

Biological and chemical studies on soil contaminated with Persistent Organic Pollutants (POP)

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Please cite as: CHEMIK 2015, **69**, 11, 777–782

The Centre for Biotechnology of the Silesian University of Technology conducts research project FILOMATA with students of the secondary school. The funding was obtained under the programme of the Minister of Science and Higher Education “Universities of Young Inventors”.

The studies have shown stimulating effect of calcium peroxide (CaO_2) on change of physicochemical and biological parameters of soil contaminated with used engine oil (UEO) and levamisole (LEV), a veterinary drug.

In samples with introduced CaO_2 two times higher decrease of LEV was observed. For UEO, removal effect was comparable, while introduced CaO_2 optimized soil pH and physical and chemical changes leading to production of increased amount of catechol in relation to phenol.

Introduction

Progress in application of modern methods of instrumental analysis (High Performance Liquid Chromatography, HPLC, Mass spectrometry MS, Raman, X-Ray, IR, UV-Vis spectroscopy, etc.) results in increased identification of persistent organic pollutants (POP) such as petroleum products (including PAHs), pesticides, antibiotics in various components of natural environment [1, 2]. However, the current state of environmental pollution with these substances makes it necessary to look for new methods of their removal that would provide better results than those used nowadays [3 – 5].

Bioremediation is a good alternative for conventional technologies used for removal of POPs. Techniques using environmental ability to self-clean can be, after proper adaptation of microorganisms, effective and commercially attractive, but are usually time-consuming; in case of incorrect course can generate side products that can equally contaminate natural environment as starting substances. The latest research focuses on work involving increasing efficiency of these processes [6, 7]. Such possibility is provided by technologies combining chemical and biological processes of decomposing pollutants.

The studies involved determination of physicochemical and biological changes in soil contaminated with used engine oil (UEO) and levamisole (LEV), a veterinary drug with application of indigenous microflora (naturally present in soil), whose activity was stimulated with calcium peroxide (CaO_2). The selection of substances from POP group was based on their commonness in the environment.

Calcium peroxide (CaO_2) was used in such doses and concentrations that did not eliminate biological processes, but enhanced and stimulated them [8]. The literature data highlights a dual action CaO_2 , i.e. generation of free radicals causing decomposition/decrease in persistent organic pollutants and generation of oxygen required for aerobic biodegradation processes [9]. Thus, occurrence of hybrid biological-chemical system was assumed, where chemical substance of peroxide nature was used as a stimulator of biological activity.

The presented research concept was set out in project accepted by the Ministry of Science and Higher Education and which was funded as a result of competition in the programme “Universities of Young Inventors”. The programme helps students of middle and secondary school to develop their scientific activity and stimulate innovation and creativity in solving research problems. Financial support for the academic institution for the project covers costs of reagents needed for studies and scientific and educational materials.

To our joy, for over two hundreds submitted from entire Poland, the application of the Centre for Biotechnology got second place in the ranking of the Ministry, after the Faculty of Biology of the Adam Mickiewicz University in Poznan. The letter of congratulations to the Rector of the Silesian University of Technology was sent by Prof. Lena Kolarska-Bobińska, Minister of Science and Higher Education, where she stressed importance of the continuity of education from kindergartens, schools, to universities.

During the project, students shown practical skills related to testing solutions (lysimetric leachate) and solid samples (soil). They also learned new biological methods for indication of ecotoxic effect of both contaminants (oil derivatives, pharmaceuticals), as well as intentionally introduced to the environment substance CaO_2 of expected stimulating action. The number of repetitions allowed statistical analysis appropriate for biological studies. The project was interdisciplinary in nature, as it required both chemical and biological expertise and application of engineering solutions when organising test station (construction of lysimeter system with sprinklers and technological calculations).

Tests were conducted in lysimetric systems (Photo 1) that simulated natural behaviour of substances leached from the upper soil layer due to precipitation.



Photo 1. Test station – lysimeters

The studies involved use of:

- natural substance with organic substance content equal to approx. 2% (average for Polish soils determined by the Institute of Soil Science and Plant Cultivation)
- as pollutant – petroleum product, i.e. used engine oil (UEO) and pharmaceutical substance, levamisole (LEV) – antiparasitic veterinary drug used at livestock fattening farms.

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- calcium peroxide (CaO_2) – strongly alkaline calcium compound, slowly dissolving in soil solution exhibiting environmental chemical and biological activity (increasing pH, generating oxygen, stimulating decomposition of pollutants by formation of free radicals affecting their chemical structure).

