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RESEARCH OF THE SYNTHESIS PROCESS OF ALIPHATIC HYDROCARBONS WITH THE PARTICIPATION OF A CO-CATALYST FROM SYNTHESIS GAS

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ИССЛЕДОВАНИЕ ПРОЦЕССА СИНТЕЗА АЛИФАТИЧЕСКИХ УГЛЕВОДОРОДОВ С УЧАСТИЕМ СОКАТАЛИЗАТОРА ИЗ СИНТЕЗ-ГАЗА

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ABSTRACT: In this article, the characteristics of the synthesis of hydrocarbons from CO and H_2 in the presence of catalysts containing Co coated with alkali metals were studied, the results of the study of the catalytic effect of aluminum oxides and aluminosilicates of different porosity were presented, the liquid synthesis products for the sample based on aluminum oxide selectivity increased from 41 to 92% when potassium catalyst was added, selectivity of methane formation decreased from 29 to 4%, the effect of the nature of the support (A_2O_3 and SiO_2) and 20Co/ The addition of potassium to the SiO_2 sample did not change the CO conversion by 86-87%, but increased the yield of C_{5+} hydrocarbons and their selectivity:

KEY WORDS: Aluminum oxide, catalyst, Co-K catalyst, Fischer-Tropsch, aliphatic hydrocarbons, Liquid hydrocarbons, CO conversion, Co-catalyst.

АННОТАЦИЯ: В статье изучены особенности синтеза углеводородов из CO и H_2 в присутствии катализаторов, содержащих Co, покрытых щелочными металлами, представлены результаты изучения каталитического действия оксидов алюминия и алюмосиликатов различной пористости.селективность образования метана с 29 до 4%, влияние природы носителя (A_2O_3 и SiO_2) и 20Co/ Добавление калия в образец SiO_2 не изменило конверсию CO на 86-87%, но увеличило выход углеводородов C_{5+} и их селективность:

КЛЮЧЕВЫЕ СЛОВА: оксид алюминия, катализатор, Co-K катализатор, Фишера-Тропша, алифатические углеводороды, жидкие углеводороды, конверсия CO, сокатализатор.

In recent years, the demand for catalysts has been increasing, nowadays almost all catalysts and sorbents are imported. Catalysts containing especially Co are one of

the main catalysts of the process for obtaining aliphatic hydrocarbons from synthesis gas [1].

In recent years, the demand for petroleum products has increased due to the dwindling reserves of oil, which is why synthetic fuels are obtained from gas and coal as a result of research. By obtaining aliphatic hydrocarbons through the Fischer-Tropsch synthesis, fuels, polymer products and organic solvents are mainly obtained, and taking into account the need for these products, the study of new catalytic properties of Co-containing catalysts and the localization of these catalysts is one of the current problems [2].

Currently, hydrocarbon Fe- and Co-catalysts are used in industry to obtain aliphatic mixture from CO and H_2. Co-containing catalysts of the Fischer-Tropsch synthesis increase the yield of alkanes as a result of the reaction.

Co catalyst to increase the amount of high molecular hydrocarbons and reduce the concentration of gaseous products is one of the important tasks in the development of Fischer-Tropsch synthesis.

The introduction of alkali metals into the Co catalyst increases the average molecular weight of hydrocarbons and reduces methane production [3].

Cobalt catalysts are active in the synthesis of hydrocarbons from CO and H_2 at temperatures of 150 - 240 °C. As the temperature increases, their activity and selectivity change. An increase in temperature leads to an increase in CO conversion and an increase in the yield of synthesis products. If the total yield of C1-C4 and CO2 hydrocarbons increases with increasing temperature, the yield of liquid hydrocarbons will exceed the maximum corresponding to the optimum temperature for obtaining these products. The selectivity of the catalyst for liquid hydrocarbons decreases with increasing temperature.

