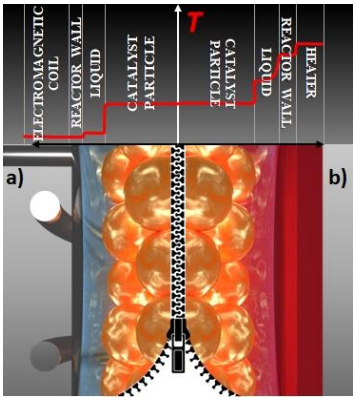
TITLE OF RESEARCH TOPIC: Electrification of bio-based compounds hydrogenation by induction

Summary: Magnetic catalyst materials containing magnetic nanoparticles embedded in high-specific area support and decorated with active metal(s) will be synthetised and thoroughly characterized for magnetic, textural and redox properties with state-of-the art techniques (XRD, XPS, TPD, TPR, TEM, BET…). Their activity to hydro(deoxy)genate biomass or biomass-derived building blocks into value-added chemicals will be initially tested in conventionally-heated high-pressure stirred reactors. Samples will be collected, intermediates and products will be identified and quantified by GC-MS, UHPLC, NMR and/or FTIR analytic techniques in order to determine kinetics of the reaction(s). Finally the catalysts will be tested in a quartz reactor inserted in an electromagnetic coil with oscillating electric current, which will result in inductive heating of magnetic catalyst particles where the reaction(s) will take place. Based on the catalytic performance the surface temperature on the catalyst will be determined using the kinetic parameters obtained by the regression analysis of the results obtained by the conventionally-heated experiments.

Research techniques used: Catalyst synthesis will involve incipient wetness and wet impregnation methods, materials will be characterized with techniques available at the department: XRD, XPS, TPD, TPR, TEM, BET, py-DRIFT etc. Stirred batch slurry reactors and continuous fixed bed or trickle bed reactors will be used for catalytic testing, either classically or inductively heated. Samples will be analyzed by GC-MS, UHPLC, NMR and/or FTIR analytic techniques in order to determine kinetics of the reaction(s). Modelling of reaction kinetics, mass transfer and thermodynamics will be performed in Matlab or Python environment in both descriptive and predictive manner.

The reason why the topic is innovative: Europe is determined to achieve carbon neutrality by 2050 by utilizing green technologies, promoting sustainable industry, and decreasing pollution. Several chemicals used in chemical, pharmaceutical and polymer industry still rely on non-renewable sources. It is essential to develop, optimize, scale-up, and continuously operate alternative sustainable processes. Biorefining currently uses many conventional methods, but there is a pressing need for a paradigm shift in chemical engineering that introduces flexibility, optimization, and intensification of processes through induction heating. This PhD student position aims to address the energy transition and the use of transient renewables as feedstock in bio-refineries by utilizing a multi-disciplinary engineering approach and modelling techniques.



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