B) groups sections for aerobic tests. Same information applies for anaerobic tests

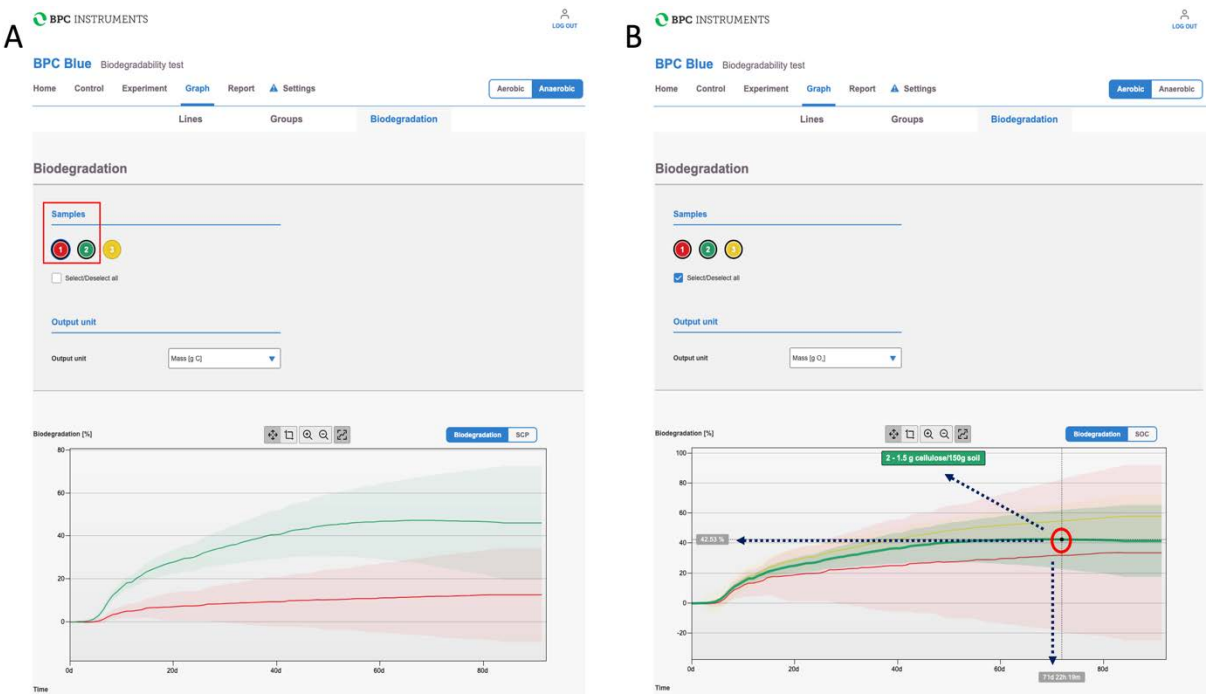


Figure 24. Illustration of the biodegradation section (A) anaerobic and (B) aerobic.

Upon initiation of gas registration, the box/line undergoes a color transformation from a grayish hue to match the specific color of the corresponding line. In this new software, users have the option to zoom in both graphs in order to get a better visualisation of the real-time data. Within the graph, users can select individual points along the curve, and for each selected point, details about the corresponding time and biodegradation rate will be provided, as highlighted in **Figure 24 – B**.

NOTE: The graph requires at least two data points (i.e., flow cell openings) in order to display information. To simulate an opening during testing, briefly remove the FCU and place it right back; wait a few seconds and then repeat the action one more time. If everything is working properly, a line should appear in each graph.

Users have the flexibility to download and generate reports at any time during the experiment from the **Report** tab. This page offers the option to download data from each channel (**lines section**) as well as groups of samples (groups section). The raw data can be obtained in a CSV format, allowing for individual line downloads or combining them into a single file. The report page provides various customizable settings, as outlined in **Figures 25 and 26**.

