BS EN 16087-1:2011

BSI Standards Publication

Soil improvers and growing media — Determination of the aerobic biological activity

Part 1: Oxygen uptake rate (OUR)

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 16087-1:2011.

BSI, as a member of CEN, is obliged to publish EN 16087-1:2011 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval as a European Standard.

The UK committee voted against the publication of this standard because it considered that the reproducibility obtained in inter-laboratory evaluation was not an adequate basis on which to establish a reference method. This could cause problems in the event of dispute or litigation.

The standard deviations of reproducibility in the inter-laboratory validation trials of this method were poor and there is a low probability of getting the same result from two laboratories analysing the same sample. In the worst cases the standard deviation of reproducibility was nearly the same as the mean analysis (after rejection of outliers). For example, for the peat based growing medium no. 2, the mean was OUR 15.49 mmol O_2/kg OM · h, S_R 12.84; for Compost 2 the mean was OUR 14.29 mmol O_2/kg OM · h, S_R 12.79.

Technical Committee AW/20 advises that this standard will not reliably discriminate between the stability of growing media and soil improvers or constituents thereof.

The UK participation in its preparation was entrusted to Technical Committee AW/20, Top soil and other growing media.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 70566 3

ICS 65.080

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2011.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16087-1

November 2011

ICS 65.080

English Version

Soil improvers and growing media - Determination of the aerobic biological activity - Part 1: Oxygen uptake rate (OUR)

Amendements du sol et supports de culture - Détermination de l'activité biologique aérobie - Partie 1: Cinétique d'absorption de l'oxygène (OUR)

Bodenverbesserungsmittel und Kultursubstrate - Bestimmung der aeroben biologischen Aktivität - Teil 1: Sauerstoffaufnahme (OUR)

This European Standard was approved by CEN on 17 September 2011.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword

This document (EN 16087-1:2011) has been prepared by Technical Committee CEN/TC 223 “Soil improvers and growing media”, the secretariat of which is held by ASI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2012, and conflicting national standards shall be withdrawn at the latest by May 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

SAFETY PRECAUTIONS – Care should be taken when handling substances of caustic nature or samples that may contain sharps or is of a dusty nature.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard describes a method to determine the aerobic biological activity of growing media and soil improvers or constituents thereof by measuring the oxygen uptake rate (OUR). The oxygen uptake rate is an indicator of the extent to which biodegradable organic matter is being broken down within a specified time period. The method is not suitable for material with a content of particle sizes > 10 mm exceeding 20 %.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13039, *Soil improvers and growing media – Determination of organic content and ash*

EN 13040, *Soil improvers and growing media – Sample preparation for chemical and physical tests, determination of dry matter content, moisture content and laboratory compacted bulk density*

EN ISO 3696, *Water for analytical laboratory use – Specification and test methods (ISO 3696:1987)*

3 Principle

The material is suspended in water. The respiration rate (i.e. oxygen uptake rate) is estimated by measuring the pressure drop in the headspace (i.e. gas phase in the closed space above the water phase). The produced CO_2 (carbon dioxide) is removed by a suitable alkaline absorbent. The measurements are performed under defined conditions.

4 Apparatus

4.1 Testing facility

Temperature controlled room, climate cabinet or water bath, temperature adjustable to (30 ± 2) °C.

4.2 Pressure transducer

Operating range 0 kPa to 20 kPa (accuracy ± 0,1 kPa) and record for measuring 2 to 4 times per hour for seven days.

4.3 CO_2-absorbent containing unit

4.4 Reaction vessel

1000 ml to 2500 ml with a CO_2-absorbent containing unit (see 4.3) and the pressure transducer (see 4.2) gastight connected (see Figure B.1).

4.5 Mixing device

Shaking table (120 ± 20) rpm or magnetic stirring unit and banded magnetic stirrer (see Figure B.2).

4.6 Balance

With a scale interval of 0,01 g.

4.7 pH meter

With slope adjustment and temperature control.

4.8 Dispenser

Dispensers or pipettes, adjustable units of 0,5 ml.

4.9 Glassware

Beakers and measuring cylinder.

4.10 Sieve

10 mm mesh size.

5 Reagents

5.1 Water of class 3

According to EN ISO 3696.

5.2 pH buffer

86 g/l KH_2PO_4, 89 g/l $Na_2HPO_4 \cdot 2H_2O$, mix ratio of 1: 4 for pH 7; the solution is stable for 2 months if stored at (5 ± 3) °C.

Commercially available buffers may be used as well.

5.3 Macro nutrient solution

Solve the following masses of chemical compounds in 1000 ml water (see 5.1): 4,3 g NH_4Cl, 5,4 g $CaCl_2 \cdot 2H_2O$, 4,3 g $MgSO_4 \cdot 7H_2O$, 0,03g $FeCl_3 \cdot 6H_2O$.

