ALCHEMHY
ALTERNATIVE ROUTES FOR BASIC CHEMICALS PRODUCTION USING HYDROGEN AS FEEDSTOCK

Project progress – D3.1. Catalysts advancements for methanol synthesis

One of the core areas of the project is the synthesis of methanol using carbon dioxide (CO_2) and hydrogen (H_2)—a promising approach that not only produces a valuable chemical utilising renewable H2 but also helps reuse CO_2 that would otherwise be released into the atmosphere.
Within ALCHEMHY, two innovative technologies are being developed for this purpose: Small Flexible Methanol Reactor (SFMR) and Plasma Catalytic Hydrogenation (PCH). Both technologies rely on specially designed catalysts, materials that accelerate chemical reactions and are essential for efficient methanol production. Recent progress in this area is described in Deliverable 3.1, “Catalyst advancements for methanol synthesis”, which reports on the work carried out so far.

Progress on catalysts for the SFMR Technology
For the SFMR technology, researchers have considered a wide range of catalysts for future production. The catalytic activity tests revealed how different preparation methods, chemical compositions, and operating conditions influence their performance, indicators such as: CO_2 conversion, methanol selectivity and catalyst lifetime. One of the important characteristics for the catalysts to be used in the SFMR is the stability under challenging conditions, including the presence of contaminants such as sulphur, which are commonly found in real industrial environments. The performance of catalysts with chosen formulations was compared with that of commercially available ones, showing that while catalyst development within the project is still an ongoing activity, existing commercial catalysts can already serve as a useful benchmark for early SFMR reactor development.

Progress on catalysts for plasma-assisted Methanol Synthesis
For the PCH technology, catalyst development began with an extensive review of scientific literature to identify the most promising materials. Researchers considered not only performance but also practical aspects such as scalability. Initial testing revealed that physical factors—such as how the catalyst is packed inside the reactor and the size of catalyst particles—

play a major role in how the plasma behaves. These factors affect plasma ignition, stability, pressure build-up, and electrical discharge characteristics.
So far, no methanol production has been observed under the tested conditions, although there has been conversion of CO_2 into the chemical precursor CO, and alternative catalyst formulations are currently being explored. These results highlight the complexity and challenges of plasma-assisted methanol synthesis and show that reproducing results reported in scientific literature can be difficult in practice.

More consolidated results will be presented in the final deliverable D3.6, which is expected to be completed in spring 2026.

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