Underground Sun Conversion

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Keywords: Power-to-Gas, Energy Storage, Natural Gas

Introduction

The global objective to reduce greenhouse gas emissions causes a progressive substitution of fossil fuels by renewable energy carriers. As a consequence, the demand of energy storage is increasing drastically. A promising option is the conversion of electrical energy into hydrogen H_2 and substitute natural gas (SNG) via the power-to-gas process. H_2 is formed by water electrolysis, which can then be transformed to methane CH_4, using chemical-catalytical or biological methanation reactors. In the present case, porous underground storages act as bio-reactor and gas storage at the same time.

Project

In the preceding project "Underground Sun Storage" the behavior of H_2 / natural gas blends in porous underground gas storage was investigated. Besides experiments in laboratory environment, a small depleted gas field was filled with a mixture of 10 % H_2 and 90 % CH_4. During the examinations, it was established that naturally occurring microorganisms in porous underground storage can transform H_2 and CO_2 to CH_4 and H_2O. Further investigations showed considerable potential of microorganisms for CO_2 and H_2 conversion. The laboratory results are shown in Figure 1.

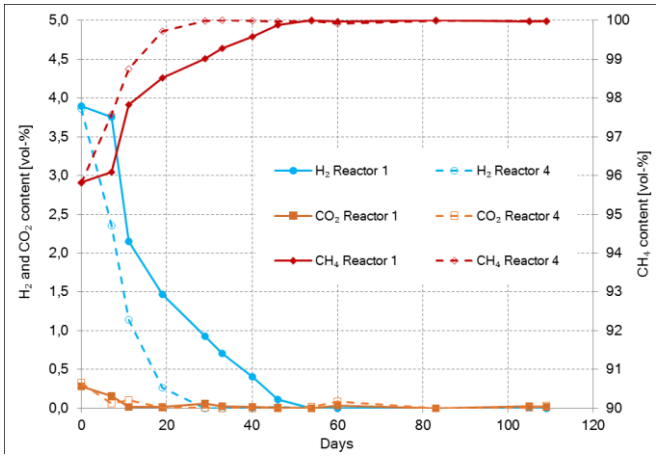

Figure 1: Concentration profile of gas components in two reactors; gas blend: 4 % H_2, 0.3 % CO_2 in CH_4; *Source: Schritter, Loibner. University of Natural Resources and Life Sciences Vienna/ Department IFA Tulln Institute of Environmental Biotechnology* [1]

Starting with a stoichiometric mixture of H_2:CO_2 = 4:1, the reacting gases are consequently converted to CH_4 and H_2O. Therefore, the underground storage could possibly be used as bio-reactor while storing H_2 / CO_2 / natural gas blends. Obviously, the reaction time with approximately 50 days is too long for industrial applications, but due to the promising results, RAG AG initiated a follow-up project "Underground Sun Conversion".

The aim of the project is a combined usage of porous natural gas storages as energy storage and biological methanation reactor. In this case, the reactor would be nearly invisible. Furthermore, the already established infrastructure poses a significant economic asset. During the project (03.2017 – 02.2021) the existing field test facility will be adapted to perform experiments under realistic conditions. The gas blend is inserted via an injection well into the reservoir. While the gas is stored, the reactants are converted to CH_4. The gas gained at the production well should consist of pure natural gas. Possible remains of H_2 and CO_2 are separated by membrane gas treatment and can be recycled to the injection well. A simplified flow scheme of the proposed process can be seen in Figure 2.

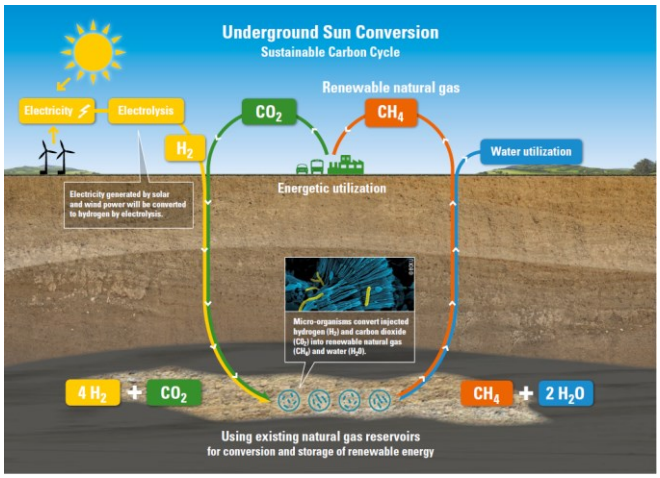

Figure 2: Underground Sun Conversion - Sustainable Carbon Cycle; process scheme [2]

Currently, merely preliminary work is finished, which includes development of process concepts, process simulation and first lab experiments.

Partners

The consortium consists of Rohöl-Aufsuchungs Aktiengesellschaft RAG (consortium leader), University of Natural Resources and Life Sciences Vienna (BOKU) / Department IFA Tulln Institute of Environmental Biotechnology, Austrian Centre of Industrial Biotechnology GmbH (ACIB), Montanuniversitaet Leoben, Axiom angewandte Prozesstechnik GmbH and Energieinstitut an der Johannes Kepler Universität Linz.

Acknowledge

The project is funded by the Austrian Research Promotion Agency (Underground Sun Conversion, 855231) and the Austrian Klima- und Energiefonds.

References

[1] Rohöl-Aufsuchungs Aktiengesellschaft *et al.,* "Underground Sun Storage: Publizierbarer Endbericht," Oct. 2017.

[2] Rohöl-Aufsuchungs Aktiengesellschaft, *Underground Sun Conversion - Sustainable Carbon Cycle: Infografik.* [Online] Available: http://www.underground-sun-conversion.at/en/downloads/infographics.html#prettyPhoto. Accessed on: Dec. 18 2017.