Environmental Technology

Respirometer

BSBdigi - O_2

BSBdigi - CO_2

Description

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BOD Measuring System BSB digi

The system can be universally used and is well suited for routine measurement of BOD values in sewage plants, factories and water monitoring facilities as well as in research centers.

The system complies with the „German standard for the investigation of water, waste water and sludge“ (DIN 38 409 - H 52) and can also be employed for investigations beyond this standard.

Applications

Apart from routine determination of biochemical oxygen demand, the BSB digi system can also be used for:

- ***the determination of BOD_5 (acc to. DIN EN 1899-2, 1998-05 DEV H 52)***
- ***decomposition tests in water and soil (mineral oils, hydrocarbon chlorides)***
- ***toxicity tests***
- ***the determination of biological activity of different substrates (e.g. compost, seeping water on dumps)***
- ***respirometric measurement***
- ***AT_4***

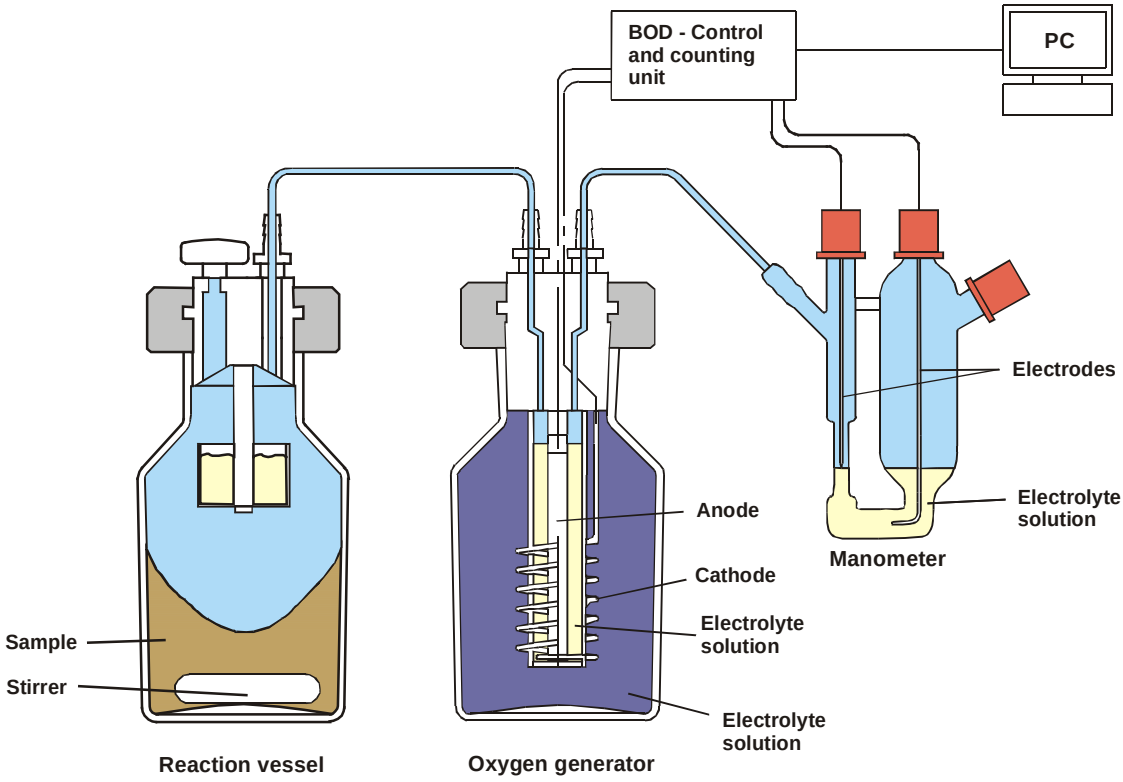
Many other applications are possible and thinkable. Our experts will be with pleasure at your disposal for further information.

