I.A.Anvarova”Oil and gas business and technology of their processing"

assistant lecturer of the department (KSTU)

D. Sh. Shukurova, 2 nd year student of the technological direction of the petrochemical industry

Uzbekistan Karshi city

STUDY OF THE CATALYTIC PROPERTIES OF THE SELECTED CATALYST FOR THE PRODUCTION OF HIGH MOLECULAR WEIGHT LIQUID SYNTHETIC HYDROCARBONS FROM SYNTHESIS GAS

Abstract: Nowadays, the production of products that meet environmental requirements is mainly focused on studying the catalytic nature of catalysts in the production of synthetic liquids from gas. In this article, the effect of the selected catalyst preparation method for the production of high-molecular liquid synthetic hydrocarbons from synthesis gas, i.e. a mixture of carbon dioxide and hydrogen, on the composition of the catalyst, the dependence of carbon dioxide conversion on the synthesis temperature, the dependence of methane yield on the synthesis temperature, the dependence of ethane, propane, butane and ethylene, propene, butenes on the synthesis temperature, and the dependence of liquid synthetic hydrocarbons on the synthesis temperature were studied.

Keywords: Catalyst, conversion, synthetic hydrocarbons, synthesis gas, methane, carbon monoxide.

Introduction: In recent years, the demand for high-quality raw materials and fuels has been increasing, and it has become urgent to study the catalytic activity of selected catalysts for the production of high-molecular liquid synthetic hydrocarbons from synthesis gas, i.e. a mixture of carbon dioxide and hydrogen, and to increase product yield. [1]. This method does not pose any difficulties for laboratory tests, which require small amounts of the catalyst for the production of high-molecular liquid synthetic hydrocarbons from synthesis gas, i.e. a mixture of carbon dioxide and hydrogen[2]. The tests were conducted under the following optimal conditions: pressure 0.1 MPa, volume flow rate 100 h-1. The results were compared with the parameters of the sample prepared in 3 passes.

As can be seen in Figure 1, the sample prepared with 3 passes was more active over the entire temperature range - its carbon dioxide conversion was 5-10% higher than that of the other two samples. The samples prepared with 1 and 2 passes were practically indistinguishable from each other in this respect. The temperature dependences of the methane yield for the three samples are shown in Figure 8. In the low temperature range, the methane production was practically the same for all three samples. Thus, the methane yield was 1 g/m3 of the exhaust gas at 160 °C and 5-6 g/m3 at 180 °C. Only the methane yield of the sample prepared in 1 pass at 200 °C for the production of high molecular weight liquid synthetic hydrocarbons from synthesis gas, i.e. synthesis gas, differed significantly: the methane yield in it was 30 g/m3 compared to 20-22 g/m3 for the other samples [3].

The yields of ethane, propane, butane and ethylene, propene, butenes were practically the same for all three samples of the catalyst selected for the production of high molecular weight liquid synthetic hydrocarbons from synthesis gas, i.e. a mixture of carbon dioxide and hydrogen. At 160 °C, ethane, propane, butane and ethylene, propene, butenes were detected in residual amounts in the exhaust gas. As the temperature increased, the yield gradually increased and at 200 °C was 10-13 g/m3 (Fig. 3). The dependence of the yield of liquid synthetic hydrocarbons on the temperature of the process of obtaining high-molecular liquid synthetic hydrocarbons from carbon dioxide and hydrogen is presented in Figure 4. As a result of experimental studies, it was found that the yield of liquid synthetic hydrocarbons increased with increasing temperature in the process of obtaining high-molecular liquid synthetic hydrocarbons from carbon dioxide and hydrogen and reached a maximum at 190 ° C. At the optimal temperature, the yield of liquid synthetic hydrocarbons was 136, 140, 145 g/m3 of the gas passed through the selected catalysts for obtaining high-molecular liquid synthetic hydrocarbons from synthesis gas prepared by 1, 2 and 3 times absorption, i.e. from a mixture of carbon dioxide and hydrogen [4].

