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Application report Respiration activity of soils (standard test preparation)



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Matrix: **Soils and solids**
Analytical applications
no. 2

**Measurement of the
respiration activity of
soils with the
OxiTop® Control
measurement system**

Standard test preparation

1st edition, July 1999

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Note: This report was made by using OxiTop[®] Control. All measuring procedures can easily be transferred to the OxiTop[®]-IDS system.

Area of application

Determination of the respiration activity of soils, composts, mud and all other solid materials in the measuring range of 1.5 to 1800 mg O₂/[kg*d] in the range of activities:

- Agricultural investigations
- Pollution investigations
- Waste investigations
- Basic research

Further information and references on this subject are given in the bibliography items, [1] - [12].

Measurement principle

Manometric measurement of oxygen consumption with simultaneous absorption of CO₂ in caustic soda solution. Selection of a suitable measuring range through the use of measuring vessels of various sizes and different quantities of test material.

Material

OxiTop[®]-C heads (WTW, Weilheim, FRG)

OxiTop[®] OC 110 controller (WTW, Weilheim, FRG)

ACHAT OC PC communication software (WTW, Weilheim, FRG)

Data transmission cable, type AK 540/B for RS 232

Measuring vessel MG 1.0 and 1.5 with DV/MG lid-locking device (WTW, Weilheim, FRG)

Temperature-controllable room or temperature-controlled cabinet of the variants,

TS606/2 ...TS606-G4/Var (WTW, Weilheim, FRG)

Personal computer, minimum requirement: 80486 processor, 16 MB RAM, RS232 interface

Windows 3.1 or 3.11 operating system, EXCEL[®]5.0 spreadsheet program (Microsoft)

Laboratory balance (least reading: min. 0.1 g)

Glass beakers (50 mL)

Transfer pipette, 50 mL

Measuring cylinder, 50 mL

Caustic soda solution (1 mol/L)

Vaseline

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Conducting the measurement

Con-sec. no.	Workstep	Explanations, comments, notes
1	<p>Adjust the material sample to be examined for optimum water content for the purpose of the examination [1]</p> <p>Reserve a part of the material for a dry substance determination [3]</p>	<p>For soils: normally half (50%) of the maximum water capacity.</p> <p>For composts: Adjustment of the consistency based on the sample of the empirical test [2].</p> <p>Depending on the question being investigated, water contents deviating from this can be adjusted..</p>
2	<p>Determination of the amount of sample suitable for the test (100 to 300g).</p> <p>Determination of the suitable measuring vessel (MG 1.0 or MG 1.5)</p>	<p>The amount of sample and vessel size are determined afterwards depending on how high the respiration activity of the sample material is expected to be.</p>

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Con-sec. no.	Workstep	Explanations, comments, notes
	For very low measuring ranges, a measuring vessel with a volume of 0.55 L can be used (Weck company, Öfringen, FRG) with, however, a lid-locking device without a holder for the absorption vessel (For recommendations, see table 1)	For higher respiration rates, a reaction vessel that is as large as possible and an amount of sample that is as small as possible (see table 1) should be selected. For amounts of sample that are too low, the representativity of the sample becomes smaller.
3	Place the loosely broken up material into the measuring vessel	
4	Apply a thin coat of vaseline to the sealing ring of the lid-locking device.	Caution! Do not use silicon grease as this can cause damage upon contact with the OxiTop® measuring heads
5	Insert the absorption vessel with 50 mL caustic soda solution (1M) into the holder of the lid-locking device	The concentration of CO ₂ absorber should be as low as possible due to changes in the dry substance (water loss). (Recommended <2M)
6	Put on the lid and fasten it with the 4 clips (4x90°)	
7	Insert the rubber sleeve	Do not grease this joint! If necessary, trim the rubber sleeve as a seal!
8	Seal the Oxitop®-C measuring head by screwing it on	Tighten moderately without the use of force!
9	Place the test preparation into the constant temperature room or thermostat cabinet.	It is advisable to preheat all materials and components to ensure constant starting conditions and to prevent incorrect measurements.
10	Start recording the measurements using the controller in the "Pressure p" mode	The total measurement time depends on various factors. Measurement times of around 7 days are recommended for natural soils; however, a general recommendation cannot be given. 360 measuring values are recorded at equidistant time intervals over the entire measuring period
11	To prevent oxygen-limiting measuring conditions arising, the measurement data of the measuring heads are transferred to the controller at regular intervals. If the defined pressure value or the selected warning pressure of -100 hPa, for example, is undercut while processing the affected measuring vessels/samples by ventilating, addition of nutritive solution, sampling, refilling of the CO ₂ absorber etc., call up the instantaneous value before starting and after ending the	In the case of manometric/respirometric determination of the respiratory activity, the partial pressure of oxygen in the sealed measuring vessel decreases during the measurement. If a minimum partial pressure of oxygen is maintained, the biological activity of the microorganisms is not affected. The Oxitop®-C Control measuring system documents the entire pressure progression or the oxygen consumption as a graphic function

