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ECXX_LABYY_ NOMChercheur_ Numer
ECXX = ECLi, ECL, ECM, ECN, CS
LABYY = acronyme du laboratoire
NOMChercheur = nom du chercheur émetteur du sujet
Numer = numéro de la proposition (01, 02, ….) pour le chercheur

PhD Proposal 2017

School: Ecole Centrale Marseille	
Laboratory: IRPHE – M2P2	**Web site: www.irphe.fr, www.m2p2.fr**
Team: Biomechanics (IRPHE) **Waste and Wastewater Treatment (M2P2)**	**Head of the team: V. Deplano (IRPHE)** **A. Soric (M2P2)**
Supervisors: O. Boiron (IRPHE) – A. Soric(M2P2)	**Email: olivier.boiron@centrale-marseille.fr**
Collaboration with other partner during this PhD: **In France: Y. Knapp (UAPV) / MT Giudici-Orticoni (BIP laboratory, Marseille)**	**In China:**

Title: Microscale characterization and modelling of biofilm interactions with its substrate
Scientific field: Bioengineering / Fluid Mechanics / Chemical Engineering
Key words: biokinetics; biofilm; nutrition; biotransport

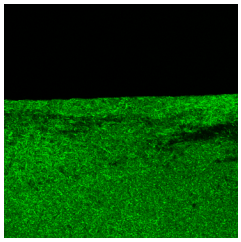
Details for the subject:
(Maximal length of 2 pages, including images, list of reference, …The pdf file should not exceed 1Mo)

Background, Context:

Biogas production from wastes and wastewater is a key issue in the energy transition. Indeed, some bacteria have the ability to produce methane or hydrogen from organic molecules in anaerobic conditions (in the absence of oxygen). Because these organic molecules represent a high fraction of urban wastes and wastewater composition, these anaerobic mechanisms could be applied to these substrates in order to produce energy carriers and so recover energy from pollution removal. Even if this process is known for several decades and already industrially implemented there are still scientific questions needed to be elucidated.
This process known as anaerobic digestion could be carried out in different type of bioreactors. Among all technological possibilities biofilm reactors have several advantages like a high microbial concentration and so high efficiency for smaller volumes than classic bioreactors (Barca et al, 2015). If it is true that metabolic pathways and microbiological mechanisms involved in these processes are quite know but they are not yet all elucidated.
Moreover, the efficiency of this process is directly linked to a lot of different parameters physical (flow, T), chemical (pH, composition) and biological (biofilm behavior).
Among all the parameters involved in the development of the biofilm, hydrodynamic plays a key role to maintain the optimal growth conditions (pH, nutrient concentrations, mechanical load, etc..) and one of the most important challenge is to understand the best design and environmental conditions to achieve the highest density of microorganisms and biogas production within the system.

Research subject, work plan:

The aim of this thesis is to investigate interactions between flow conditions and biofilm behavior by coupling an experimental study to the devlopment of a transfer model.
To tackle this issue we propose to adapt experimental devices already available in IRPHE and M2P2 labs to study biofilm behaviour at microscale. An experimental device dedicated to the study of interactions between the biofilm and its liquid environment (especially nutrients and metabolites exchanges) should be developped.
Biofilm will be grown under different flow conditions in microchambers already designed and available in M2P2 laboratory. Then biofilm growth would be followed by microscopy using fluorescence techniques. At the same time the microPIV system available at IRPHE laboratory should help to investigate hydrodynamic of the system by particles tracking in microchambers in the presence of biofilm.
This experimental study would give the key parameters needed to propose a model of interactions between the local hydrodynamic, bulk and friction velocities, and the biofilm structure and its growth capacity.


E. Coli GFP under UV light

The study would take special care to dissolved gas excreted by the biofilm, the formation of biogas bubbles (by aggregation of microbubbles) and their behavior in the flow till the outlet of the chamber. The knowledge of the biogas microbubbles formation and behavior in the micro bioreactor is a very challenging experiment. We propose to measure the biogas bubbles size by using quantitative image analysis from the PIV images but the transfer model between

biofilm and liquid phase should give clues about the capability of the system to initiate these bubbles.

The candidate should have a good knowledge of continuum mechanics. Knowledge (numerical or experimental) of fluid mechanics and/or biomechanics would be appreciated.
This research will be conduct in collaboration with Y. Knapp from LPEC (Avignon University) and MT. Giudici-Orticoni from Laboratory of Bioenergetics and Protein Engineering (BIP, Marseille).

References:

C. Barca, A. Soric, D. Ranava, MT Giudici-Orticoni, JH Ferrasse, Anaerobic biofilm reactors for dark fermentative hydrogen production from wastewater : A review, Bioresource Technology, vol 185, 386-398, 2015