Temperature equally affects the main indicators of the process of synthesis of hydrocarbons from CO and H_2. The optimal synthesis temperature is their individual characteristic and is determined by the composition of the catalyst, as well as the conditions of its preliminary purification. The results of studying the influence of the nature of a wide variety of supports (alumina oxides and aluminosilicates of different porosity) on the properties of cobalt systems in the synthesis of hydrocarbons from CO and H_2 are presented [4].

Table 1

Synthesis of hydrocarbons from CO and H_2 in Co/carrier catalysts T=190 °C, R=1 atm

catalyst	X_{CO}%	Output g/m^3	Selectivity %

$Co/A1_2O_3(1)$	47	6	4	87	3	5	4	90	1
$Co/A1_2O_3(2)$	58	15	10	96	4	11	8	80	1
$Co/A1_2O_3(3)$	67	19	17	104	4	12	12	75	1
$Co/A1_2O_3(4)$	51	17	14	76	3	14	13	72	1
Co/ Ac(1)	16	2	2	29	2	5	5	88	2
Co/ Ac(2)	23	2	1	43	3	4	3	91	2
Co/ Ac(3)	22	3	2	40	1	6	5	88	1
Co/ Ac(4)	30	5	5	52	2	7	8	84	1
Co/ Ac(5)	34	6	7	58	0	8	9	83	0

In the studied series of catalysts for 10 Co/AC(1-5) samples, high selectivity for target synthesis products (83-91%), their low yield (29-58 g/m^3) and low CO conversion of 16-34% were observed.

$10Co/Al_2O_3(1-4)$ systems showed high activity: XCO 51-67%, the yield of liquid hydrocarbons was 76-104 g/m^3, therefore, the study of the properties of Co-catalysts in the synthesis of hydrocarbons 1 from CO and H_2 -4 was carried out in the presence of samples prepared on the basis of Al_2O_3 with structural properties similar to supports. (Table 1) Properties of Co-system catalysts prepared on the basis of SiO_2 for Fischer-Tropsch. Fischer-Tropsch synthesis catalysts were also studied. To increase the activity of the catalyst, the amount of cobalt in Co/Al_2O_3 and Co/SiO_2 samples was increased to 20%.

We studied the influence of the nature of the support (Al_2O_3 and SiO_2) on the properties of 20Co-1K / Al_2O_3 and 20Co-1SiO_2 catalysts. Comparison of this series of samples at a synthesis temperature of 200°C showed that the addition of 1% potassium resulted in a significant decrease in CO conversion for the alumina-based Co-system: from 94 to 67% (Figure 1).

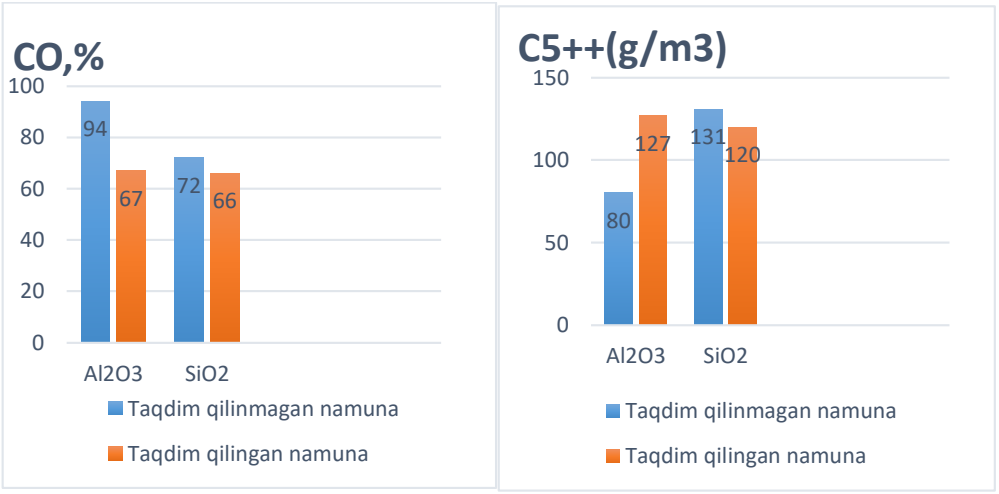

Figure 1. Effect of catalyst nature on CO conversion of 20Co(0-1)K/Al_2O_3 (SiO_2) and yield of C_{5+} product in hydrocarbon synthesis from CO and H_2 at T=200 °C.

