The abatement of airborne volatile organic compounds and odors using combined pulsed corona discharge and photocatalytic oxidation

Summary

Clean indoor air is an essential determinant of healthy life and people's well-being. Refractory volatile organic compounds and odors emitted from buildings, construction materials and indoor equipment comprise a broad range of health issues. Air purification methods integrated with ventilation systems allow to reduce indoor air pollution. Thus, the overall goal of the present project is to examine the combination of pulsed corona discharge (PCD) and photocatalytic oxidation (PCO) aimed to chemical degradation of airborne pollutants. Several important questions need to be addressed on the course of proposed research: What is the role of temperature in the formation of oxidative species in plasma environment? How to improve the degradation of ozone in PCO? How successful could be the application of solar energy to induce PCO process?

Research field:	Chemical, materials and energy technology
Supervisors:	Sergei Preis Juri Bolobajev
Availability:	This position is available.
Offered by:	School of Engineering Department of Materials and Environmental Technology
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

Nearly 200 pollutants are present in indoor air, most of which are volatile organic compounds (VOCs) that are emitted to the indoor air from regularly used products. Among the sources of air pollution are cleaning products, dwelling construction materials, kitchen activities and furniture, whereas outdoor sources include traffic and neighboring industries. Conventional air purifiers installed in the buildings include filtration, electrostatic precipitation, or adsorption processes. Among them, only adsorption method can remove VOCs from the polluted air, transferring the substance from gaseous media to solid phase without, however, destroying it. Accumulation of hazardous substances in adsorption columns requires continuous maintenance and periodic replacement. Thus, more advanced solutions are required for tackling the problem. Ideally, air pollutants must be degraded chemically to less harmful molecules.

Pulsed corona discharge (PCD) and photocatalytic oxidation (PCO) deserve particular attention for showing promising results in degrading VOCs at high energy efficiency, demonstrating the best performance when used in combination. Tandem use of both technologies is on its early stage and thus requires the optimization of certain parameters. In general, the project should examine the benefits, risks, opportunities and implications of using PCD/PCO tandem. Among the specific goals are distinguishing the role of air temperature in PCD-induced degradation of VOCs and other air pollutants, reducing the concentration of ozone generated by PCD, the use of solar energy (ultraviolet) for activation of PCO.

Responsibilities and (foreseen) tasks

- Compile an analytical framework for examining experimental approaches of the research
- Developing instrumental methods for qualitative and quantitative analysis of chosen pollutants in different matrices
- Planning of research activity, data collection and conduction of experimental studies
- Writing of publications in high quality peer-reviewed international scientific journals

Applicants should fulfil the following requirements:

- a master's degree in materials and environmental technology, or civil engineering
- a clear interest in R&D with special focus on hands-on activity
- a clear interest in the topic of the position
- excellent command of English

- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to provide assistance in organizational tasks relevant to the project

(The following experience is beneficial:)

- Experimental and/or theoretical environmental chemistry
- Working knowledge of analytic chemistry
- Working knowledge of instrumental analysis (HPLC- MS/PDA, GC-MS, FTIR, UV-Vis spectroscopy, electroanalytical chemistry)
- Working knowledge of scientific data analysis and interpretation
- Previous experience working in chemical laboratory

We offer:

- 4-year PhD position in the department of materials and environmental technology, which mission is to provide the high-level of internationally recognized teaching, research and development
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of environmental protection, chemical engineering

About the department

The mission of the Department of Materials and Environmental Technology is to lead the high-level, internationally recognized teaching, research and development in Estonia in the field of materials and environmental technology. As a part of present department, the main research area of the Laboratory of Environmental Technology is the treatment of air, water and soil mostly with so-called Advanced Oxidation Processes (AOPs). This concept is applied to a range of different oxidative technologies, the common feature of which is the formation and employment of a powerful oxidant, hydroxyl radical (HO•).

(Additional information)

For further information, please contact Prof. Sergei Preis sergei.preis@taltech.ee and senior lecturer Juri Bolobajev juri.bolobajev@taltech.ee or visit https://www.taltech.ee/en/

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