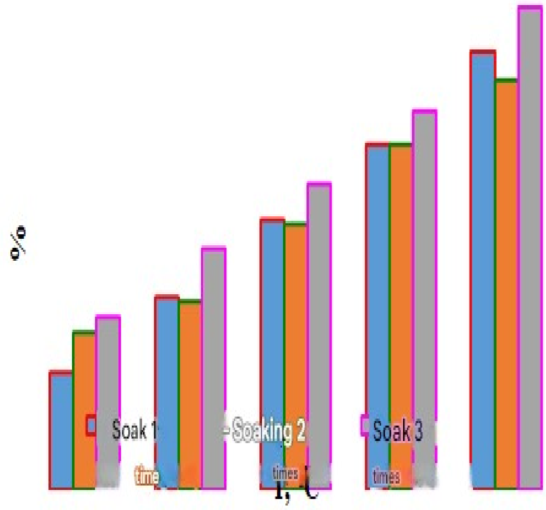

Figure 1. Dependence of CO2 conversion on synthesis temperature

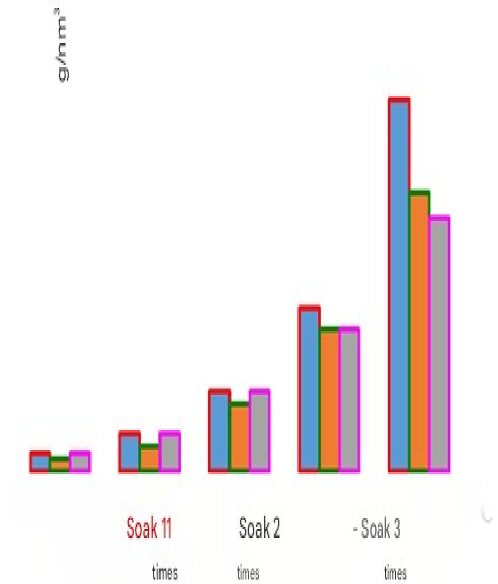

Figure 2. Dependence of methane yield on synthesis temperature

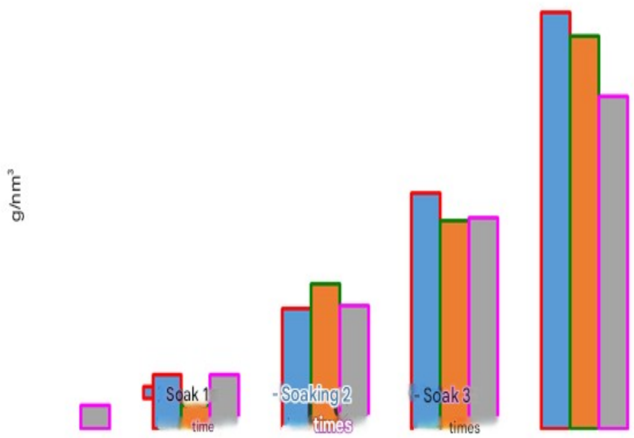

Figure 3. The yield of ethane, propane, butane and ethylene, propene, butene depends on the synthesis temperature

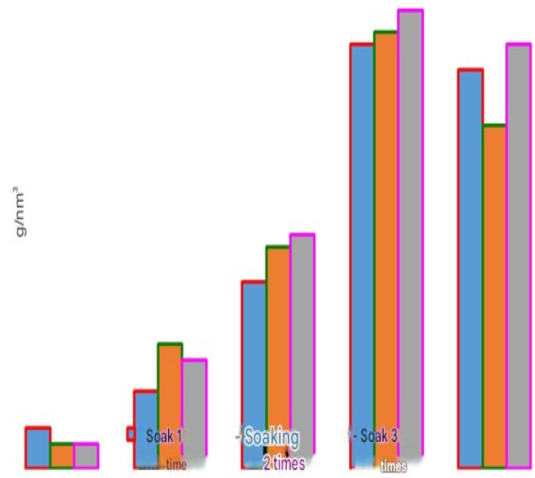

Figure 4. Synthesis temperature of liquid synthetic hydrocarbon products dependence

RESULT: The selectivity for methane formation in the production of high molecular weight liquid synthetic hydrocarbons from carbon monoxide and hydrogen remained almost unchanged, at 6-7% (Table 1).

