Utilization of Catalytically Active Foams for Enhancing Energy Efficiency in Chemical Reactors.

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About 90% of the chemical processes include catalysis, whereas the most of these process are heterogeneous. Therefore, improving the energy efficiency in chemical reactors is a very crucial issue in order to fulfill the 20-20-20 objectives of EU climate protection and energy efficiency.

Foam substrates as catalyst support have been in the focus of research in recent years especially, for multiphase reactions for instance Tourvieille et al. [1], who investigated packed millichannels with catalytically active foams reported a very high overall mass transfer when compared with conventional reactor types (Fig. 2). In the present study (Lali [2]), a tubular reactor that was packed with a Pd/Al_2O_3 foam packing with a length of 50 cm and a diameter of 1.8 cm. The hydrogenation of α-methylstyrene (AMS) to cumene was employed for characterization of the reactor performance due to availability of literature data for other reactor types that facilitated a comparison.

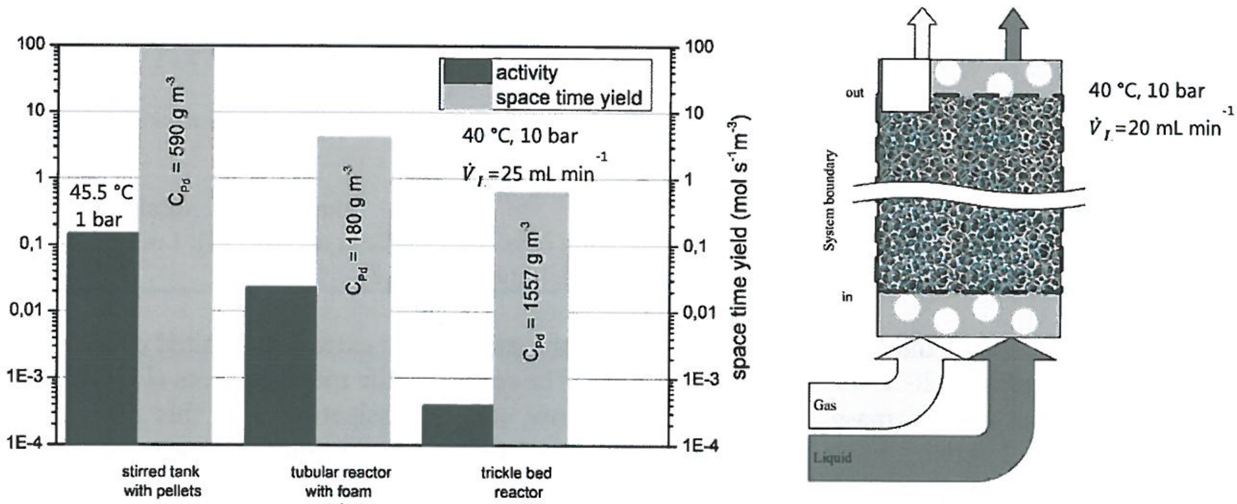

Fig. 1:A) Comparison of the reactor performance of foam catalysts with a trickle bed reactor and the intrinsic reaction rate at 40 °C B) reactor scheme in this study

Compared to a trickle bed reactor with an identical liquid flow rate and initial temperature of 40 °C and a total pressure of 10 bar, the foam catalysts show about 1000% enhancement of activity and space time yield (Fig. 1), whereas about 90% less Palladium 30% and less Hydrogen were needed for foam catalysts. The values for a stirred tank are reported by Meille et al. [3] for the intrinsic kinetic of this reaction that represent on Fig. 1 the maximum possible activity.

The experiments were carried out in a co-current upward flow. This operation mode was favoured because the downward flow was found to be very sensible to manufacturing tolerances (caused bypass flow) of the foam packing and a weak spreading of liquid in the downward flow was observed.

