**CO2 methanation activated by Ni/MgO catalysts**

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**Highlights**

* Ni/MgO catalysts are active for the CO2 methanation and 100 % selective to CH4.
* Higher Ni load leads to higher CO2 conversion.
* The rate law shows a correlation between frequency factors and Ni load.

**1. Introduction**

Carbon dioxide hydrogenation utilizes CO2 to produce hydrocarbons and carbon monoxide. The product selectivity is influenced by the catalyst and the process parameters. If methane is the main product, the process is called CO2 methanation. [1] CH4 can be transported in already existing pipelines for natural gas and acts as a chemical hydrogen storage.

CO2 + 4 H2 → CH4 + 2 H2O

A bifunctional nickel magnesium oxide catalyst was investigated. Nickel provides the adsorbent capacity for hydrogen and is highly selective to CH4. [2] MgO activates carbon dioxide and suppresses possible catalyst deactivations. [3] MgO reduces the negative impact of water on the catalyst. The Ni/MgO catalyst is a cheap, highly active, easy to synthesize and robust catalyst. [4] The reaction kinetics for the CO2 methanation and the catalysts activity were investigated to describe the reaction for a future industrial application.

**2. Methods**

The Ni/MgO catalysts were prepared via wet impregnation. Calcined magnesium oxide was mixed with a solution of nickel nitrate hexahydrate (Ni(NO3)2\*6H2O) and water. The catalysts were dried, calcined and reduced in hydrogen atmosphere. Four Ni/MgO catalysts were prepared with 11, 17, 21 and 27 w% nickel load.

The CO2 methanation experiments were performed in a bench scale fixed bed tubular reactor. The product gas was continuously analyzed by a Caldos27 thermal conductivity analyzer for H2 and Uras26 infrared photometer for CO2, CO and CH4. The H2:CO2:N2 ratio of the feed gas flow was 56:14:30 and ambient pressure was applied. Steady state experiments were performed between 533 to 648 K and 1.2 m3 kg-1 h-1 to 14.9 m3 kg-1 h-1.

**3. Results and discussion**

A high nickel load leads to a higher CO2 conversion. The highest CO2 conversion was achieved at 598 K with a 27 w% Ni/MgO catalyst. At higher temperature the CO2 conversion drops caused by the lower equilibrium conversion. Nickel loads over 30 w% are only beneficial for temperatures lower than 600 K. The methane selectivity was 100 % for every Ni/MgO catalyst.



**Figure 1.** CO2 conversion for the carbon dioxide methanation with catalysts of varied Ni load at 3.7 m3 kg-1 h-1 and the equilibrium CO2 conversion.

The rate law of the CO2 methanation consists of a forward reaction, a backward reaction and an adsorption term. The temperature dependence was modelled by an Arrhenius approach. The frequency factors show a correlation to the Ni load of the catalyst.

**4. Conclusions**

The CO2 methanation is an opportunity to reduce CO2 emissions. A bifunctional Ni/MgO catalyst is active for the CO2 methanation and 100 % selective to CH4. Higher nickel loads result in higher CO2 conversions up to 30 w% nickel load and 600 K.

**References**

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