Study of the use of iron-based catalyst for the sorption-enhanced methanation process

SmartHiFe2

Student

Nicolas Mutti

Introduction: Interest in reducing greenhouse gas emissions and developing sustainable solutions for renewable energy production has led to an increasing interest on using carbon dioxide as a resource, rather than waste. Through its reaction with hydrogen, carbon dioxide can be converted into methane and water through catalysts. In this project, the use of an iron-based catalyst is studied, with the aim of reducing production costs. In addition, the use of 13X zeolite as a catalytic support allows the water produced during the reaction to be absorbed, promoting the production of 100 percent pure methane and improving the overall conversion yield of the process. This innovative approach is known as SmartCat, on base of a sorption-enhanced methanation.

Objective: The objective of the project is to replace nickel with iron in sorption-enhanced methanation, thereby reducing catalyst costs. To this end, three different metal compositions within the catalyst are tested, each synthesized by two different methods: a single step or two steps. The samples are initially tested in a fixed-bed reactor with a diameter of 10 mm, measuring carbon dioxide conversion and methane selectivity. Based on the results obtained, the samples with the best catalytic performance are selected. Then, the three most promising samples are subjected to two cycles of methanation in a 30 mm fixed-bed reactor, analyzing the carbon dioxide conversion and methane selectivity trends after each cycle.

Result: The results obtained show that samples with a lower percentage of metal have lower catalytic performance than those with a higher amount of metal. In addition, samples synthesized by a single step have a lower porous surface than those obtained by two steps. This phenomenon is probably due to the use of more carbon-containing precursors in single-step synthesis, which could leave residue in the sample, compromising its structure. In conclusion, the sample with composition 0.250Co0.750Fe synthesized by two-step showed the best performance in terms of conversion and selectivity, remaining effective even after the second reaction cycle.

Scheme of the sorption-enhanced CO2 methanation.
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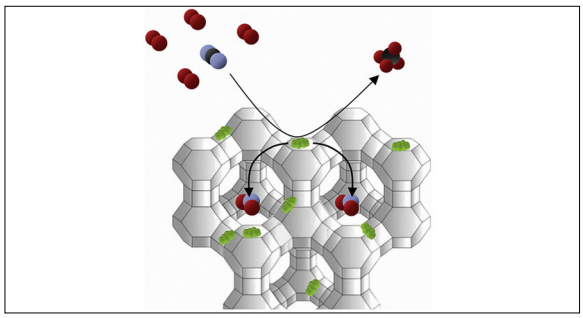
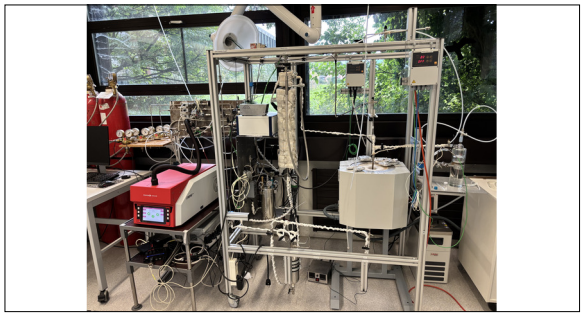
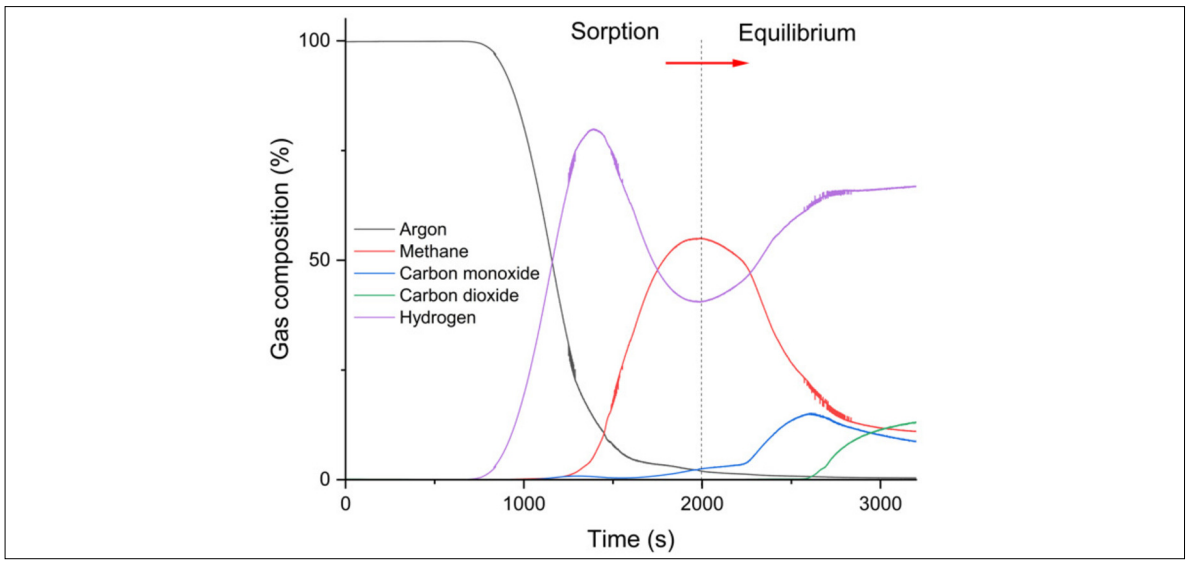


Sorption-enhanced methanation setup.
Own presentment



Gas composition from a sorption-enhanced methanation experiment, measured by MS.
Own presentment



Advisor
Prof. Dr. Andre Heel

Subject Area
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