Advantages

- ***The compact construction requires little surface space***
- ***By a continuous balance of consumed oxygen, a very high oxygen depletion can be detected without sample dilution***
- ***Tempering is carried out in air, thus no corrosion and no creeping current***
- ***The oxygen consumption can be registered for any random time intervals, thus an affirmative consumption curve is always possible***
- ***thank to its modular design, the BSB digi system can be extended to up to more than 100 measuring points. This allows individual adaption of the system to the requirements of the user***
- ***high pressure constancy***
- ***no stress for bio- organism***

Operation principle

The operation principle of the system is based on the direct method and the coulombmetric oxygen measurement. A sample is agitated in the reaction vessel with a magnetic stirrer so that it absorbs oxygen to the point of saturation. The resulting carbon dioxide is bound by an absorbing agent. These processes give rise to a partial vacuum which, in turn, controls the electrolytic generation of oxygen via a contact pressure gauge. A precise time control switches the oxygen generator on for a certain time until a defined amount of oxygen has been generated (1 mg / L O_2 = 1 mg / L BOD). The sum of all BOD values is registrated at the measuring insert or added and stored for each measuring point via computer control system. The stored data can then be displayed on the screen in form of tables or graphics, or printed.



Scheduled diagram of the principle of BSB digi

Software

BSBdigi software allows you to gather and process BSB-data of the BSBdigi instruments of the SELUTEC GmbH.

BSBdigi works with menus and windows. You can use the mouse and / or the keyboard. The user interface is easy and fast to learn, so even occasional users can work with it.

Several cells of a measurement can be combined in a measuring series, for which the oxygen consumption is measured in a fixed time interval over a certain time. On the monitor you can observe the current values at any time. The chronological course of the oxygen demand can be shown or printed in form of a table or graphics.

Important events as the start or the end of a measuring series will be recorded. You can also add your own notes to the protocol.

A screen saver program can be activated at your own timing.

You can store your data within BSBdigi in different formats (for example EXCEL, QuattroPro) on a disk for further evaluation.

