Praca dyplomowa inżynierska

Deactivation of Ni/CeO_2 catalysts during Sabatier reaction

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Introduction

Methane is the main component of natural gas, its heat of combustion is lower than any other hydrocarbon but the ratio of the heat of combustion to the molecular mass shows that methane, being the simplest hydrocarbon, produces more heat per mass unit than other complex hydrocarbons. It is used as a vehicle fuel and is claimed to be more environmentally friendly than other fossil fuels. This is why there is great interest in producing methane from CO2. Well-known process for converting CO2 to a useful product involves reaction with H2 (hydrogen) over a metal catalyst to produce methane. This methanation process, also called the Sabatier reaction.

Purpose and scope of work

The purpose of this work is to investigate deactivation of Ni-based catalyst during CO2 methanation over CeO2 support. Catalysts were prepared and tested under methanation conditions. The aim of this study is to compare their deactivation behavior and their resistance towards carbon formation and nickel sintering.
Scope of work includes:

- Literature review
- Catalysts preparation and examination
- Conducting the experiment and products examination

Theoretical part of experimental method

Because of the established electricity production from renewable sources energy requires to be storage and that is a problem. CO2 methanation is one of the promising solution because of the possibility of storage as liquefied natural gas and the hassle-free transportation in the existing natural gas infrastructures

Experimental part

The Ni/CeO_2 catalyst was prepared by the precipitation-deposition method. Weight % loading of Ni differences were caused by diverse decomposition of metal on support surface. Experiment was carry out in fixed-bed reactor where catalyst was flashed with inert gas (N_2) to remove content of oxide subsequently reduce with H_2.

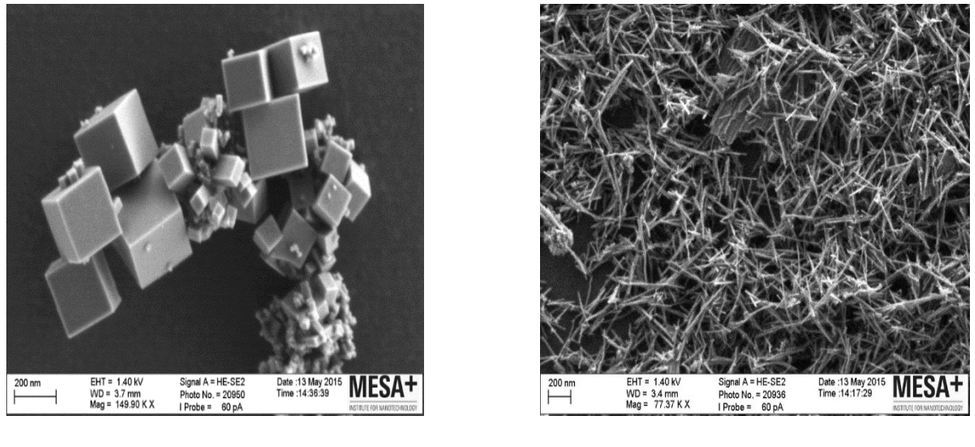

Figure 1. SEM image of Ceria cubes and rods

First experiment was perform under 350 °C, 1 bar and inlet CO_2: H_2: N_2 flow [mL/min] respectively 3.06 : 11.96 : 15.08 . It was alleged that in this temperature CO_2 conversion was close to equilibrium and on each used catalyst nearly the same what make it difficult to study results. Wherefore experiment condition were changed to 300°C and also inlet gases CO_2: H_2: N_2 flow [mL/min] respectively 6,04 : 24,07 : 30.16 .

Results

At 300°C conversion was far away from equilibrium in comparison to attempt carried out at 350 °C, what allow to see the difference between catalysts and lead to conclusion that 10% of Ni loading on he support in he shape of rods is the most efficient of all.

Catalysts is strongly influenced by the surface area, porosity, expose planes of the support material and particle size. These properties of support material not only influence the dispersion of metal particles but also affect the metal-support interactions. Ni supported on CeO2 rods, an excellent catalytic activity and coke resistance has been reported during CO2 reforming of methane. The enhance activity is attributed to the increase bonding strength between the Ni metal and particles with the ceria support.