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Ternary and Quaternary Molybdenum Nitrides with Iron, Cobalt and Nickel

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Abstract

Contemporary research on ammonia synthesis catalysts focuses on finding more effective and sustainable solutions for the industrial Haber-Bosch process. This process, despite its groundbreaking nature, is characterized by high energy consumption due to the extreme pressure and temperature conditions in which it is carried out. The development of new catalytic materials can significantly reduce the energy requirements of this reaction and reduce carbon dioxide emissions. Considering the global importance of ammonia as a key precursor of fertilizers, improving its synthesis process has significant implications for food security and environmental protection. Research directions focus on modifying existing catalyst systems and searching for new materials with higher catalytic activity. The aim of this work is to prepare selected ammonia synthesis catalysts and assess their potential.

This dissertation concerns the preparation of catalysts for the synthesis of ammonia, consisting of ternary and quaternary molybdenum nitrides with iron, cobalt and nickel, from the preparation of oxide precursors in the process of hydrothermal precipitation, through the processes of obtaining the active form of nitrides to the study of the catalytic activity of these materials.

In the process of synthesis of oxide precursors, a series of compounds containing two or three different metallic elements were prepared. The conditions of conducting this process (temperature, pH, concentration of substrates in the solution) and their effect on the structure of the obtained precursors were determined.

The reduction process was carried out by two methods, with calcination of precursors and subsequent reduction of oxides in ammonia and without calcination. The activity of almost all obtained catalysts exceeded the activity of currently used industrial catalysts, in some cases almost three times.

Keywords: ammonia synthesis, catalyst, production of precursors, ternary nitrides

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