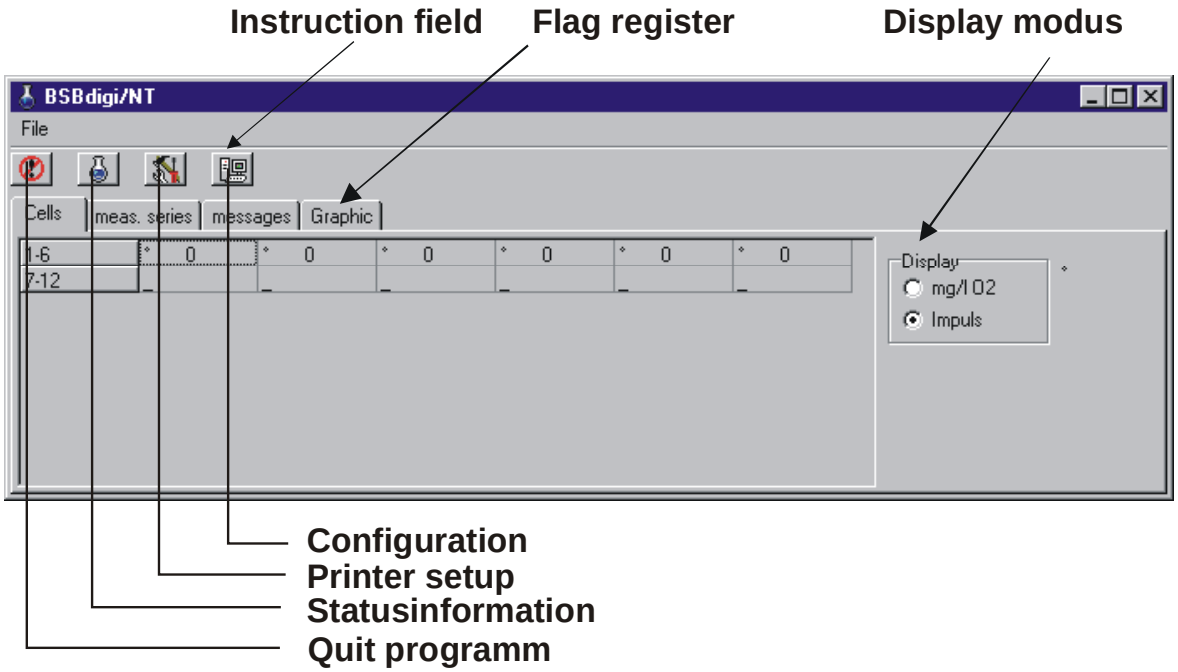


figure 1: display structure of BSBdigi

Description of the system

Thanks to the modular design of the BSB digi system it can be combined in many ways. The single components are described in more detail below.

BSB-digi Basic unit

The standard BSB digi basic device consists of 6 units. The magnetic stirrers are driven by an electric drive.
The basic unit can be used as a single system, or several basic devices of 6 units can be mounted one above the other with corresponding racks and telescope systems.

The versions with sample vessels 3 x 2 ltr. / 3 x 5 ltr. And larger oxygen vessels are based on the standard system.

Sample Measuring System

The sample measuring vessel contains the sample. The sealing stopper has corresponding connectors for the tubing of the oxygen vessel and holds the CO_2 absorber. Soda lime is used as absorbing agent for CO_2.
Vessel standard volume 500 ml for 250ml sample.
Available vessels: 250 ml, 1.000ml, 2.000ml and 5.000ml.

Oxygen vessel

Oxygen is generated by electrolysis in the oxygen vessel. The complete electrolysis part is attached to the sealing stopper for the vessel. Cupric sulfate is used as electrolyte. The system can be completely sealed against the outer pressure in order to ensure that no other gases are enerated except oxygen.

Precision Manometer

The precision manometer is made of glass and has two stainless steel electrodes. The switch electrode has a pointed tip and is centered in a capillary immersion tube which is open at the bottom. This immersion tube reaches into the electrolyte reservoir with which it forms a communicating tube. The immersion tube has a connection to the oxygen generator. A low-conductive H_2SO_4- solution is used as electrolyte. Both electrode connections are made via flexible lines to the collective plug output.

BSB-digi Measuring insert

For each measuring point a BSB digi measuring control unit is required for the exactly current of the oxygen vessel . These inserts are wired in the basic unit. Each can house 6 BSB digi places and includes the clock-pulse module for these 6 inserts. The required stabilized power unit is located in the control unit of the thermostated cabinet. For communication with the computer only one USB communication cable is needed. Each BOD value is registered in the RAM of the microprocessor counter which is integrated in the measuring insert. At the same time, the measured values are logged into the computer. In case of power failure the datas are stored in the RAM for more than one day.

Thermostated Cabinet

The thermostated cabinet ensures an exact reference temperature of 20℃ (±0,5℃) and has room for max. 18 measuring points (500 ml vessel). The BSB digi basic units are mounted on telescope systems for comfortable operation. The plug connections to the computer system are led out or are at the outside.

BSB-digi Computer System

For automatic measuring operation of the system it is recommendend to use a suitable personal computer. The standard PC which is delivered with the system has the following configuration:

IBM compatible, Pentium computer,
1 GB RAM, 10,0 MB free on fixed disk,
CD-ROM, VGA graphic card,
USB
WIN 2000 and upward all versions

Applications and Standards for (Respirometer BSB)

DEV G1 (1971): Bestimmung der Summe des gelösten Kohlendioxids, 2. Konduktometrisches Verfahren, Deutsche Einheitsverfahren, 6. Lief., Weinheim: VCH

DIN EN 1899-1 (1998-05) (Ersatz 38409, T. 52, 1987-05): Wasserbeschaffenheit, Bestimmung des Biochemischen Sauerstoffbedarfs nach n Tagen (BSBn), T. 1: Verdünnungs- und Impfverfahren nach Zugabe von Allylthioharnstoff (ISO 5815: 1989, modifiziert, Dt. Fass. EN 1899-1: 1988, DEV H 51).