UEO pollutant and LEV was introduced to 1 kg of soil in the amounts of 2% and 4.5 mg/kg, respectively. CaO_2 was also added. Physical and chemical analyses of soil were conducted in order to determine starting parameters, after which soil was placed in lysimeters for 6 months. Soil in lysimeters was watered regularly every 7 days with 0.01M CaCl_2 solution acting as rain. Amount of rain per day was calculated based on 2013's average rainfall. Soil leachates were collected in glass flasks secured against excessive evaporation and analysed regularly every 6 weeks (Photos 2, 3, 4).



Photo 2, 3, 4. Project participants during classes in the laboratory

The experiment was conducted with three repetitions for each sample:

1. soil – reference sample (lysimeters: 1, 2, 3)
2. soil with CaO_2 , 0.5 g/kg causing increase of pH by 1 (lysimeters: 4, 5, 6)
3. soil with used engine oil – UEO (lysimeters: 7, 8, 9)
4. soil with UEO and CaO_2 as for system II (lysimeters: 10, 11, 12)
5. soil with levamisole – LEV (lysimeters: 13, 14, 15)
6. soil with LEV and CaO_2 as for system II (lysimeters: 10, 11, 12)

Diagram of lysimeter tests of soil contaminated with POP is presented in Figure 1.

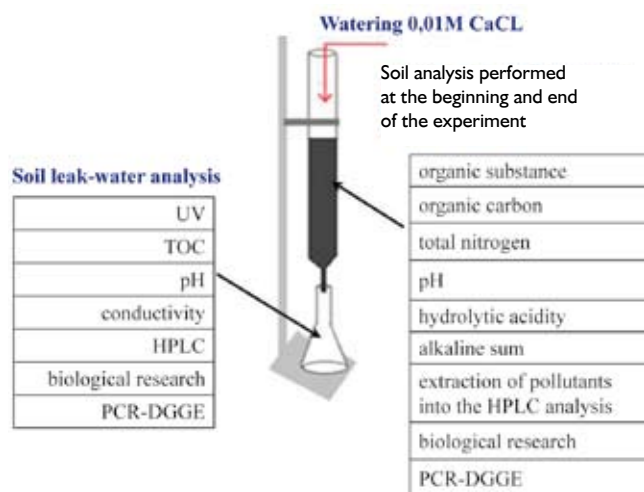


Fig. 1. Diagram of lysimeter tests

A measurable effect of completed tests is obtaining results increasing chances of success of the young people participating in biology and chemistry contests. Currently, the research results are comprehensively analysed. Its results will be used to prepare the publication. Within the project, patent publication P. 41 1232 "Biostimulation method for solid substrate with calcium peroxide, especially in technological processes" was submitted.

Acknowledgments

Project "FILOMATA and biological and chemical studies of soil contaminated with persistent organic pollutants", number FSB/16/RJP8/2015/512, which foresees the active participation of 17 students of Secondary School FILOMATA in Gliwice was conducted with the funds of the Ministry of Science and Higher Education. Teachers coordinating actions of students were Mrs. Dominika Sadowska (chemistry teacher) and Sabina Wesoły (biology teacher), while involved FILOMATA's students show above average interest in chemistry and biology and have knowledge enabling conducting research work and analysis of obtained results. The project was easier to conduct thanks to selfless assistance of TIGRET dealing with modern screening techniques in quality tests of food, water and soil. With goodwill of Mr. Grzegorz Piątkowski, vice president, biological tests were conducted using ISO-standard and OECD guidelines compliant tests.

Biological tests were performed under supervision of Ph.D. student, Monika Nowrotek, M.Sc., Eng. "Dokto-RIS" project fellow, under scholarship programme for innovative Silesia co-funded by the European Union from the European Social Fund.

Students participating in the project: Agnieszka Wiczorek, Maja Popiół, Martyna Parlak, Emilia Ulkowska, Michał Skórkowski, Mateusz Świerczek, Krzysztof Paczka, Michał Bujok, Dawid Glikich, Michał Madej, Katarzyna Waniczek, Katarzyna Bek, Alicja Rejs, Alicja Winnicka, Julia Bałazy, Tomasz Cieśliński and Marcin Kleibert .

