Title: Design, study and modeling of a compact reactor based on self-cleaning adsorbent textile for indoor air treatment under real conditions

Titre : Conception, étude et modélisation d'un réacteur compact basé sur un textile adsorbant autonettoyant pour le traitement de l'air intérieur dans des conditions réelles

Keywords: Heterogeneous photocatalysis, Adsorption and regeneration, chemical oxidation, modeling, mass transfer limitation, air treatment, volatile organic compounds (VOC)

Contextual elements

This thesis will be performed within the framework of the ANR[1] TEXAD project, which is an interdisciplinary and collaborative project between three academic partners (CIP-ISCR-ENSCR, IRCELYON , IGGCM -Rennes 1) and Brochier Technologies (industrial partner). The project TEXAD aims to develop an innovative and sustainable technology of remediation that can be integrated into a stand-alone mobile module. Such modules placed in a room (office, meeting room, classroom…) allow to treat indoor air. The concept consists in using adsorption as trapping technique coupled with an advanced oxidation process (AOP) for pollutant degradation, allowing to develop a sustainable purifier. This coupling will allow on one hand to avoid the propagation of potentials intermediate pollutants from AOP and on the other hand it will allow to avoid a potential release of pollutants from adsorbent before its saturation. The module will be validated firstly in 1 m^3 chamber according to standards and secondly in 30 m^3 climatic chamber simulating the actual operating conditions.

Objectives and specific thesis program

The thesis subject concerns a research work on the performances of VOCs degradation using combined photocatalysis and adsorption in a compact continuous reactor based on a new media based on a self-cleaning textile combining an adsorbent (activated carbon) and a photocatalyst (TiO_2) supported on side-emitting optical fibers connected to UVA LEDs. in order to investigate the efficiency of the best new catalysts under different configurations of reactor:

The first stage aims to (i) qualify the reactors' performances, (ii) determine the influence of the parameters related to the gas flow (residence time, temperature, relative humidity...), mode of treatment (adsorption, regeneration and photocatalytic oxidation), (iii) identify and quantify eventual by-products due to the various characteristics of the gas and (iv) optimize the design and operating conditions to avoid formation of by-products.

In a second stage, the design will be optimized considering different flow patterns (tangential flow or cross flow), increasing compactness while controlling hydrodynamics (promoting mass transfer without excessive headloss) and robustness to fluctuating air qualities (day/night, pollutant mixtures) and the regenerative efficiency.

The third stage will focus on the various possible treatment modes and their scheduling (loading and regeneration of the adsorbent, with or without continuous UV irradiation, open or closed loop, …) for optimal performance. Several photocatalysis regeneration studies will be carried out in detail on an open and a closed loop.

Finally, all the experimental results obtained during this work will be combine to develop, fit and validate a mechanistic model which should make it possible to design a final stand-alone module. Its performances will be validated in a 1 m^3 chamber according to standard practice and secondly in 30 m^3 climatic chamber simulating the actual operating conditions.

The Candidate will be part of the Chemistry and Process Engineering team (CIP-ISCR-ENSCR) in Rennes, which has a long-lasting experience on advanced oxidation processes, adsorption processes, and organic micropollutant treatments.

[1] Agence Nationale de la Recherche, French public funding agency for research programs

Skills requested

The candidate must have knowledges and skills in the fields of chemistry, chemical engineering or environmental engineering. Modeling and simulation skills will be very appreciated.

He (She) must be autonomous in his (her) work. He (She) must have also specific skills for a research project: curiosity, scientific precision, perseverance, teamwork. French language will be appreciated.

Location

Ecole Nationale Supérieure de Chimie de Rennes (ENSCR)

Institut des Sciences Chimiques de Rennes , UMR 6226

Equipe Chimie et Ingénierie des Procédés

Duration - Funding

3-years with an ENSCR doctoral contract

Thesis start date: November 1st 2023

Doctoral specialty: Chemistry: Environmental Processes

Monthly remuneration: defined by French regulation relative to the doctoral contract (gross salary ~2000 €/month)

Application form

Candidates should submit a CV and a letter of motivation by email before 15/09/2023 to:

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