DIN EN 1899-2 (1998-03) (Ersatz 38409, T. 52, 1987-11): Wasserbeschaffenheit, Bestimmung des Biochemischen Sauerstoffbedarfs nach n Tagen (BSBn), T. 2: Verfahren für unverdünnte Proben (ISO 5815: 1989, modifiziert, Dt. Fass. EN 1899-2: 1988, DEV H 52). Sowie deren Erweiterung des Verfahrens DIN EN 1899-2 (H 55)

DIN EN 29439 (1993-04): Wasserbeschaffenheit - Bestimmung der vollständigen aeroben biologischen Abbaubarkeit organischer Stoffe im wässrigen Medium - Verfahren mittels Analyse des freigesetzten Kohlenstoffdioxids (ISO 9439: 1990, Dt. Fass. EN 29439:1993; DEV L 23).

DIN EN 29408 (1993-04): Wasserbeschaffenheit - Bestimmung der vollständigen aeroben biologischen Abbaubarkeit organischer Stoffe in einem wässrigen Medium über die Bestimmung des Sauerstoffbedarfs in einem geschlossenen Respirometer (ISO 9408: 1991; Dt. Fass. EN 29408: 1993; DEV L 22).

DIN 54900-2 (1998) Prüfung der Kompostierbarkeit von Kunststoffen, T. 2: Prüfung auf vollständige biologische Abbaubarkeit in Laborversuchen; Verfahren 1 - Prüfung auf vollständige biologische Abbaubarkeit in wässrigem Medium durch Bestimmung des biochemischen Sauerstoffverbrauchs in einem geschlossenen Respirometer; Verfahren 2 - Prüfung auf vollständige biologische Abbaubarkeit in wässrigem Medium durch Bestimmung der Entwicklung von Kohlenstoffdioxid. Verfahren 3 - Prüfung auf vollständige biologische Abbaubarkeit und der Disintegration in Kompost durch Bestimmung der Entwicklung von Kohlenstoffdioxid.

ISO 9408 (1991): Water Quality - Evaluation in an aqueous medium of the ultimate aerobic biodegradability of organic compounds - Method by determining the oxygen demand in a closed respirometer.

ISO 7827, 1994: Water quality - Evaluation in an aqueous medium of the ultimate aerobic biodegradability of organic compounds - Method by analysis of dissolved organic carbon (DOC).

Respirometer BSB CO_2

Determination of aerobic biodegradability

Respirometer combining the detection of O_2-consumption with CO_2-production

The methods available for the determination of aerobic biodegradability are numerous. Most of them are time-consuming and not automated. Final conclusions however with respect to the ultimate biodegradability of an organic compound are only possible with proving the extent of the C-conversion into CO_2 as metabolic end product, see equation 1.
Conventional Respirometers allow only the continuous measurement of O_2 consumption in a biological system. In order to essentially improve this technique a respirometer was equipped with a „simple“ system for the measurement of carbon dioxide, see Fig. 1. The amount of CO_2 microbialy generated is estimated via its absorption in a KOH solution with measuring the change in conductivity. Determining O_2-consumption in connection with CO_2-production during the biological degradation process allows a secure and unambiguous judgment of biodegradation. Thus an evaluation of the extent of ultimate aerobic biodegradation, defined as the breakdown of an organic chemical compound by microorganisms in the presence of oxygen into carbon dioxide, water, mineral salts (mineralization) and new biomass can be approached. In addition it improves the possibilities of a desirable C-balancing.

$$\mathbf{C_cH_hO_oN_n} + (c + 0{,}25h - 0{,}5o - 0{,}75\,n)\,\mathbf{O_2} \rightarrow c\,\mathbf{CO_2} + (0{,}5h - 1{,}5n)\,\mathbf{H_2O} + n\,\mathbf{NH_3} \quad \mathbf{(1)}$$