When the number of passes is reduced, the content of isosaturated hydrocarbons formed in the catalyst almost doubles and reaches 33% in a sample prepared for one pass (Table 2, Figure 1). At the same time, there are no changes in the functionality of the selected catalyst for the production of high molecular weight liquid synthetic hydrocarbons from synthesis gas, i.e., a mixture of carbon monoxide and hydrogen.

Table 1

Effect of the preparation method of the selected catalyst for the production of high molecular weight liquid synthetic hydrocarbons from 15%Co-15%Fe-5%Ni-1%ZrO2/YUKSsynthes-gas on the synthesis performance

Number of wins method	T_{olp} °C	K_{CO}> %	Density, g/m3				S_{CH4} %	S Pentane and higher molecular weight liquid synthetic hydrocarbons
			CH_4	C_2-C_4	C_{5+}	CO_2		
1 time	190	74	14	10	139	16	8	86
2 times	190	75	12	9	141	14	7	87
3 times	190	81	11	9	147	13	6	88

Table 2

Effect of the preparation method of the selected catalyst for the production of high molecular weight liquid synthetic hydrocarbons from 15%Co-15%Fe-5%Ni-1%ZrO2/YUKS synthesis gas, i.e. a mixture of carbon dioxide and hydrogen, on the composition of the catalyst

Number of wins	Composition of liquid synthetic			Saturated hydrocarbon		
	olefin	n- alkane	i- alkane	C_5—C_{10}	C_{11}-C_{18}	C_{19+}
1 time	9	60	35	64	36	8
2 times	9	64	31	59	35	11

3 times	9	76	19	42	44	19

Thus, simplifying the preparation procedure slightly reduces the activity of the catalyst selected for the production of high molecular weight liquid synthetic hydrocarbons from a mixture of syngas and hydrogen, the yield of the target liquid synthetic hydrocarbons, and the selectivity of their formation. Reducing the number of absorptions increases the isomerization capacity of the 15%Co-15%Fe-5%Ni-1%ZrO2/YUKS catalyst selected for the production of high molecular weight liquid synthetic hydrocarbons from a mixture of syngas and hydrogen, despite the absence of changes in its surface acidity.

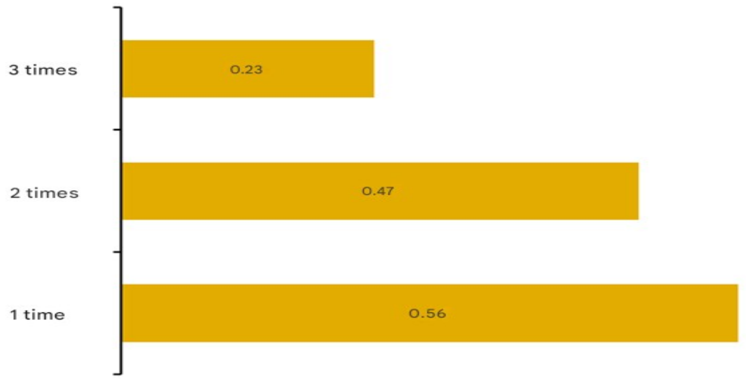

Figure 5. The amount of absorption depends on the ratio of iso/n-saturated hydrocarbons effect

Conclusion: The results of the research studied the effects of the catalytic activity of the catalyst obtained on the thermodynamics of the process, in particular the dependence of the synthesis temperature on the yield of carbon dioxide, methane, ethane, propane, butane, ethylene, propene, butene, and liquid synthetic hydrocarbons.

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