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Cobalt-based catalyst supported on modified shungite for Fisher-Tropsch synthesis

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Fischer-Tropsch synthesis (FTS) converts synthesized gas into hydrocarbons, environmentally clean and free of sulfur, nitrogen, aromatic compounds, and heavy metals in the presence of a catalyst. It is well known that the properties of the catalyst support, such as specific surface area, porosity among others are important factors in obtaining high dispersion particles. Generally, the supports used for cobalt catalysts are Al_2O_3, TiO_2 and SiO_2. Their main disadvantage is their interactions with the metal that results in the formation of the hybrid compounds witch results in the loss of their catalytic activity, moreover, they have a very high temperature of reduction. One way of overcoming this problem is the use of carbon supports, which have a weak interaction with metals. In this work we developed new catalytic system for FT-synthesis, using modified Shungite as support. Firstly, modification of pristine shungite was carried out by treatment with sodium hydroxide, hydrochloric acid and perchloric acid to remove aluminosilicate, silicate components, and metal oxides. Then shungite was impregnated with aqueous solution of cobalt nitrate $Co(NO_3)_2$, dried in air at 100°C and calcined at 900°C. The morphology and microstructure of pristine shungite particles, as well as the supported co-catalyst were observed by using a scanning electron microscope JEOL7500F at an accelerating voltage of 5.0 kV. SEM image of synthesized catalyst shows that the particle size of cobalt deposited on the modified shungite ranged between 100 and 300 nm. After modification and impregnation of the carbon support has acquired more uniform structure. EDX analysis showing the following elemental composition of catalyst (wt.%): O42.79; C17.79; Si22.98; Al16.35; and Co4.09. This analysis confirmed that in the course of modifying, shungite changed its elemental composition, i.e. the undesirable components have been removed. Catalytic tests on the obtained co-catalyst powder were conducted using a laboratory setup FT synthesis flow type under atmospheric pressure without catalyst reduction. The synthesis was carried out in the working environment of a mixture of H_2 and CO with a volume ratio of 3/1 at a temperature range of 200 to 440°C and at a space velocity of 1500 hr1 (volume flow rate 5 cm^3/s). The analysis of the gaseous and liquid products was carried out by gas chromatography apparatus Kristallyuks 4000 and GC1000 chromos. It showed the formation of hydrocarbons C_1C_4, C_{5+}, the formation of which takes place predominantly in the direction of obtaining methane CH_4. The maximum output CH4 was observed at a relatively high temperature of 350°C. Further increase in temperature led to a decrease in the concentration of methane. Thus, a new cobalt based catalyst supported on modified shungite was presented. The material exhibits active properties and allow to obtain synthetic hydrocarbons namely C_1C_4, C_{5+} under atmospheric pressure. This material can be used in the process of methanation of synthesis gas to produce a methane rich fuel gas. Since modified shungite provides a large surface area and high dispersion of the catalyst, it can be used as a promising support in catalysis applications.

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Water gas shift in membrane reactor: An experimental study

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The hydrocarbon steam reforming is a industrial process for procuding hydrogen and carbon monoxide. The reaction is strongly endothermic and operating temperature is very high. The reaction is following:

$CH_4 + H_2O <==> H_2+CO$

At the end of the process in reformer stream, there is high CO presence, pollutant for a lot of catalyst. To improve H_2 production, CO is reacted with steam (water gas shift reaction) in presence of Fe-Cr and Cu-Zn catalyst at high and low temperature. Nowday, the PSA (pressure swing adsrober) is used for H_2 purification. A novelty metod to produce and purify H_2 is to use a membrane reactor. An experimental study has been conducted varying the operating condition such as: Temperature and pressure reaction, space velocity, H_2/CO feed molar ratio, membrane surface, sweep gas and membrane reactor configuration. In all test, the H_2 purity was 100%.

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