Steam Reforming of the Olive Mill Wastewater in Multifunctional Reactors

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Olive oil production is one of the agro-industrial sectors with major critical environmental impacts: the olive oil mill wastewater (OMW) is a pollutant by-product of this process [1]. In this way, it was suggested the application of the OMW steam reforming (OMWSR), which can economically valorize this waste (H_2 production). A hybrid reactor configuration combining the OMWSR with H_2 and CO_2 selective removal is proposed herein for the 1st time, due to its potential to overcome the restrictions of the reversible reactions. It was compared the performance of a traditional reactor (TR), a sorption-enhanced reactor (SER - with CO_2 sorbent), a membrane reactor (MR - with an H_2-selective membrane) and the sorption-enhanced membrane reactor (SEMR - integrating both separations).

The best operating conditions for the OMWSR in a SEMR were determined in a thermodynamics analysis [2]. The H_2 yield increases with the H_2 and/or CO_2 removal. It was also verified that the advantages of the SEMR are more perceptible at lower temperatures, and so this reactor configuration can be operated under milder conditions, which favor CO_2 sorption and membrane stability. Among the prepared hydrotalcites, the one modified with gallium and with potassium, presents the highest CO_2 sorption capacity in comparison with the other synthesized and even commercial sorbents [3]. About the catalysts screening, the Rh-based, as well as the Ni/SiO_2-Al_2O and Ni-Ru/SiO_2 samples, reached the highest values of H_2 yield. Among them, the Rh/Al_2O_3 and Ni/SiO_2-Al_2O_3 catalysts presented a high and stable H_2 yield during 24 h of time-on-stream [4].

The removal of H_2 and CO_2 allowed reaching higher and stable H_2 yields in the SEMR during the pre- and pos-breakthrough time in comparison with the TR (see Fig. 1a-b)) [5]. This allows the simultaneous production of highly pure H_2 in the retentate and permeate sides. A higher improvement in terms of H_2 yield was observed when the MR and particularly the SEMR was applied (see Fig. 1c) - H_2 yield enhancement of ≈ 44 % was noted compared to the TR). It was also demonstrated that the steam reforming process, when implemented in a SEMR, can efficiently handle real OMW effluents, with high productions of H_2.

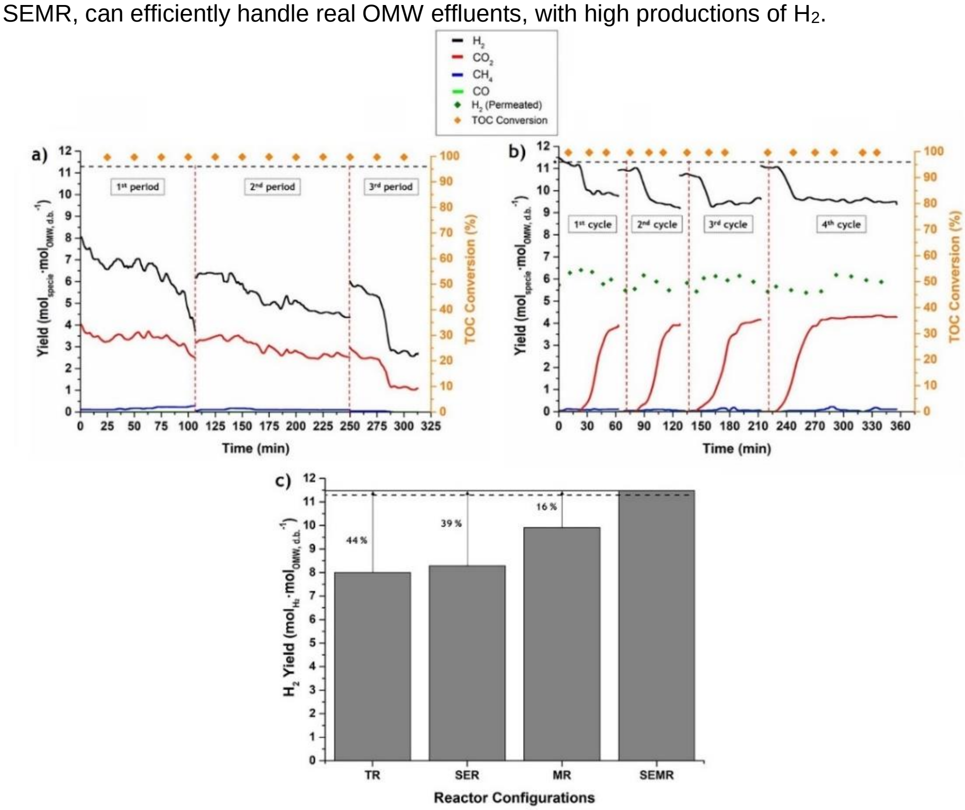

Fig. 1. Gaseous species yield and TOC conversion in a) TR or b) SEMR at 400 °C/4 bar. c) H_2 yield with different reactor configurations at 400 °C/4 bar.

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