PhD position / Offre de financement de thèse

Flame arrester and deflagration suppression properties of Catalytic Open Cell Foams.

A breakthrough in chemical production could be achieved by adapting technologies for the production of key chemicals to new markets using Process Intensification (PI). PI could indeed enhance physical phenomena such as mass and heat transfer that often limit the intrinsic chemical activity. Recently, Open Cell Foam Reactors (OCFR) have emerged as possible gas-liquid-solid catalytic reactors to solve such issues. These materials are available in large quantities and with a large diversity considering dimensions ï cell diameters from µm to mm - and nature ï metals, ceramics, plastic,.. . Solid open-cell foams are highly porous (from 60 to 97 %) monolithic media with a continuous cross-linked strut network resulting in a quite irregular structure. These structures enable a considerable reduction of pressure drop combined to very high geometrical specific surface areas. Fluid flow can proceed in all the directions resulting in a good radial mixing. Thus, efficient heat and mass transfer performances are expected. Also, deflagration suppression effects, flame and detonation quenching, flame arresters properties of foams have been evidenced in the literature, albeit not for chemical processes. The PhD project aims to evaluate the use of OCFR for G/L, G/L/S and G/S demanding, exothermic and potentially explosive oxidation reactions. The target reaction, the oxidation of aldehydes (AL) into acids, is also of strong industrial interest. The choice was dictated because by the fact that this reaction is also very challenging - it is exothermic (ca. ï 250 kJ.mol-1), it presents selectivity issues, and the AL/O_2 reaction mixture is potentially explosive ï and also because it could be readily performed without a solid catalyst thus leading to easier experimentations.

To run the project, a consortium involving two academic teams, one in catalytic processes and chemical engineering (LGPC Lyon) and the other specialized in combustion and dynamics of flames (ICARE Orléans), has been set with the aim at using advanced gas-solid and gas-liquid-solid reactor technologies. The objective is both to extend the fundamental knowledge on advanced reactors but also to demonstrate a generic solution to operate oxidation processes safely with oxygen rich gases.

The PhD student will work on i) the functionalization of the foams surface by catalytic materials or other materials aiming at modifying the surface properties at LGPC; ii) the explosion mitigation effect assessment using the detonation tube and the functionalized/unfonctionalized structures at ICARE; iii) the optimization of potentially explosive G-L reactions at LGPC in the validated foam reactors. In order to achieve his PhD work, the student will spend time at the two teams at Lyon and Orléans.

The applicant must hold a master degree or an equivalent degree in Chemical Engineering and should be able to combine skills in experimental sciences and modelling/computing. Experience in catalysis or material science will be appreciated. In this project, the PhD student will have a pivotal role to ensure a good communication and collaborative spirit between the two teams. Consequently, the candidate is expected to have a strong interest for collaborative projects, excellent communication skills and a strong motivation for research.

Partners

LGPC Dr. Claude de Bellefon, Laboratory for Catalytic Process Engineering, CPE Lyon, the School of Chemistry & Chemical Engineering, University of Lyon (UMR5285 CNRS/CPE/UCBL)

ICARE Dr. Nabiha Chaumeix, Institut de Combustion Aérothermique Réactivité et Environnement (UPR3021 CNRS Orléans).

Application The position is available on October 1st, 2016. A CV, an application letter, two letters of supports from recognized researchers or professors in the field of chemical engineering must be sent to claude.debellefon@lgpc.cpe.fr

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Literature

Hydrodynamics and mass transfer in a tubular reactor containing foam packings for intensification of G-L-S catalytic reactions in co-current up-flow configuration. Leveque, J.; Philippe, R.; Zanota, M.-L. ; Meille, V.; Sarrazin, F.; Baussaron, L.; de Bellefon, C. *Chemical Engineering Research Design* 109 (2016) 686-697.

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