SLOVENSKI STANDARD
# oSIST prEN 16087-1:2018

**01-november-2018**

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**Izboljševalci tal in rastni substrati - Določevanje aerobne biološke aktivnosti - 1. del: Stopnja porabe kisika**

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

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



**Ta slovenski standard je istoveten z:** **prEN 16087-1**

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**ICS:**

65.080 Gnojila Fertilizers

**oSIST prEN 16087-1:2018** **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

**DRAFT**
**prEN 16087-1**

October 2018

ICS 65.080

Will supersede EN 16087-1:2011

English Version

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

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

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 223.

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

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**



Ref. No. prEN 16087-1:2018 E

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# European Foreword

This document (prEN 16087-1:2018) has been prepared by Technical Committee CEN/TC 223 “Soil improvers and growing media”, the secretariat of which is held by NEN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 16087:2011.

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

# 1 Scope

This document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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)*

# 3 Terms and Definitions

No terms and definitions are listed in this document.



ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/



- ISO Online browsing platform: available at http://www.iso.org/obp



# 4 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.

# 5 Apparatus

## 5.1 Testing facility

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

## 5.2 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.

## 5.3 $CO_2$-absorbent containing unit

## 5.4 Reaction vessel

1000 ml to 2500 ml with a $CO_2$-absorbent containing unit (see 5.3) and the pressure transducer (see 5.2) gastight connected (see Figure B.1).

### 5.5 Mixing device

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

### 5.6 Balance

With a scale interval of 0,01 g.

### 5.7 pH meter

With slope adjustment and temperature control.

### 5.8 Dispenser

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

### 5.9 Glassware

Beakers and measuring cylinder.

### 5.10 Sieve

10 mm mesh size.

## 6 Reagents

### 6.1 Water of class 3



According to EN ISO 3696.

### 6.2 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.

### 6.3 Macro nutrient solution

Solve the following masses of chemical compounds in 1000 ml water (see 6.1): 4,3 g $NH_4Cl$,

5,4 g $CaCl_2 \cdot 2H_2O$, 4,3 g $MgSO_4 \cdot 7H_2O$, 0,03g $FeCl_3 \cdot 6H_2O$.

### 6.4 Micro nutrient solution

Solve the following masses or volumina of chemical compounds in 1000 ml water (see 6.1): 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 %).

### 6.5 Complete nutrient solution

Add 1 ml of micro nutrients solution (see 6.4) to 1000 ml of macro nutrient solution (see 6.3). The solution is stable for 2 months if stored at (5 ± 3) °C.

### 6.6 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.

### 6.7 $CO_2$-absorbant

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

### 6.8 NaOH (0,5 mol/l)

### 6.9 HCI (0,5 mol/l)

## 7 Procedure

### 7.1 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 5.10). 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).

### 7.2 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.

### 7.3 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).



$$EOM\ (\text{g}) = \frac{20000}{W_{\text{om}} \times W_{\text{d}}} \qquad (1)$$



where

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

$W_d$ is the dry matter 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).

$$W_{\text{s}}\ (\text{g}) = EOM \cdot C_{\text{V}} \qquad (2)$$

where

$C_V$ is the capacity of the vessel in litres.

Place the calculated quantity of the sample in the clean reaction vessel (see 5.4). Add 180 ml water and 10 ml complete nutrient solution (see 6.5) using a dispenser (see 5.8). Add 10 ml pH buffer (see 6.2) using a dispenser (see 5.8). Add 2,5 ml nitrification inhibitor (see 6.6) using a dispenser (see 5.8). Place the sample on the mixing device (see 5.5) and start the mixing for 4 h to 8 h in the conditioned room (see 5.1). 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 6.8 and 6.9).

The analyses shall be performed at least in duplicate.

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 than 5 kPa the amount of organic matter should be adjusted to 1 g.

### 7.4 Respiration measurement

Fill the $CO_2$-absorber unit (see 5.3) 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 5.2). 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.

## 8 Calculations



### 8.1 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]).

### 8.2 Calculations

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

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

where

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

$\Delta P$ 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 °C;

*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.

$$V_{gas} = V_{vessel} - \frac{W \times DM \times 10000}{\rho} - \frac{W \times W_m \times 10000}{1000^*} - V_{liquid} \quad (4)$$

* - taken as water density (kg.m$^{-3}$)

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;

$W_m$ is the moisture content, in % mass of the fresh sample according to EN 13040;.

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

$$\rho = \frac{1}{\frac{OM/100}{1550} + \frac{(100 - OM)/100}{2650}} \quad (5)$$

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

$\Delta t$ time $\Delta P$ is taken, in h.

## 9 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.