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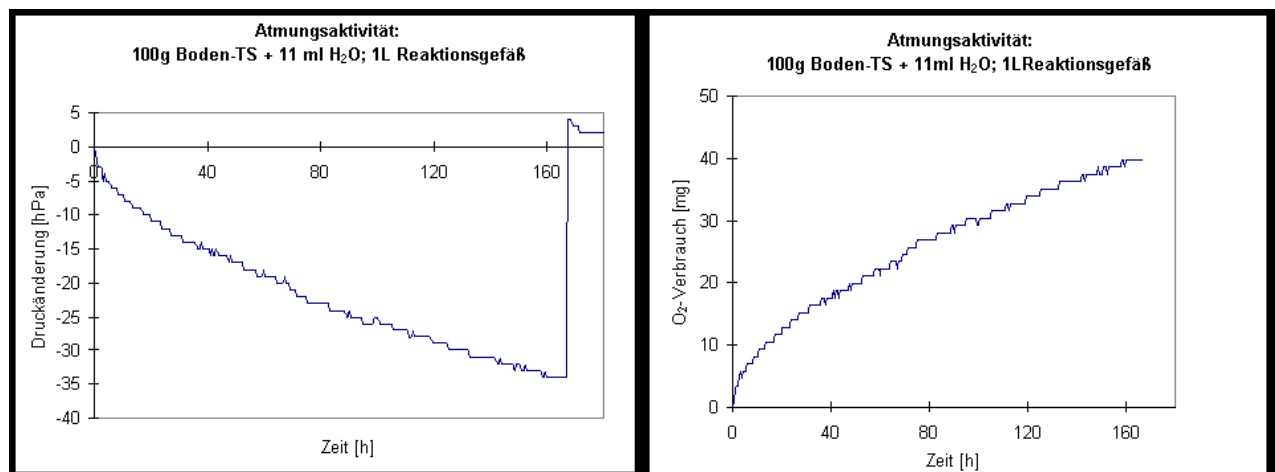
Con-sec. no.	Workstep	Explanations, comments, notes
	action and save in the controller (max. 10 instantaneous values, M01... M10)	
12	If the above-mentioned pressure range is undercut, the measuring vessel should be opened and the caustic soda solution replaced.	This procedure can be repeated as often as necessary during the specified time period or over 10 storable instantaneous values without having to restart the measuring head.
13	At the end of the measurement, the data are transmitted to a PC using the ACHAT OC software and edited with EXCEL.	The stored instantaneous values are listed at the end of the value table with M01 to M10 and can be displayed/evaluated as a continuous function by Excel (difference formation).

Table 1: Recommended vessel selection and amount of sample

Sample material	Recommended vessel volume	Recommended amount of sample
Soil, biologically less active	1.0 L*)	300 g
Soil, biologically "normally" active	1.0 L	100 to 300 g
Soil after addition of lightly degradable material	1.5 L	100 g
Compost (biologically highly active)	1.5 L	50 g

*) If necessary, a special size of 0.55 L can be used with a lid-locking device without a holder for the absorption vessel

Examples of measurement results


Figure 1

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Figure 1: Determination of the respiration activity of a soil at 20°C. 100 g of the air-dried soil were brought to a water content of 50% of the WC_{max} by adding of 11 mL of tap water. The soil was placed in a reaction vessel with a volume of 1 L and the test carried out according to the protocol mentioned above. The figure on the left shows the pressure progression recorded by the OxiTop® Control measuring system, the figure on the right shows the resulting calculated amount of consumed oxygen. After 40 h, the oxygen consumption rate was approximately linear; for the following period, an oxygen consumption rate of 42 mg O_2 /[kg TS*d] was recorded.