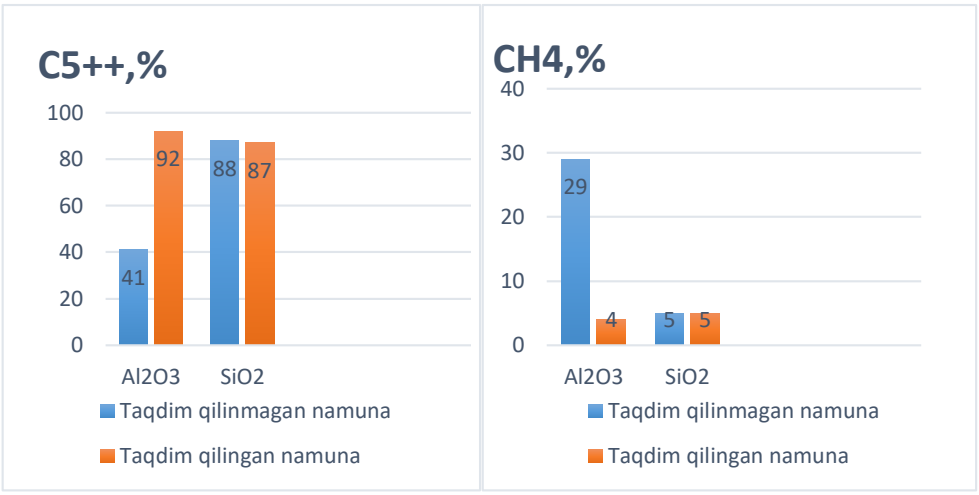

Figure 2. Effect of 20Co(0-1)K/Al_2O_3(SiO_2) catalyst on the selectivity of C_{5+} and CH_4 in the synthesis of hydrocarbons from CO and H_2 at T=200°C.

Productivity of liquid products increased from 80 to 127 g/m^3 at the same time as hydrocarbon chain growth probability α increased sharply from 0.68 to 0.91. The addition of potassium to the 20Co/SiO_2 catalyst resulted in a reduction of Xco from 72 to 66%, while the yield of liquid hydrocarbons decreased from 131 to 120 g/m^3.

For the sample based on aluminum oxide, the selectivity of liquid synthesis products decreased from 41 to 92% with the addition of a potassium catalyst, and the selectivity of methane formation decreased from 29 to 4% (Fig. 2). The addition of potassium to the 20Co/SiO_2 catalyst did not change these selectivity indicators, which were 87-88% and 5%, respectively.

Comparison of these catalysts at the optimal synthesis temperature showed that the introduction of 1% K into the Co-systems led to a different increase in the activity

of the catalysts (Table 2). The addition of potassium to the alumina-based Co-catalyst helped to increase the conversion of CO from 72 to 82%, while increasing the liquid synthesis products from 112 to 138 g / m^3 and the selectivity of their formation from 75 to 81 %.

Table 2

Synthesis of hydrocarbons from CO and H_2 in the presence of 20Co-(0-1)M sitell catalysts. CO / H_2 = 1: 2, P = 0.1 Mpa

Catalyst	°C	X_{CO} %	Output g/m^3				Selectivity %				a
			CH_4	C_2-C_4	C_{5+}	CO_2	C_{5+}	CH_4	C_2-C_4	CO_2	
Co/Al_2O_3	190	72	20	15	112	17	75	12	9	4	0.86
Co-1K/Al_2O_3	210	82	16	10	138	24	81	8	6	5	0.87
Co/SiO_2	210	86	18	17	140	21	79	9	9	4	0.83
Co-1K/SiO_2	220	87	13	14	147	24	82	6	7	4	0.82