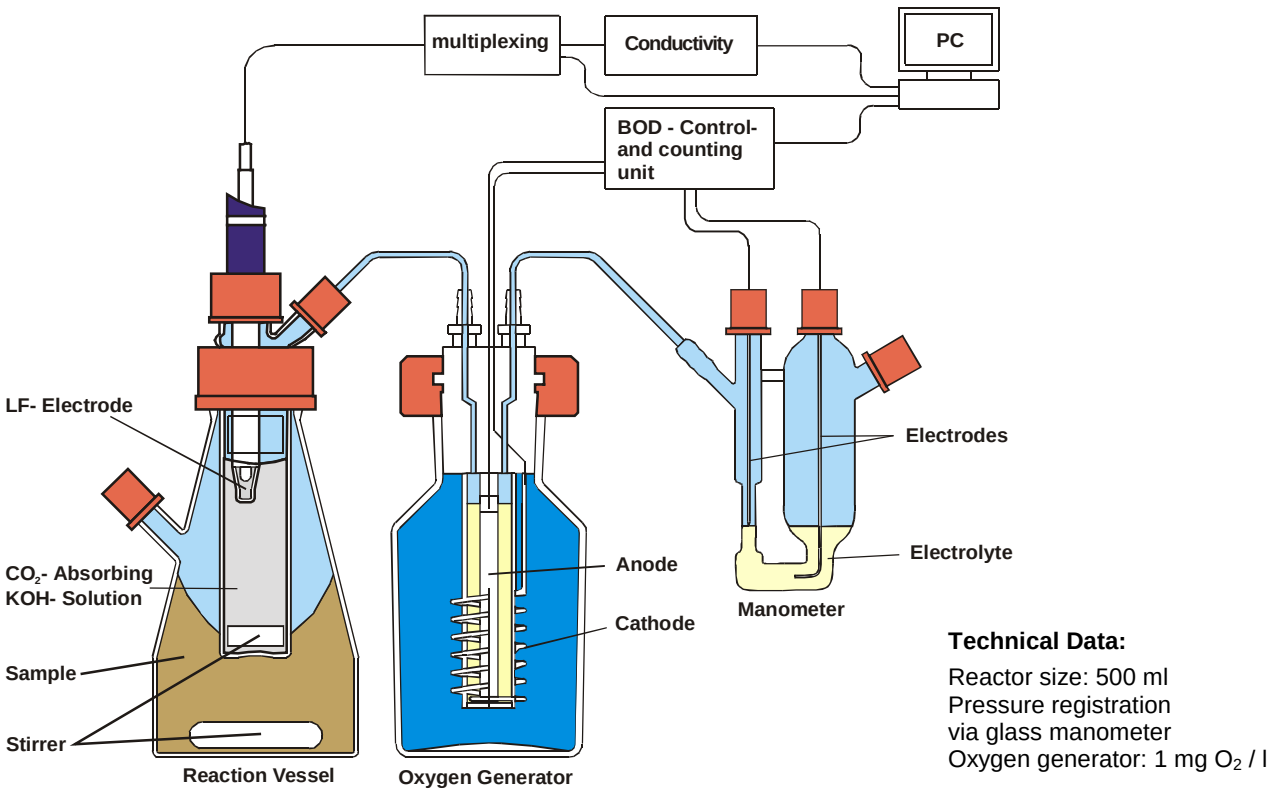


Fig. 1 Improved closed-circuit respirometer at constant pressure, with both, continuous restoration of O_2 consumed and detection of CO_2 produced

Example:
Results of a degradation test with a polymer poly-3-hydroxybutyrate-co-valerate (PHBV) are given in Fig. 2. Polymer powder was added to 250 ml phosphate buffered mineral salt medium in a concentration of 600 mg/L and inoculated at 20 °C with activated sludge (30 mg/L dry substance).

