Effect of pre-treatment conditions on Fe-based catalyst for e-fuel production via modified Fischer-Tropsch synthesis

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The study investigates the effect of pre-treatment conditions on iron-based catalysts used for e-fuel production through a modified Fischer–Tropsch process [1-2]. The aim is to optimize the yield of liquid hydrocarbons from CO_2 by examining how different calcination and reduction atmospheres and temperatures affect catalyst stability and product distribution. The catalysts, consisting of Na-doped Fe_3O_4 [3], are tested in a fixed-bed reactor and characterized before and after catalytic runs. The results show that a higher promoter content enhances CO_2 conversion and selectivity toward long-chain hydrocarbons due to the formation of Hägg carbide (Fe_5C_2). However, excessive carburization accelerates catalyst deactivation. The optimal pre-treatment [4-5] therefore balances the formation of active phases to maximize the C_6–C_{14} fraction, the olefin/paraffin ratio, and long-term catalyst stability (Figure 1). The integration of zeolites plays a key role by promoting hydrogenation and isomerization of light olefins, increasing the production of liquid fuels and supporting the economic feasibility of large-scale e-fuel production.

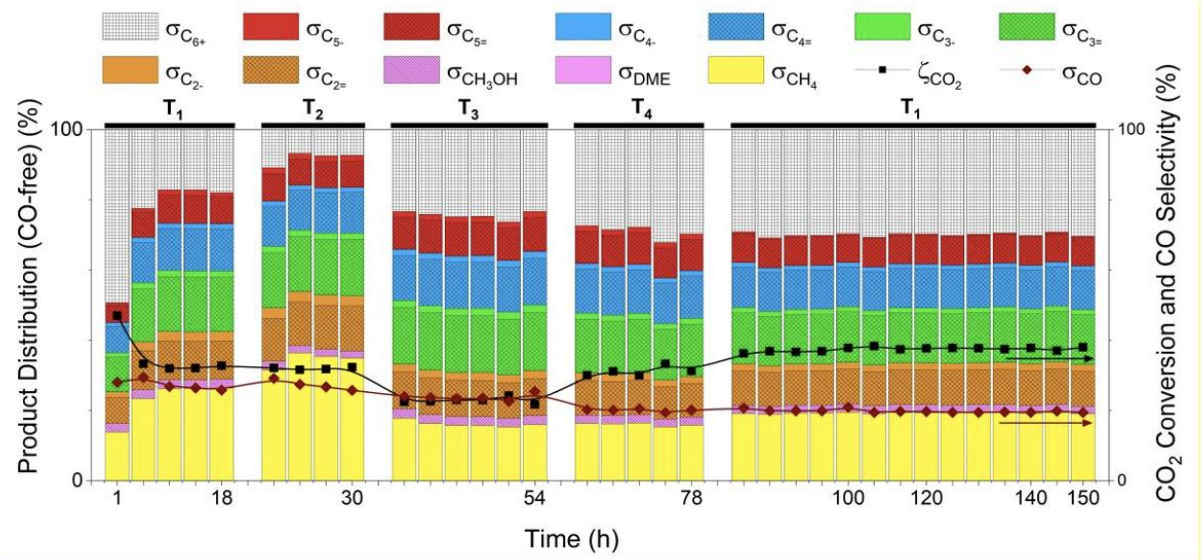

Figure 1 – Catalytic test after pre-treatment. GHSV 7 NL h^{-1} $gcat^{-1}$, 300-400 °C, 23 bara, H_2/CO_2 = 3.

[1] P. Gao, L. Zhang, et al., ACS Cent. Sci. 6 (2020)1657−1670
[2] J. Wei, Q. Ge, et al., Nat. Comm. 8 (2017) 15174
[3] E. Corrao, F. Salomone, et al., Chem. Eng. Res. and Des. 197 (2023) 449 – 465
[4] M. V. Landau, N. Meiri, et al., Ind. Eng. Chem. Res. 56, 45 (2017) 13334 – 13355
[5] Brübach, L.; Hodonj, D.,et al., Cat. 12 (2022) 630.