The addition of potassium to the $20Co/SiO_2$ sample did not change the CO conversion by 86-87%. The yield of C_{5+} hydrocarbons and their selectivity increased slightly: from 140 to 147 g/m^3 and from 79 to 82%, respectively. C_1-C_4 hydrocarbon emissions decreased from 35 to 26-27 g/m^3 for the catalysts on both supports. An increase of 10-20 °C in the optimal synthesis temperature was observed for all samples.

For the first time, activation of Co-catalyst with metals of group I (Li, Na, K, Rb, Cs) was found to increase the yield of liquid hydrocarbons and increase their average molecular weight in Fischer-Tropsch synthesis. A correlation was established between the catalytic activity and selectivity of the nature of the alkali metal 20So-M/A1_2O_3(SiO_2). The method of preparation of the catalyst is based on the sequence of impregnation of active metals and increases the efficiency of synthesis of hydrocarbons from CO and H_2 in the process, the conversion of CO and the formation of high C_{5+} products.

For Fischer-Tropsch synthesis, a Co-K catalyst was adopted, which allows the selection of liquid hydrocarbons with a synthesis gas output of up to 138 g/nm3. In this case, the resulting hydrocarbons are enriched with heavy fractions:

In summary, as a result of the research conducted, the synthesis of hydrocarbons from CO and H_2 on Co/carrier catalysts was studied for 10Co/AC(1-5) samples, and the selectivity of liquid synthesis products for the aluminum oxide-based

sample with the addition of a potassium catalyst 41 to 92%, the selectivity of methane formation was found to decrease from 29 to 4%.

LIST OF REFERENCES USED

1. Елисеев О.Л., Цапкиина М.В., Дементьева О.С., Давыдов П.Е., Казаков А.В., Лапидус А.Л. Промотирование Со-катализаторов синтеза Фишера-Тропша щелочными металлами. // Кинетика и катализ. 2013, Т.54, Х22, с. 216-221.

2. Лапидус А.Л., Елисеев О.Л., Цапкина М.В., Белоусова О.С. (Дементьева О.С.), Гущин В.В. Промотирование калием Со-катализатора синтеза ФишераТропша. // Известия РАН, Сер.хим. 2010, №9, с. 1785-1786.

3. ЛапидусА.Л., ЕлисеевО.Л., ЦапкинаМ.В., ДавьщовП.Е., БелоусоваО.С. (ДементьеваО.С.). Влияние пористой структуры носителя на свойства кобальтовых катализаторов синтеза углеводородов из СО и Нг. // Кинетика и катализ. 2010, Т. 51, № 5, с. 757-761.

4. Белоусова О.С. (Дементьева О.С.), Лапидус А.Л., Елисеев О.Л., Цапкина М.В. Синтез углеводородов из СО и Нг на промотировапных щелочными металлами Со-катализаторах. // Тезисы докладов IV Молодежной конференции ИОХ РАН. Москва, 2010, с. 80-81.

5. Rakhimov, G., Kuybokarov, O., &Karshiyev, M. (2024). Research of the catalytic properties of a catalyst selected for the production of high-molecular weight liquid synthetic hydrocarbons from synthesis gas. In *E3S WebofConferences* (Vol. 498, p. 01008). EDP Sciences.

6. Rakhimov, G. B. (2023). Development of anti-detonation additive. *Экономика и социум*, (12 (115)-1), 604-607.

7. Rakhimov, G. (2023). Increasing regeneration efficiency by recycling alkanolamines. *Sanoatda raqamli texnologiyalar /Цифровые технологии в промышленности*, *1*(2), 158-163.

8. Murtazaev, F. I., &Raximov, G. B. (2023). Synthesis of sorbents used in the separation of halogens. *Sanoatda raqamli texnologiyalar*, *1*(01).