

Institut de Chimie de Clermont-Ferrand

ICCF - UMR 6296



Object : 2nd year master research project

Title : Selective capture of phosphate from wastewaters for improved quality of the P product using Layered Double Hydroxides recyclable materials.

Supervisors :

Prof. C. Forano (Institute of Chemistry of Clermont-Ferrand, ICCF)

Collaboration with Prof. U. Gro Nielsen (South Denmark University, SDU).

Scientific context :

Phosphorus (P) is a non-renewable resource essential as fertilizer to ensure sufficient food production. The global P reserves are predicted to be depleted within 60-130 years resulting in increased P and food prices, leading to increased reliance on P-recovery. The international scientific program ReCoverP - Recovery of Phosphorus from Wastewater Treatment Systems, supported by the Danish Research Council, aims to propose a novel strategy for optimized P-recovery from wastewater in order to cover 15-25% of the Danish demand. This program focuses on the improvement of a P recovery multistep process, from the bioaccumulation and bio-digestion of P compounds, transformation into inorganic phosphates, concentration by chemical processes to the final conversion into high-value P fertilizer (Mg or NH₄ phosphate).

Objectives and detailed program :

In the frame of this international program, the French research group of the Institute of Chemistry of Clermont-Ferrand (ICCF) (Prof. Forano C.), expert on Layered Double Hydroxides, in collaboration with the South Denmark University (Prof. U. Gro Nielsen) expert in solid state NMR, will develop, the development of novel LDH materials for a higher efficient retention of Phosphate from wastewaters and their conversion into valuable P fertilizers, namely magnesium and calcium phosphate. Dynamic of P compounds in LDH materials will be deeply investigated using thermodynamic experiments and solid state characterization techniques (XRD, Raman, SSNMR). Phosphate will be captured either by LDH nanoparticles through ion-exchange or by calcined LDHs through the reconstruction process ("memory effect") followed by an optimization of methods for recycling of the LDH material. Functionalization of the LDH e.g., impregnation of the LDH adsorbent on silica coated magnetite microparticles to allow for separation by a magnetic field) will be investigated. The phosphate sequestration will be studied for a series of LDH materials with variable metal composition (Ca-Al, Mg-Al, Ca-Fe, Mg-Fe) under modeled and operating wastewater conditions using adsorption/desorption isotherm and kinetic experiments. A combination of analytical chemistry with molecular level techniques (e.g., SSNMR, XRD, IR) links the ion-exchange capability to the chemical structure of the LDH providing crucial information for the design of the best strategy for P sequestration. Liquid and solid state ³¹P NMR will be used ex-situ and in-situ to identify the speciation, mobility and Phosphate-LDH interactions. Both solid state (calcination/reconstruction) and liquid (hydrolysis/precipitation) chemical methods will be developed for the efficient conversion of phosphate containing LDH into calcium phosphates and struvite. X-ray diffraction, FTIR and Raman spectroscopies, will be implemented to follow short-range and long-range structural changes.

Conditions :

- Place : Institute of Chemistry of Clermont-Ferrand
- Period of work : 04/01/2016 – 30/06/2016
- Salary : 554 € per month

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