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Wybitni naukowcy nagrodzeni przez Premiera RP

Nagrody Prezesa Rady Ministrów przyznawane są za wybitną działalność naukową, naukowo-techniczną i artystyczną. Nagradzane są także najlepsze rozprawy doktorskie i habilitacyjne. W tym roku wyróżnionych zostało 41 naukowców i 3 zespoły naukowe. Nagrody za wybitną działalność naukową otrzymało 6 badaczy; nagrodzono także 10 rozpraw habilitacyjnych i 25 doktoratów. Pełna lista zwycięzców dostępna jest na stronie internetowej MNiSW. (kk)

(<http://www.nauka.gov.pl/>, 5.11.2015)

iENA'2015

W dniach 29 października – 1 listopada 2015 r. w Norymberdze (Niemcy) odbyła się 67. Międzynarodowa Wystawa Wynalazków iENA 2015 – Pomysły, Wynalazki, Nowe Produkty. Instytut Chemii Przemysłowej zaprezentował trzy wynalazki. Wśród nagrodzonych znalazły się: „Sprytne opakowanie biobójcze”, autorzy: dr hab. inż. Regina Jeziórska, prof. IChP; dr hab. Maria Zielecka, prof. IChP; mgr Agnieszka Szadkowska, inż. Elżbieta Bujnowska, mgr inż. Magdalena Wenda, Krystyna Cyruchin – złoty medal oraz „Absorber toksycznego formaldehydu w aminoplastach i fenoplastach”, autorstwa: dr hab. Izabelli Legockiej, prof. IChP; mgr inż. Ewy Wierzbieckiej, dr Elżbiety Wardzińskiej-Jarmulskiej, dr inż. Barbary Szczepaniak – srebrny medal. (kk)

(<http://www.ichp.pl/>, 6.11.2015)

SPOTKANIA

Grupa Adamed na Europejskim Forum Nowych Idei

W dniach 30 września – 2 października br. w Sopocie odbyło się międzynarodowe spotkanie środowisk biznesowych z udziałem przedstawicieli świata nauki, kultury i polityki. Europejskie Forum Nowych Idei skupiło 1000 osób z całego świata. Grupę Adamed w tym wydarzeniu reprezentował Maciej Adamkiewicz – Prezes Zarządu firmy. Tegoroczne debaty skupiły się wokół koniecznych priorytetów, jakie trzeba podjąć dla usprawnienia m.in. europejskiej gospodarki. Istotne miejsce w programie miały też najważniejsze wyzwania, jakie stoją przed Unią Europejską: przyszłość strefy euro, jednolity rynek cyfrowy, czy europejska unia energetyczna. (kk)

(<http://adamed.com.pl/>, 5.10.2015)

KONKURSY, STYPENDIA, STAŻE

750 mln PLN na innowacje w dużych firmach – nabór wniosków

Do końca listopada br. Narodowe Centrum Badań i Rozwoju przyjmuje wnioski w nowym konkursie dla dużych przedsiębiorstw. Konkurs przeznaczony jest dla przedsiębiorstw zatrudniających powyżej 250 pracowników. Skierowany jest na wsparcie dużych i ambitnych projektów B+R i podniesienie konkurencyjności polskich firm dzięki wykorzystywaniu rezultatów prac badawczo-rozwojowych w ich działalności gospodarczej. Konkurs pozwoli przedsiębiorstwom na wdrożenie ambitnych i innowacyjnych projektów, obarczonych często dużym ryzykiem. Budżet konkursu wynosi 750 mln PLN. Przedsiębiorcy mogą ubiegać się o dofinansowanie projektów obejmujących realizację badań przemysłowych i prac rozwojowych lub samych prac rozwojowych. Jeżeli ponad połowa całkowitych kosztów kwalifikowanych projektu jest ponoszona na badania przemysłowe, finansowanie może sięgnąć nawet 20 mln EUR. Jeśli ponad połowa kosztów przeznaczona jest na prace rozwojowe – może on zostać dofinansowany kwotą 15 mln EUR. (kk)

(<http://www.nauka.gov.pl/>, 14.10.2015)

Ideas Plus II – Szansa na dofinansowanie przełomowych odkryć

Ideas Plus II, to nowy program MNiSW, w którym o środki ubiegać mogą się naukowcy, którzy zajmują się pionierskimi badaniami. Łączna kwota przeznaczona na dofinansowania to 3,5 mln PLN. W programie MNiSW na finansowanie mogą liczyć projekty interdyscyplinarne, poruszające zagadnienia ze wszystkich dyscyplin naukowych; mogą się o nie ubiegać badacze, których projekty zostały wysoko ocenione w konkursach ERC, jednak z różnych przyczyn nie otrzymali oni grantów. Nabór wniosków rozpocznie się po otrzymaniu oficjalnych informacji z Krajowego Punktu Kontaktowego Programów Badawczych UE o wynikach konkursów ERC. Okres realizacji projektu nie może przekroczyć 36 miesięcy. (kk)

(<http://www.nauka.gov.pl/>, 4.11.2015)

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