5.4 Micro nutrient solution

Solve the following masses or volumina of chemical compounds in 1000 ml water (see 5.1): 5,0 g EDDHA 6 % iron chelate, 1,4 g $MnSO_4$, 1,1 g $ZnSO_4$, 4,2 g $Na_2B_4O_7$, 0,2 g $CuSO_4$, 0,13 g Na_2MoO_4, 1 ml/l HCl (36 %).

5.5 Complete nutrient solution

Add 1 ml of micro nutrients solution (see 5.4) to 1000 ml of macro nutrient solution (see 5.3). The solution is stable for 2 months if stored at (5 ± 3) °C.

5.6 Nitrification inhibitor

4 g/l N-Allylthiourea, $C_4H_8N_2S$ (ATU).

NOTE In closed containers, the solution is stable for at least 3 months.

5.7 CO_2–absorbant

Such as NaOH-pellets, KOH-pellets or soda lime (mixture of $Ca(OH)_2$,NaOH, KOH and water), preferably with colour indicator.

5.8 NaOH (0,5 mol/l)

5.9 HCl (0,5 mol/l)

6 Procedure

6.1 Sample preparation

The fresh sample shall be homogenised by hand. Break up lumps and agglomerates only and pass the sample through a 10 mm sieve (see 4.10). Particles > 10 mm shall not be broken up and shall be removed. Record the % mass of particles > 10 mm. If this amount is > 20 % of the total fresh mass the test is not applicable. The moist sample shall be stored at (5 ± 3) °C (max. 2 weeks).

6.2 Determination of moisture content and organic matter content

The moisture content shall be determined according to EN 13040 and the organic matter content according to EN 13039.

6.3 Starting the procedure

Calculate the mass of fresh material to be added to the reaction vessel based on 2 g of organic matter (EOM) per litre according to Equation (1).

$$EOM\ (\mathrm{g}) = \frac{20000}{W_{\mathrm{om}} \times W_{\mathrm{m}}} \tag{1}$$

where

W_{om} is the organic matter content, in % mass of the dried sample according to EN 13039;

W_{m} is the moisture content, in % mass of the fresh sample according to EN 13040.

Calculate the required mass of sample (Ws) to perform the test according to Equation (2).

$$W_{\mathrm{S}}\ (\mathrm{g}) = EOM \cdot C_{\mathrm{V}} \tag{2}$$

where

C_{V} is the capacity of the vessel in litres.

Place the calculated quantity of the sample in the clean reaction vessel (see 4.4). Add 180 ml water and 10 ml complete nutrient solution (see 5.5) using a dispenser (see 4.8). Add 10 ml pH buffer (see 5.2) using a dispenser (see 4.8). Add 2,5 ml nitrification inhibitor (see 5.6) using a dispenser (see 4.8). Place the sample on the mixing device (see 4.5) and start the mixing for 4 h to 8 h in the conditioned room (see 4.1). Do not close the bottles.

The nitrification inhibitor is added to prevent the use of oxygen for nitrification processes.

Then measure the pH of the suspension. The value should be between 6,5 and 7,5. If this is not the case, base or acid should be added (see 5.8 and 5.9).

The analyses shall be performed at least in duplicate.

NOTE At first instance an equivalent of 2 g organic matter should be used for analysis. If it appears during the test that the pressure drop during the first three days is not higher than 2 kPa then the amount of organic matter should be increased but with a maximum of 20 g dry matter. If on the other hand the pressure drop during the first three days is more then 5 kPa the amount of organic matter should be adjusted to 1 g.

6.4 Respiration measurement

Fill the CO_2-absorber unit (see 4.3) with the absorbant (see 5.7). The pellets can be used several times. Before every use they shall be inspected for colour changes. If the colour has changed they shall be replaced. Replace the bottle top sensor and ensure a gas-tight fit.

Start the shaking table (120 ± 20) rpm or magnetic stirrer (between 180 rpm and 450 rpm) and measure the pressure during seven days. Record the pressure 2 to 4 times per hour during seven days with the connected pressure transducer (see 4.2). The measurement ends in principle after seven days but can be ended if the pressure difference between the maximum and minimum value is more than 10 kPa.

NOTE If a magnetic stirrer is used and the amount of sand and gravel in the sample is high, it is important to ensure that the stirrer is not in contact with the base.

To check the tightness of the measurement system, it is necessary to include a blank measurement without sample material, but all necessary solutions.

