World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Bio-Oil Compounds Sorption Enhanced Steam Reforming

Authors : Esther Acha, Jose Cambra, De Chen

Abstract : Hydrogen is considered an important energy vector for the 21st century. Nowadays there are some difficulties for hydrogen economy implantation, and one of them is the high purity required for hydrogen. This energy vector is still being mainly produced from fuels, from wich hydrogen is produced as a component of a mixture containing other gases, such as CO, CO2 and H2O. A forthcoming sustainable pathway for hydrogen is steam-reforming of bio-oils derived from biomass, e.g. via fast pyrolysis. Bio-oils are a mixture of acids, alcohols, aldehydes, esters, ketones, sugars phenols, guaiacols, syringols, furans, multi-functional compounds and also up to a 30 wt% of water. The sorption enhanced steam reforming (SESR) process is attracting a great deal of attention due to the fact that it combines both hydrogen production and CO2 separation. In the SESR process, carbon dioxide is captured by an in situ sorbent, which shifts the reversible reforming and water gas shift reactions to the product side, beyond their conventional thermodynamic limits, giving rise to a higher hydrogen production and lower cost. The hydrogen containing mixture has been obtained from the SESR of bio-oil type compounds. Different types of catalysts have been tested. All of them contain Ni at around a 30 wt %. Two samples have been prepared with the wet impregnation technique over conventional (gamma alumina) and non-conventional (olivine) supports. And a third catalysts has been prepared over a hydrotalcite-like material (HT). The employed sorbent is a commercial dolomite. The activity tests were performed in a bench-scale plant (PID Eng&Tech), using a stainless steel fixed bed reactor. The catalysts were reduced in situ in the reactor, before the activity tests. The effluent stream was cooled down, thus condensed liquid was collected and weighed, and the gas phase was analysed online by a microGC. The hydrogen yield, and process behavior was analysed without the sorbent (the traditional SR where a second purification step will be needed but that operates in steady state) and the SESR (where the purification step could be avoided but that operates in batch state). The influence of the support type and preparation method will be observed in the produced hydrogen yield. Additionally, the stability of the catalysts is critical, due to the fact that in SESR process sorption-desorption steps are required. The produced hydrogen yield and hydrogen purity has to be high and also stable, even after several sorption-desorption cycles. The prepared catalysts were characterized employing different techniques to determine the physicochemical properties of the fresh-reduced and used (after the activity tests) materials. The characterization results, together with the activity results show the influence of the catalysts preparation method, calcination temperature, or can even explain the observed yield and conversion.

Keywords : CO2 sorbent, enhanced steam reforming, hydrogen
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020