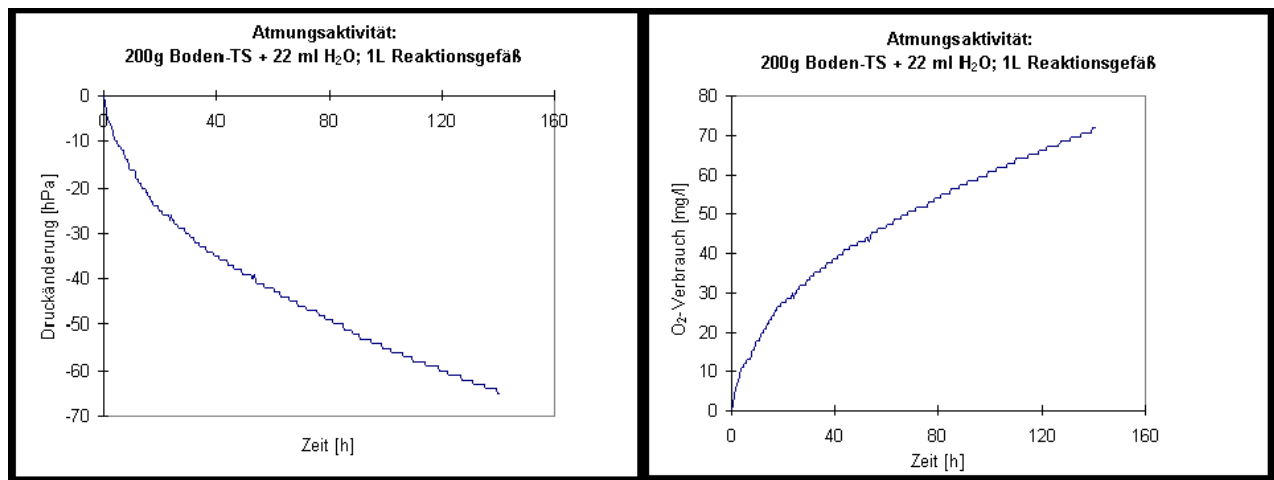


Figure 2: Determination of the respiration activity of a soil at 20°C. 200 g of the air-dried soil were brought to a water content of 50% of the WC_{max} by adding of 22 mL of tap water. The soil was placed in a reaction vessel with a volume of 1 L and the test carried out according to the protocol mentioned above. The figure on the left shows the pressure progression recorded by the OxiTop® Control measuring system, the figure on the right shows the resulting calculated amount of consumed oxygen. After 60 h, the oxygen consumption rate was approximately linear; for the following period, an oxygen consumption rate of 35 mg O_2 /[kg TS*d] was recorded.

The same soil was used for both of the tests described above. The results correspond quite well within the limits of measurement uncertainty. However, differences can be seen in the start-up phase (in the first 20 to 60 hours). How this is to be evaluated is the subject of further investigations. For reasons of transparency, the starting time (= lag phase) after which this was reached should be indicated in addition to the measurement result of the respiratory rate. The observation that a freshly moistened soil exhibits increased respiratory activity in the first few hours is already described in the literature.

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Note

The information contained in our application reports is only intended as a basic description of how to proceed when using our measurement systems. In isolated instances or if there are special general conditions on the user side, exceptional properties of the respective sample can, however, lead to a change in the execution of the procedure or require supplementary measures and may, in rare cases, lead to a described procedure being unsuitable for the intended application.

In addition, exceptional properties of the respective sample such as special general conditions can also lead to different measurement results.

The application reports have been prepared with the greatest possible care. Nevertheless, no responsibility can be accepted for the correctness of this information.

The current version of our general terms of business applies.



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