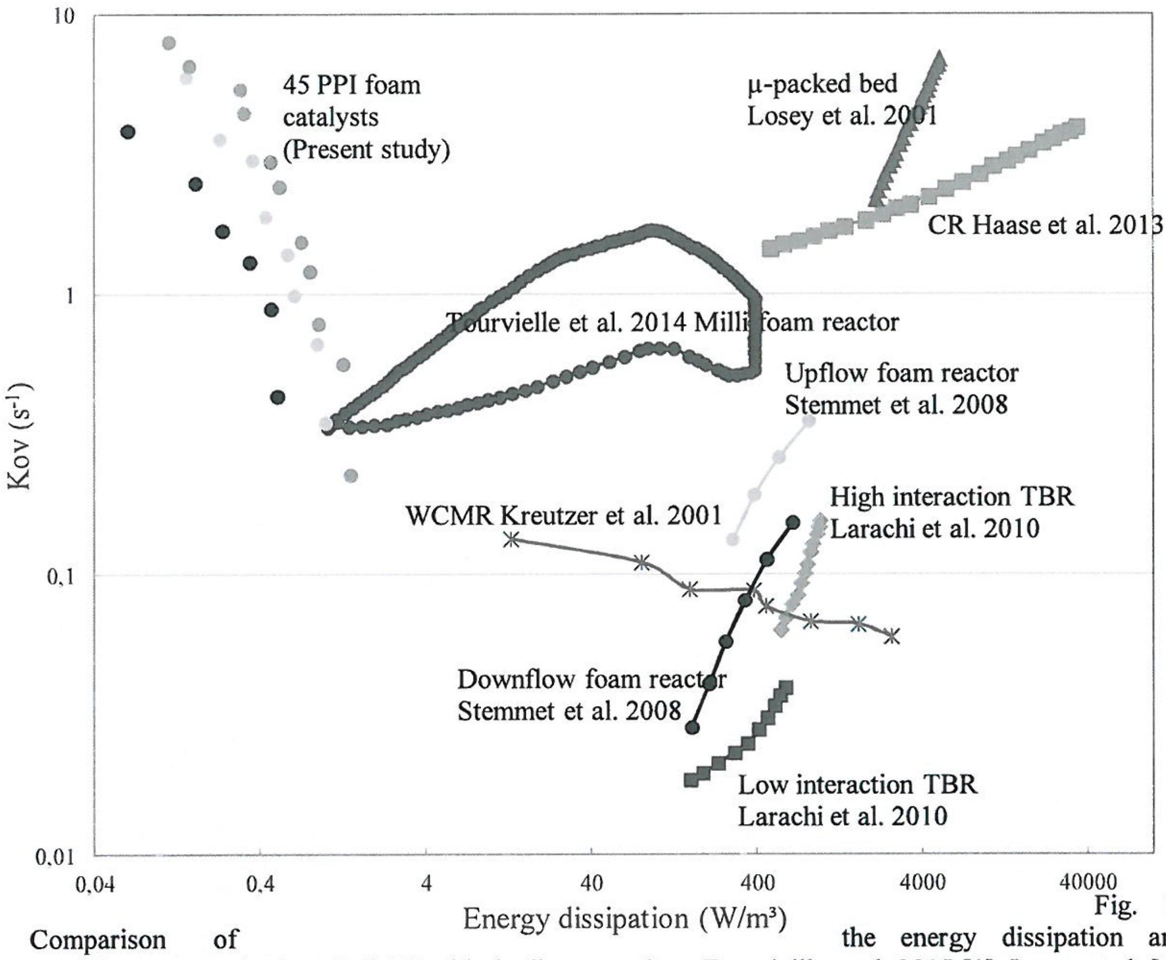

Fig. 2: Comparison of the energy dissipation and overall mass transfer from Lali [2] with the literature data; Tourvieille et al. 2015 [1], Losey et al. [4], Haase et al. [5], Kreutzer et al. [6], Stemmet et al. [7], Larachi et al. [8]

Furthermore, the overall mass transfer was measured in an externally limited condition at a temperature of 120°C and a pressure of 1 bar. The results of the measurements (Fig. 2) show a very high overall mass transfer at a very low energy dissipation. For this reason, the catalytically active foams can considerably contribute to the enhancement of energy efficiency of chemical reactors.

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