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Adsorbent materials for desulfurization processes under supercritical water conditions

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Statement of the Problem: It is recognized that the great technological potential of the catalytic super critical water (SCW) gasification of biomass for biofuel production. However, an important issue related to the poisoning of the catalyst by sulfur (S) compounds remaining in the SCW phase is still to be solved. To design efficient S adsorbents at SCW conditions is a challenge since, the sorbent material, which is sought as metal oxide (Me_xO_y), must be structurally stable and in the same time to be able to capture S from both inorganic and organic sources under SCW conditions. The purpose of this work is to design and obtain supported nano Me_xO_y adsorbent materials for efficient desulfurization in SCW. Our previous results reported on the impact of sorbent geometry on the S adsorption in SCW.

Materials & Methodology: SCW impregnation of Me_xO_y (ZnO, CuO, Mn_2O_4, Fe_2O_3) on activated carbon was performed in a continuous flow tubular reactor (Figure), also used for S sorption experiments. In situ neutron imaging (NI), molecular dynamics (MD) and computational fluid dynamics (CFD) were the main techniques used to obtain fundamental knowledge on the phenomena taking place when different S species are adsorbed by Me_xO_y in SCW.

Findings: The NI results, reporting on the S in SCW density profiles and flow patterns through the adsorbent were used for the validation of models applied in MD and CFD. The SCW desulfurization efficiency of different Me_xO_y was established.

Conclusion & Significance: The findings of the present study are of great importance when the goal is to mitigate the deactivation of the catalyst by S from the foregoing biomass gasification by SCW.

Figure: Dedicated experimental setup for desulfurization under SCW conditions.

Recent Publications

1. Lachos-Perez D, et al. (2017) Applications of subcritical and supercritical water conditions for extraction, hydrolysis, gasification, and carbonization of biomass: a critical review. Bio fuel Research Journal 4(2):611-626.
2. Stucki S, et al. (2009) Catalytic gasification of algae in supercritical water for biofuel production and carbon capture. Energy & Environmental Science 2(5):535-541.
3. Peng G, C Ludwig and F Vogel (2017) Catalytic supercritical water gasification: Interaction of sulfur with ZnO and the ruthenium catalyst. Applied Catalysis B-Environmental 202:262-268.
4. Ates A, et al. (2014) The role of catalyst in supercritical water desulfurization. Applied Catalysis B: Environmental 147:144-155.

5. Maxim F, et al. (2017) The impact of sorbent geometry on the sulphur adsorption under supercritical water conditions: a numerical study. Biomass Conversion and Biorefinery 7(4):479-485.

Biography

Florentina Maxim has her expertise in the Hydrothermal Synthesis and the Characterization of Nano Metal Oxides. She has completed her Doctorate in the "Morphology control of nano ferroelectric metal oxides" work carried out in the group of Professor Paula Vilarinho at University of Aveiro, Portugal in 2010. After several research fellowships for Electron Microscopy, she was leading the project for Young Independent Research Team funded by the Romanian National Foundation UEFISCDI. Since 2015, she is working as a Postdoctoral Scientist at Paul Scherrer Institute, Switzerland and her major research activities are in the field of advanced materials for energy harvesting from biomass (algae) by supercritical water processes.

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