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PhD dissertation abstract

Synthesis and characterization of materials with an apatite structure as catalysts for alcohol steam reforming

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Decreasing resources of fossil fuels and growing air pollution forces to searching for an alternative energy sources. The main advantage of these type of sources is greenhouse gases free energy production. One of alternative energy sources is hydrogen. It is defined as energy carrier for future due to its high energy density and combustion without emission of air pollutants. Nowadays, the main method of hydrogen production is steam reforming of methane. Therefore, it is so important to find a fossil fuel free method of hydrogen production.

A promising possibility of hydrogen generation is steam reforming of alcohols. The main idea of this method is obtaining alcohol from a renewable energy sources – biomass. During reforming process, the alcohol reacts with steam and as a result, the hydrogen is generated. However, it is necessary to use an appropriate catalyst to achieve high hydrogen yield. The primary goal of this PhD dissertation was the synthesis and physicochemical characterization of calcium hydroxyapatite based catalysts for application in alcohols steam reforming.

Calcium hydroxyapatite (HAp) was synthesized by microwave-assisted hydrothermal and precipitation methods. Cobalt and cobalt-cerium based catalysts were obtained by substitution of calcium ions in HAp structure and dry impregnation. In order to characterization of samples, the structure, textural properties, the reducibility in hydrogen stream and mass changes in function of temperature were studied. Catalytic properties were analyzed in alcohols steam reforming reactions.

Studied catalysts show a high catalytic activity in ethanol steam reforming. The complete ethanol conversion can be achieved over these catalysts. In comparison to the ethanol conversion, the hydrogen yield is significantly affected by the method of introduction of active phase. Catalysts obtained by substitution of calcium ions in HAp structure ensure the much lower hydrogen yield then catalysts prepared by impregnation method. It could be a result of Co^0 lack during catalysts test.

High conversion of alcohol and hydrogen selectivity were also obtained in glycerol steam reforming reaction. Significant effect of reaction temperature on hydrogen selectivity was observed. Steam reforming of glycerol is endothermic reaction and that why the hydrogen selectivity increases with temperature. Decreasing hydrogen selectivity is caused by increase the amount of feed through catalyst bed.