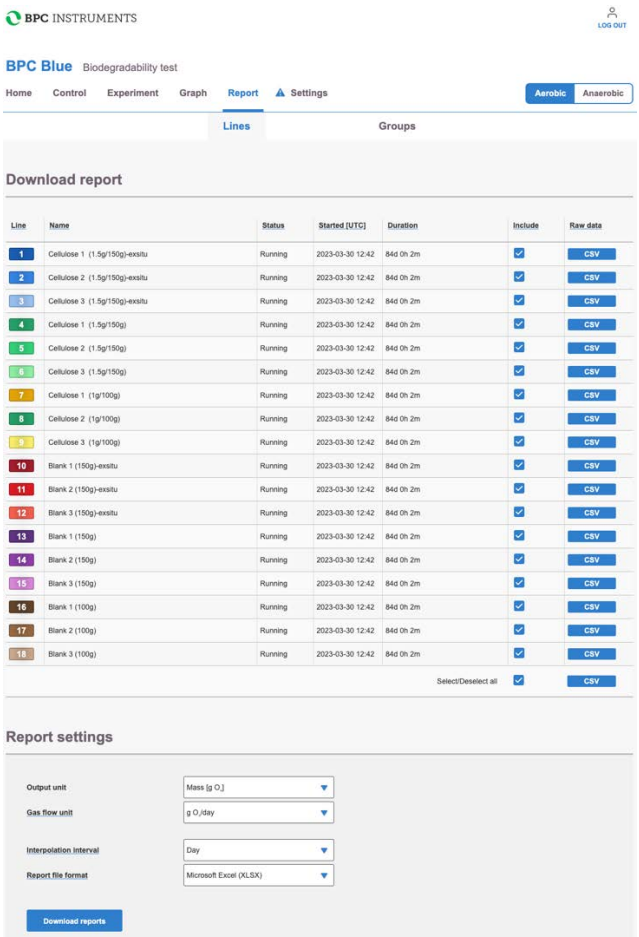


Figure 25. Report page – Lines section.

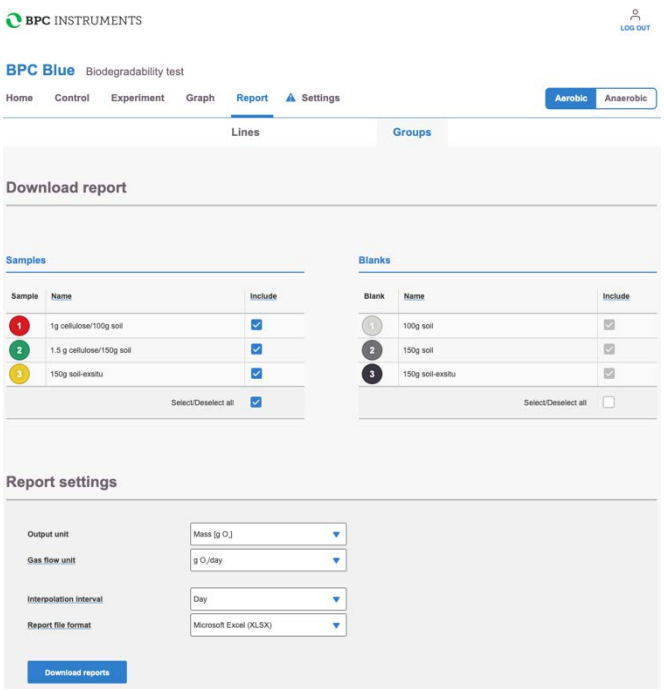


Figure 26. Report page – Groups section.

The **Settings** page (**Figure 27**) serves as a comprehensive hub for instrument configurations, providing various information and functions such as versions, licenses, reset function, experiment type and a logfile. Occasionally, you may notice a blue triangle with a white exclamation mark next to the settings tab in the software. This symbol indicates that there are log entries requiring review or adjustments. If the symbol appears next to a specific setting, it means that particular setting requires attention. A practical example is illustrated in **Figure 27**, where a warning pertaining to instrument level calibration is displayed. The warning message not only highlights the specific issue but also offers detailed guidance on resolving the problem. To clear the warning on the logfile, the clear log button needs to be pressed after reviewing and saving the information.

Two settings are generally described below:

1. **Network settings**: Displays IP and Mac address for the instrument. Also allows for configuring the built-in network adapter using either DHCP or manual configuration.
2. **System warning log**: Contains a list of events registered by the instrument which might be useful when trying to resolve an issue. Please have this information ready when contacting support.

