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# WTW OxiTop® システム アプリケーションレポート

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## はじめに

過去30年間、WTW OxiTop®は、生物化学的酸素要求量（BOD）の測定と高度な呼吸活性測定試験の分野で定着した用語である。これまでに、20万個を超えるOxitopヘッドが世界中で販売された。これらの製品は、業界だけでなく科学分野でも大きな役割を果たしてきた。Google Scholarで公開された論文を「Oxitop」というキーワードで検索すると、4380件の結果が得られる。特に、最近の10年間で論文数が大幅に増加した（図1）。

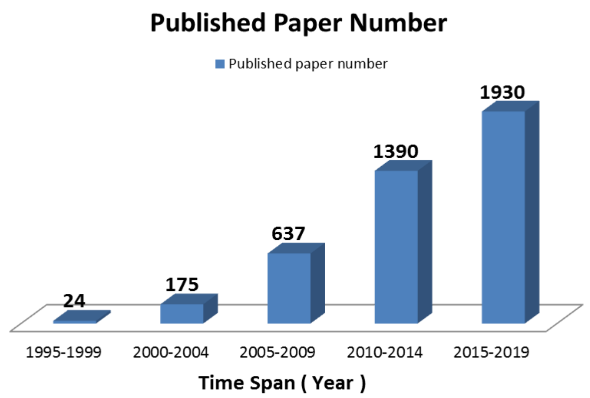


**図1 Google ScholarでOxitopというキーワードで検索した際に表示された論文数**

OxiTop®システムはBOD測定だけでなく、呼吸活性測定試験においてもより多くの利点が実証されている (Roppola et al. 2007)(Silveira et al. 2019)。本報では、測定原理、主なアプリケーションを紹介する。

## 主な特長

- 確実な結果を得られる扱いやすさ、BOD測定結果を直接表示
- Bluetoothによるワイヤレス測定
- 最大圧力範囲：1500 hPa、最大測定期間：180日
- OECD/微生物学に準拠した生物学的分解性の測定 - DIN ISO 29 408 / ISO 9408 / OECD 301 Fに準拠した実験手順

## 測定原理

OxiTop®システムは、圧力センサーを利用して、一定温度下において密閉容器内の気体の位相圧力変化（減圧）を測定する。圧力低下は基本的な呼吸の作用によるものである。**$CO_2$ は、NaOHにより吸収される。

$$C_{(有機物)} + O_{2\,(ガス)} \rightarrow CO_{2\,(ガス)} + H_2O$$

酸素利用速度（OUR）と二酸化炭素の発生の計算は、圧力降下の測定に基づいている。圧力降下はOxitopヘッドのデータロガー機能で日毎に記録される。呼吸活性測定試験中の典型的な圧力降下を図2に示す。

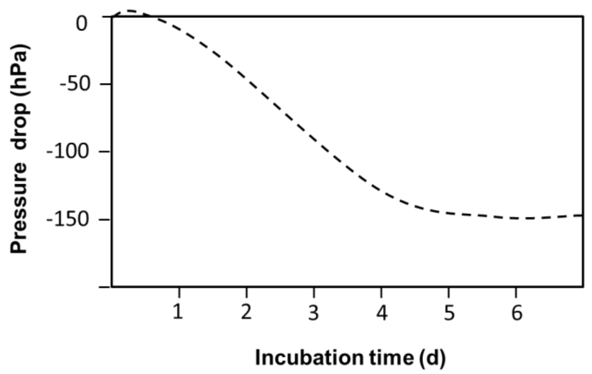


**図2 呼吸活性測定試験中の典型的な圧力降下**

OURや二酸化炭素の変化は、物質のモル数と理論的な酸素消費量の方程式による圧力降下の関係から求めることができる（Lueders 2010）：

$$\Delta P = \frac{nR\Delta T}{V}$$

$\Delta P$ – 圧力降下 (kPa),
n – 物質のモル数 (kモル)
$\Delta T$ – ガス温度の変化 (ºK)
R – 一般的なガス定数 (8.134 kJ/モルe· ºK)

