

Excellent T Control in Compact Fischer–Tropsch Reactor with Al Packed POCS

Martino Panzeri, Carlo Giorgio Visconti, Gianpiero Groppi, Enrico Tronconi

Laboratory of Catalysis and Catalytic Processes, Politecnico di Milano, Milan, Italy

Abstract

In recent years the interest in the conversion of CO, CO₂, hydrogen, and biomass into valuable products has grown significantly, driven by the need to reduce greenhouse gas emissions and produce green fuels. Among the viable pathways, Fischer–Tropsch synthesis (FTS) stands out due to its versatility in generating suitable fuels. The FTS process, however, presents several challenges: it is highly exothermic ($\Delta H_n^\circ = -165$ kJ/mol CO), kinetically controlled, and strongly influenced by temperature in terms of product selectivity. To efficiently utilize distributed feedstocks (i.e. carbon oxides and hydrogen), miniaturization and redesign of conventional reactor technologies become essential. A promising approach involves integrating thermally conductive structured internals into cooled tubular reactors [1]. Such internals, based on periodic open cellular structures (POCS), offer a controlled geometry and can be packed with catalyst pellets, enabling a large catalyst inventory and enhanced heat management [2]. In fact, thanks to the open design offered by 3D printing techniques, adoption of conductive internals boosts the heat removal from the reactor core toward the external coolant.

Aluminium POCS with a skin [2,3] recently emerged as strong candidates for such applications, combining mechanical integrity with excellent thermal

performance. In this study we assess the effect of POCS geometry (porosity, cell density, clearance with tube wall) on the operation of a compact pilot-scale FTS reactor. We show that tailored designs allow single-pass CO conversions exceeding 70% (Fig. 1A), heat duties around 1 MW/m³, and C₅⁺ productivities up to 0.35 kg/kg_{cat}/h. The appropriate design of the conductive structured internals impacts the axial temperature profiles, with reduced gradients as the overall heat transfer coefficient grows to 1.3 kW/m²/K, Fig. 1B.

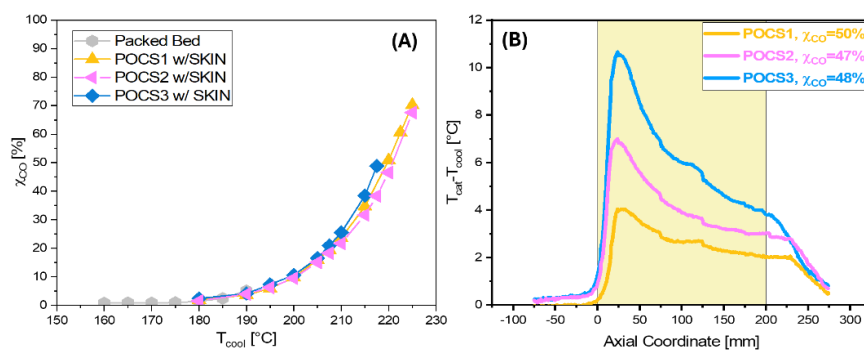


Fig. 1. (A) CO conversion in packed bed reactor and with Al packed POCS, (B) axial T-profiles in FTS reactor loaded with different Al packed POCS

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