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PhD Proposal 2017

School: Ecole Centrale de Lille	
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Team: Energy-Materials	**Head of the team: Andrei Khodakov**
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Collaboration with other partner during this PhD: **In France:**	**In China:**

Title: *New MicroGasic Fluidized Bed Reactor for the respect of the environment* *Application: conversion of syngas to ultraclean hydrocarbon fuels.*
Scientific field: MICROFLUIDIC, MATERIALS SCIENCE, PROCESS, ENERGY
Key words: Microreactor, Catalysis, Nanocomposites, Fluidization

Details for the subject:

Background:

The design of microreactor (microgasic-system) has demonstrated for its potential and its interest in numerous branches of industry. Currently, lot of reactors are very large in size and use particles with low surface area which requires high gas velocity. This, leads to large quantity of waste resulting into high cost of waste and energy. In the current socio-economic context, it is necessary to reduce the size of the reactor to decrease the quantity of waste and the energy for the production of solids. Novel microreactor (Miniaturized fluidized bed or microfluidized bed) can be efficiently used for a large number of applications in environmentally friendly processes.

Context:

Miniaturized fluidized bed exhibits great advantages compared to conventional fluidized beds, such as a large specific contact surface, a fast dissipation of heat (ideal for the exothermic reactions) and better mass and heat transfer. The microfluidized bed is characterized by small amounts of bed materials, high gas velocity, low flow rate, densification of reactors and low operation costs. It is certain that this technology opens new fields of studies and applications, such as mobile processes (production of hydrogen, Fischer-Tropsch synthesis, methanation) and applications to expensive and rare products (very small amount of powders).

Research subject:

The microgasic reactor (microfluidized bed/gas-solid) will be used for the suspension (or dispersion) of the micronic to nanometric powders at a very high gas velocity in microtubes. Moreover, the dispersion of the particles and the contact between gas and the particles (reaction system) will be carried out in tubes of sizes lower than 100 µm which has very complex configuration and "innovative" design. Although this process has real challenges such as complexity of the dynamics flow, the very cohesive powders (1, 2, 3, 4) in its design. It has more advantages like its ability to react gas and the active product without support, absence of attrition (fragmentation) of the particles, increase in the heat-transfer surface and thermal stability of the reactor.
However, the major and complex problems in this process are the desagglomeration and the separation of micronic and nanometric particles and the good design of microfluidized bed system. The very low size of the tubes makes it possible to obtain high speed of gas and a turbulent flow which allows a better shearing of the agglomerates and the dispersion of particles. Furthermore, the design of the process allows good dispersion, good gas-solid mixture and finally better separation of gases and the solid at the end of the reaction (5).

Work plan:

The program of this thesis is structured around the following items:

- Development and design of the microreactor
- Study of micronic and nanometric powders behaviour
- Study of the hydrodynamic and thermal behaviour (gas-solid)
- Description and calculation of interparticle forces
- Numerical modeling of nanopowders behaviors
- Development of diagnostic method to characterize fluidization behaviors based on pressure fluctuation measurement and analysis
- Application: Optimisation of catalytic performance in the microreactor for conversion of syngas to ultraclean hydrocarbons fuels.

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