詳細な嫌気性計算式は、WTWアプリケーションノート（Lueders 2010）にある。

## アプリケーション

OxiTop®システムには多くの機能があり、研究者に幅広い分野で使用されている。直近15年間に発表されたOxiTopに関する論文をレビューし、主に生分解試験アプリケーションを列挙したものを表1に示した。モデルチェンジした生物学的分解試験用のOxitopシステムの写真を図3に示した。

上位3つのアプリケーションは、木材防腐剤（PHB、
PHAを含む）、土壌呼吸活性分析、油の分解性である。

**表 1　直近の15年間に発表されたOxiTop® の生分解分野のアプリケーション**

| 生分解 | 参考文献 |
| --- | --- |
| 木材防腐剤, PHA, PHB | (Vähäoja, Piltonen, et al. 2005a) (Prokkola 2015) (Protection and 2016 n.d.) (Vähäoja, Piltonen, et al. 2005b) (Piltonen et al. n.d.) (Pabón Pereira et al. 2012)(Domeizel, Khalil, and Prudent 2011) (Myszograj, Kozłowska, and Krochmal 2014) (H Najdegerami and Bossier 2019)(Chan et al. 2019) |
| 土壌 | (Platen and Wirtz n.d.)(Bautista et al. 2017)(Garcia, Roldan, and Garzon 2011)(Koler 2017)(Martín Rubio 2017)(van Bruggen et al. 2015)(Choi et al. 2017) (Lièvre and Masuel 2012)(Evangelou 2007) (Board, Sulfide, and Carbon 2018) 朝倉 宏 |
| 油 | (Vähäoja, Kuokkanen, et al. 2005)(Dokukins and Muter 2016) (Kuokkanen et al. 2004) (Vähäoja, Roppola, et al. 2005) (Karhu et al. 2009) |
| 医薬品 | (Vaňková 2010a) (Vaňková 2010b) |
| 廃棄物 | (Ozimek, Agrophysica, and 2012 n.d.) (Pabón Pereira 2009) (Caffaz et al. 2007) |
| 界面活性剤 | (Quinete et al. 2010) (Jurado et al. 2013) |
| 揮発性疎水性物質 | (David M. Brown et al. 2018) |
| 有機化合物 | (Junker, Paatzsch, and Knacker 2010)(Masy et al. 2016) |
| プラスティック | (Samu 2013)(Tosin et al. 2012)(Ahn et al. 2011) (Walczak et al. 2015) |
| 揮発性炭化水素 | (David M Brown et al. 2018) |
| 生物凝集剤 | (Norli et al. 2011) |
| 包装材料 | (Aryal 2019) |
| 不織布 | (Hartikainen 2015) |
| 生体高分子 | (Kopeć, Gondek, and Baran 2013) |
| 泡沫 | (Król, Prochaska, and Chrzanowski 2012) (Beneš et al. 2020) |
| ペルフルオロオクタンスルホン酸塩 | (Choi et al. 2016) |
| キチン質 | (Brzezinska, Jankiewicz, and Walczak 2013) |
| ナフタレン | (Bagi et al. 2014) |
| コラーゲンハイドロゲル | (Zainescu, Albu, and Constantinescu 2018)(GAIDAU et al. 2014) |
| カチオン性および両性原料 | (Gheorghe, Lucaciu, and Pascu 2012) |
| 自然風化した車のタイヤ | (Polesel et al. 2018) |
| コリンアミノ酸 | (Yazdani et al. 2016) |
| 農薬 | (Aimer, Benali, and Serrano 2019) |
| シリコン | (Laubie et al. 2012) |
| 革 | (Silveira et al. 2019) |

OxiTop®-IDS A 6

OxiTop®-IDS AN6

OxiTop®-IDS B6/B6M/B6M2.5

**図3　OxiTop®** 生分解性試験セット

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邦訳作成
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