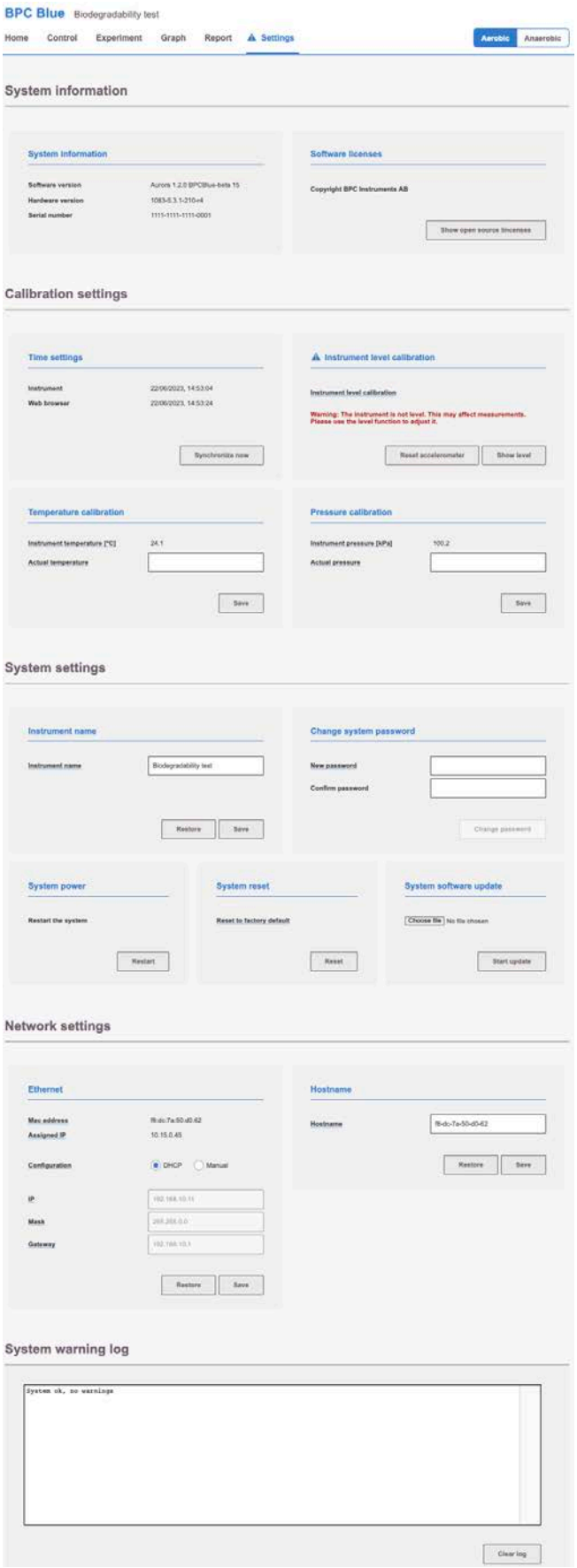


Figure 27. Image of the settings page.

Chapter 05: Maintenance and Spare Parts

In order to ensure that the instrument and its constituent parts will operate properly for a long period of time, it is crucial to follow the instructions described on this manual. The lifespan of the instrument and its components will depend heavily on how the equipment is used and well maintained. Always make sure to use the instrument according to the following guidelines:

- The instrument must be kept in a dry and clean environment.
- Avoid applying tap water as bath liquid in the thermostatic water bath, since the minerals included in this type of water might negatively impact the material of the bath chamber (calcification or corrosion of stainless steel).
- The flow cell units cannot be opened and are considered consumables.
- Reactors and stirrers are consumables that can be autoclaved.
- To clean the detection unit, wipe it with a damp piece of cloth and, if required, a gentle form of detergent. Water must not get into the machine, since it can harm electrical components.
- The used NaOH solution must **NOT** be poured into the sink. It should be saved in dedicated vessels and disposed as hazardous waste.

All consumables are easily replaceable in the instrument. The spare parts can be ordered from BPC Instruments. For further information, please visit our webshop (link below):
https://webshop.bpcinstruments.com

BPC Instruments also provides a *Maintenance Package* where users can get all consumables that are recommended to be changed at regular intervals.