7 Calculations

7.1 Theoretical background

The pressure drop as a function of time in principle looks like Figure B.3. During the first period (0 to 8) h the pressure rises by the rising pressure of water vapour in the headspace. Thereafter is a short period (0 to 12) h in which the pressure is more or less stable. This is the growing phase of microorganisms and is dependent on the amount of active microorganisms initially present. In the third period, the pressure drops linearly and in the fourth phase the pressure drop decreases to become constant. In the final phase the oxygen runs out.

From the pressure drop in the third period the respiration rate is determined (see Figure B.3). The pressure drop shall not be more than 10 kPa (this is equivalent to a decrease of the oxygen content from 20 % to 10 %), because at a higher pressure drop the oxygen supply to the water can be limiting (see Veeken [1]).

7.2 Calculations

The oxygen consumption (Oc, in mmol O_2/kg OM) is calculated from the pressure drop (ΔP) in the headspace according to Equation (3):

$$Oc = \frac{\Delta P \cdot 10}{R \cdot (273{,}15 + T)} \times \frac{V_{gas} \cdot 10000}{W \cdot DM \cdot OM} \quad (3)$$

where

Oc is the oxygen consumption, in mmol O_2/kg OM;

ΔP is the pressure drop in the headspace, in kPa;

R is the gas constant (83,14 L . kPa . K^{-1} . mol^{-1});

T is the temperature the measurement is performed, in ºC;

W is the initial mass of the sample, in kg;

DM is the dry matter content of the sample, in % mass;

OM is the organic matter content of the sample, in % DM mass;

V_{gas} is the volume of the gas phase, in ml.

$$V_{gas} = V_{vessel} - \frac{W \cdot DM \cdot 10000}{\rho} - V_{liquid} \quad (4)$$

where

V_{vessel} is the total volume of vessel, in ml;

V_{liquid} all added liquids (water, nutrient solution, pH buffer and ATU solution, in ml;

ρ is the calculated sample density, in kg · m^{-3}.

$$\rho = \frac{1}{\frac{OM \cdot W \cdot DM}{1550} + \frac{(1 - OM) \cdot W \cdot DM}{2650}} \quad (5)$$

NOTE The sample density is calculated from OM, W and DM and should not to be confused with the laboratory compacted bulk density.

The oxygen uptake rate (OUR, mmol O_2 · kg^{-1} · OM · $hour^{-1}$) is calculated from Oc and the related time period according to Equation (6).

$$OUR = \frac{Oc}{\Delta t} \quad (6)$$

where

Δt time ΔP is taken, in h.

8 Test report

The test report shall contain at least the following:

a) a reference to this standard;

b) all data required for a complete identification of the sample;

c) the number of replicates;

d) the mean OUR, rounded to one decimal place;

e) details of all work cycles not contained in this standard or that were considered optional, as well as all factors that may have influenced the results.

Annex A
(informative)

Validation

Samples:

PBGM 1: peat based growing medium no. 1

PBGM 2: peat based growing medium no. 2

Bark: uncomposted bark

Compost 1: compost no. 1

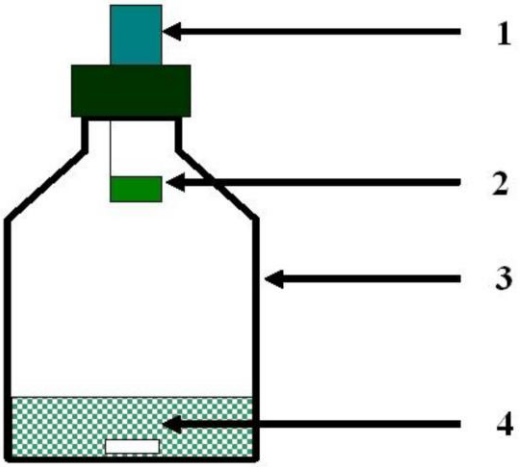
Compost 2: compost no. 2

Table A.1 — Summary of the results of the OUR (oxygen uptake rate)

Sample	PBGM 1	PBGM 2	bark	compost 1	compost 2
	mmol O_2/kg OM · h				
Number of laboratories retained after eliminating outliers	9	9	8	9	9
Number of outliers (laboratories)	1	0	0	0	0
Mean value	5,44	15,49	7,81	10,75	14,29
Repeatability standard deviation, s_r	1,45	5,49	1,20	1,40	2,01
Repeatability relative standard deviation	0,27	0,35	0,15	0,13	0,14
Repeatibility limit, $r = 2{,}8\ s_r$	4,05	15,37	3,37	3,93	5,62
Reproducibility standard deviation, s_R	2,16	12,84	4,41	4,66	12,79
Reproducibility relative standard deviation	0,40	0,83	0,57	0,43	0,90
Reproducibility limit, $r = 2{,}8\ s_R$	6,06	35,94	12,34	13,05	35,81