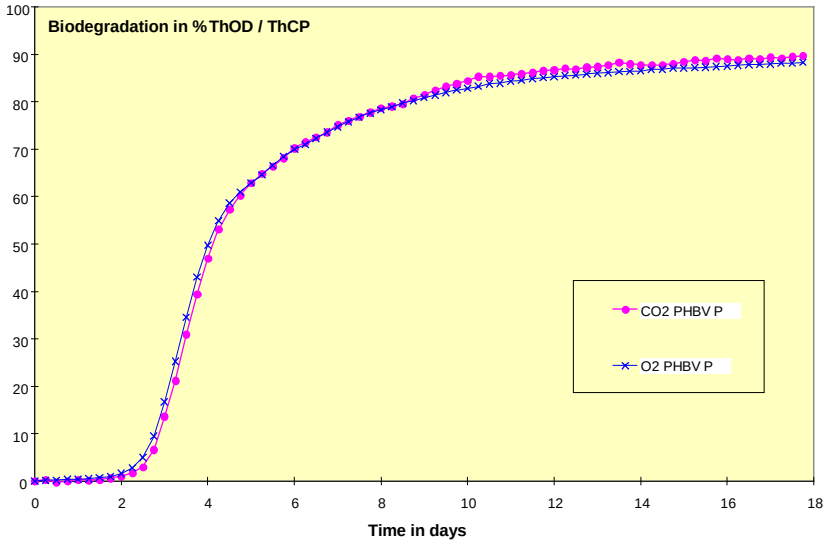


Fig. 2: PHBV powder degradation, aqueous system, 20°C. Standardized presentation of O_2-consumption and CO_2 -production by Theoretical Oxygen Demand, (ThOD) and Theoretical Carbon- dioxide Production (ThCP)

In this degradation test values of O_2 and CO_2 measured were nearly overlapping, represented here as standardized ThOD and ThCP. PHBV-biodegradation starts after a lag-phase of 2,5 days and after 18 days a degradation of 90 % ThCP is achieved. Via a C-balance including biomass and DOC (Dissolved Organic Carbon) a recovery rate of about 101 % was reached here.

This new test system, based on a "simple" respirometer is enlarged to a combined testing unit including the detection of CO_2. It allows beyond oxygen consumption to determine the continuous progress in mineralization (Sturm-Test).

This means one system covers several standards:

ISO CD 14851: Evaluation of the ultimate aerobic biodegradability of plastic materials in an aqueous medium - Method by determining the oxygen demand in a closed respirometer
ISO CD 14852: Evaluation of the ultimate aerobic biodegradability of plastic materials in an aqueous medium - Method by analysis of released carbon dioxide
ISO 9439 (1990): Water Quality - Evaluation in an aqueous medium of the ultimate aerobic biodegradability of organic compounds - Method by analysis of released carbon dioxide
ISO 9408 (1991): Water Quality - Evaluation in an aqueous medium of the ultimate aerobic biodegradability of organic compounds - Method by determining the oxygen demand in a closed respirometer
DIN 54900 part 3 (Entwurf 1997): Bestimmung der vollständigen biologischen Abbaubarkeit von polymeren Werkstoffen in Laborversuchen Stoffe in einem wässrigen Medium über die Bestimmung des Sauerstoffbedarfs in einem geschlossenen Respirometer
DIN EN 29 439 (1993): Wasserbeschaffenheit - Bestimmung der vollständigen aeroben biologischen Abbaubarkeit organischer Stoffe in einem wässrigen Medium - Verfahren mittels Analyse des freigesetzten Kohlenstoffdioxids
OCDE 301 F (1992): Manometric Respirometry test
ASTM D 5209-92: Standard test method for determining the aerobic biodegradation of plastic materials in the presence of municipal sewage sludge
ASTM D 5271-93: Standard test method for determining the aerobic biodegradation of plastic materials in an activated-sludge-wastewater-treatment system