

Catalysts for sorption enhanced reforming with oxidation/reduction cycles

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Hydrogen demand by chemical and energy industries is continuously growing and steam methane reforming is the most extended hydrogen production process with high CO₂ emissions associated. Nowadays, CO₂ capture is a promising option to decrease global CO₂ emissions and there is great interest worldwide in developing new CO₂ capture technologies aiming to reduce the energy penalty. However, combined strategies of hydrogen production with CO₂ capture and catalysts able to work under such process conditions are still at a very early stage of development. The Ca-Cu process is a recent invention [1]. Based on the fundamentals of oxygen and heat transfer in chemical looping processes, Ca-based sorbents are used in combination with Cu oxides allowing CO₂ capture and in situ sorbent regeneration. Coupled to a proper catalyst, simultaneous hydrogen production is possible by means of adding a steam reforming step to the cyclic operation [2]. The actual challenge is to find appropriate reforming catalysts that withstand the typical Ca-Cu process conditions and can work in multiple cyclic operation (oxidation-reduction cycles). In addition, these catalysts must also be active at low steam/methane ratios for maintaining high energy efficiency and reduce Ni content to avoid its pollutant effects.

The present investigation is aimed to study the limits of application of catalysts provided by Johnson Matthey© (HiFUEL R110 and a PGM-based reforming catalyst) in the conditions of sorption enhanced reforming with Ca-Cu process. The materials will be studied in different conditions of temperature and gas hourly space velocity and their activity and stability will be measured in multi-cycle oxidation/reduction tests. A laboratory-scale facility consisting on several mass flow controllers, a system to evaporate water and an electrically heated oven containing a tubular quartz reactor holding a fixed bed of the catalytic material is used for these purposes. The composition of the product gas is continuously analyzed by mass spectrometry. With the aim of gaining deeper understanding on the stability of the materials their characterization will be performed by TPR and SEM analysis.

Initial results show the applicability of samples at an early stage of cycling testing in the whole range of conditions studied. Experimental concentrations of the different gases involved in the process perfectly match theoretical data of equilibrium. However, it is also observed that some experimental results at extreme conditions start to differ from the theoretical ones when the number of cycles increases.

References

- [1] Abanades J.C., Murillo R., 2009, PCT/ES2010/0705852009
- [2] García-Lario A.L., Aznar M., Grasa G.S., García T., Murillo R., J. Power Sources, 2013, 242:371-379.