Annex B
(informative)

Specific information on the OUR-test



Key

1 pressure transducer

2 CO_2-absorber

3 reaction vessel

4 sample suspension, optionally with banded magnetic stirrer (see Figure B.2)

Figure B.1 — Reaction vessel *OUR*

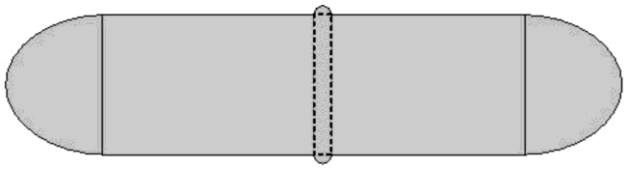
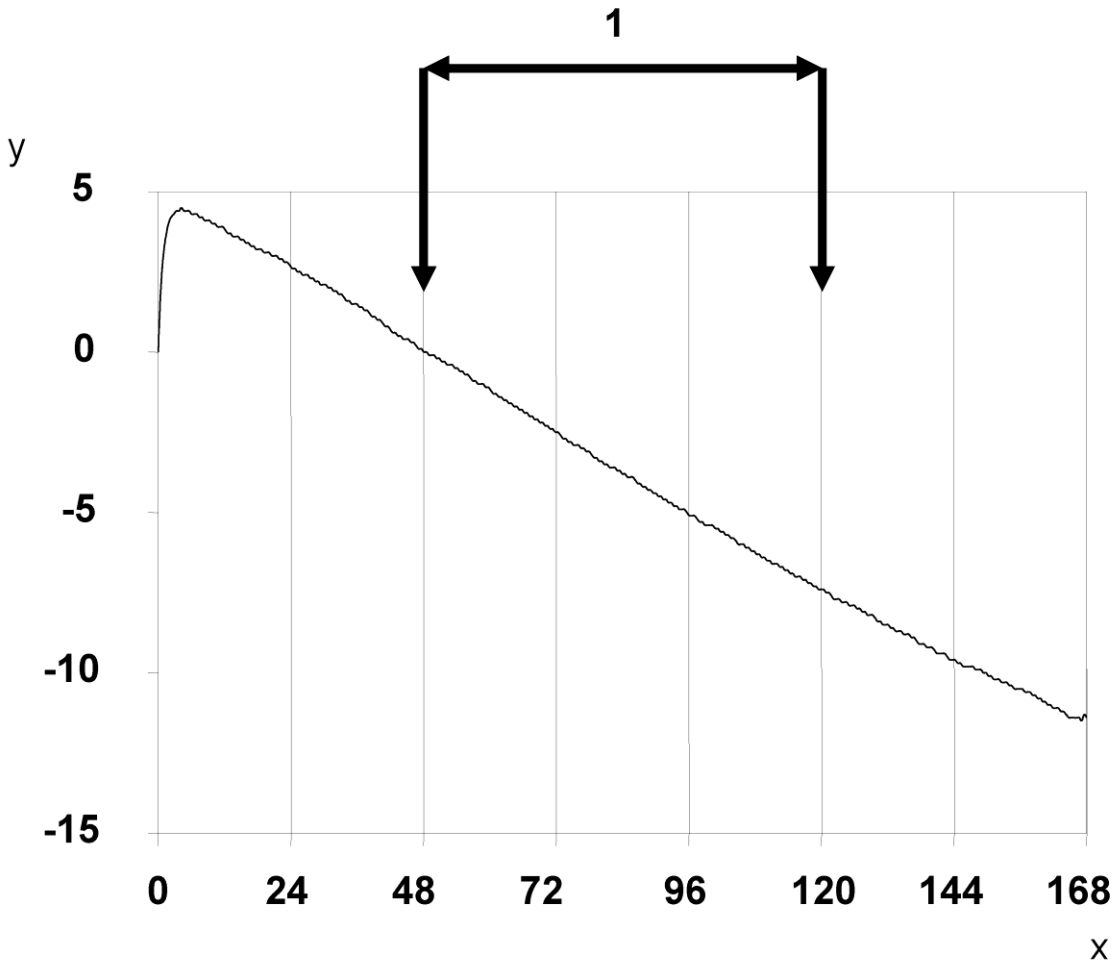


Figure B.2 — Banded magnetic stirrer



Key

1 3rd period, relevant for the measurement

X time (h)

Y pressure drop (kPa)

Figure B.3 — Typical time pressure relation during the OUR-test

Bibliography

[1] Veeken, A.H.M., 2003, *Oxitop measurings system for standarised determination of respiration rate and N-mineralisation rate of organic matter in waste, compost and soil.* Sectie milieutechnologie, Wageningen.

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™