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Study of the Effect of Catalyst in Methane Conversion

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Abstract

Methane and carbon dioxide conversion rates and hydrogen specificity of the process of steam and oxide-carbon (IV) oxide conversion (reforming) of methane during catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts. When carried out in the developed membrane reactor (CH4:CO2=1:1), the dependence of the initial gas mixture on the flow rate is shown. Membrane-water process (880 and 910) is described in a reactor designed for catalytic conversion in the presence of steam and carbon dioxide and under the influence of catalysts.

Keywords: synthesis gas, methane, catalyst, membrane reactor, carbon monoxide (IV), carbon dioxide and hydrogen.

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in the world on obtaining synthesis gas from methane in one stage and on its basis methanol and dimethyl ether, which are distinguished by their economic efficiency. The selection of inexpensive and active catalysts with high productivity and selectivity for carbonate conversion of methane with carbon dioxide and obtaining synthesis gas from steam and conversion of carbon dioxide and methane into carbon dioxide with the participation of carbonate conversion and steam. The process of obtaining synthesis gas from carbonate conversion, based on a comprehensive study of its thermodynamic justification and the creation of energy- and resource-saving technologies, is of great importance.

A distribution reactor used for catalytic and non-catalytic thermal conversion of methane using a catalyst with high catalytic activity and efficiency. Reactors of this type, used for thermal conversion of methane in the presence of a catalyst with high catalytic activity and efficiency, usually use a membrane that maintains the minimum required concentration of one of the reactants (a substance included in the process) in the process mixture, thereby preventing additional processes.

Figure 1 shows various types of flow charts for feeding steam and methane gas to reactors designed for the conversion of carbon monoxide (IV) in the process of converting methane to carbon monoxide (IV).

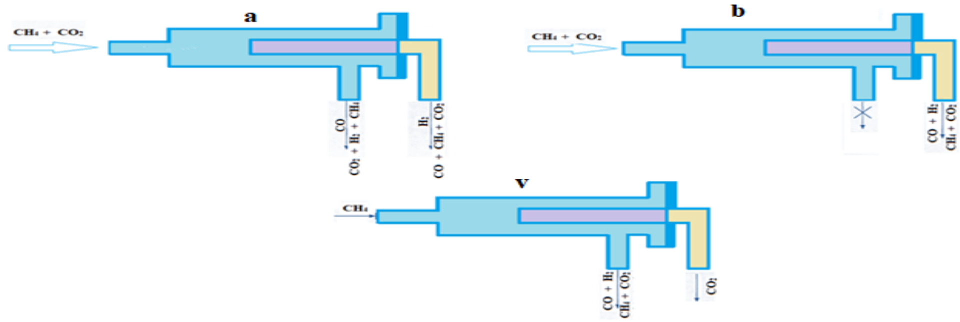

Fig. 1. Schemes of different types of membrane reactors designed for processing methane into water vapor and carbon dioxide: a-extractor , b-contactor , c- distributor

The extractor type methane conversion with water vapor and carbon monoxide (IV) is suitable for the conversion of methane with carbonate under the influence of carbon monoxide (IV) and steam-carbonate conversion with water vapor and carbon monoxide (IV) in the developed membrane reactor (Fig. 1.a), the pre-mixed feedstock entering the process is fed to the reactor designed for the conversion of water vapor, methane and carbon monoxide (IV), where the catalytic process and gas separation take place, then the process products, i.e. the exhaust gas and hydrogen from the reactor designed for the conversion of water vapor, methane and carbon monoxide (IV), are discharged through two channels : standing channel (gases that have not passed through the membrane) and a permeate channel (gases that have passed through the membrane). In a membrane reactor of the "contactor" type, designed for the conversion of methane with water vapor and carbon monoxide (IV) (Fig. 1.b), the feedstock entering the premix process is used for the conversion of methane with water vapor and carbon monoxide (IV), is poured into the designated reactor and passes through the membrane, the products of the process, i.e. carbon dioxide and hydrogen, are removed through the permeate channel . In the case of a membrane reactor of the "distributor" type, designed for the conversion of methane with water vapor and carbon monoxide (IV) (Fig. 1.c) , gases are fed into a reactor designed for the conversion of methane with water vapor and carbon monoxide (IV), separately: methane (propane) through the inlet, carbon dioxide through the permeate channel ; the products of the process, i.e. carbon dioxide and hydrogen, are removed through the holding channel.

After completion of the tests in the membrane reactor designed for the catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts, the membrane catalyst was cooled to room temperature in a stream of inert gas (e.g., high-pressure nitrogen), passivated, and methane was removed from the reactor designed for the catalytic conversion in the presence of water vapor and carbon dioxide and under the influence of catalysts with water vapor. In addition, to determine the catalytic activity in crushed form, the membrane catalyst was crushed to a fraction of <0.8 mm and placed in the reactor designed for the catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts.

If a membrane reactor designed for catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts operates on the "extractor" principle, then the membrane catalyst must perform not only catalytic tasks, but also separation tasks, therefore catalysts of the composition $(Ni_2O_3)_x*(Co_2O_3)_y*(ZrO_2)_z*(MoO_3)_k/SiO_2$ were selected. If a membrane reactor designed for catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts operates on the "contactor" principle, then the membrane catalyst must ensure intensive contact of the initial substances entering the process with the catalyst and not perform separation tasks. If a membrane reactor designed for catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts operates on the principle of a "distributor", then the membrane catalyst should perform catalytic functions, but this is not the case. It is necessary to have separation functions.

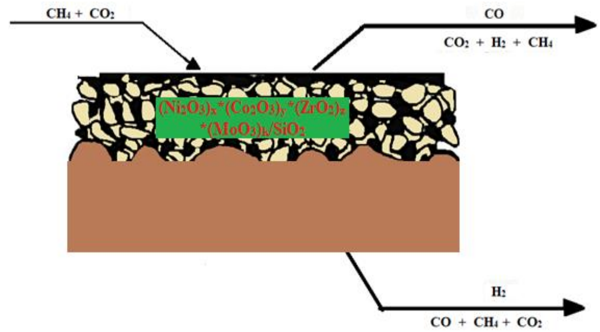

Fig. 2. Operating principle of a membrane catalyst in a membrane reactor designed for catalytic conversion of "extract" methane in the presence of water vapor and carbon dioxide and under the influence of catalysts.

Fig. 2 shows the conversion rates of methane and carbon dioxide and the hydrogen specificity of the process of steam and oxide-carbon (IV) oxide conversion (reforming) of methane during catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts. When carried out in the developed membrane reactor ($CH_4 : CO_2 = 1:1$), the dependence of the initial gas mixture on the flow rate is shown.

If we assume that the rate of interaction of H_2 and CO_2 depends on the concentrations of gaseous substances entering into both processes, then the higher the order of carbon dioxide, the greater the share of this process, as a result of which the specificity for hydrogen decreases. For the same reasons, the specificity for hydrogen increases with an increase in temperature from 880°C to 910°C .

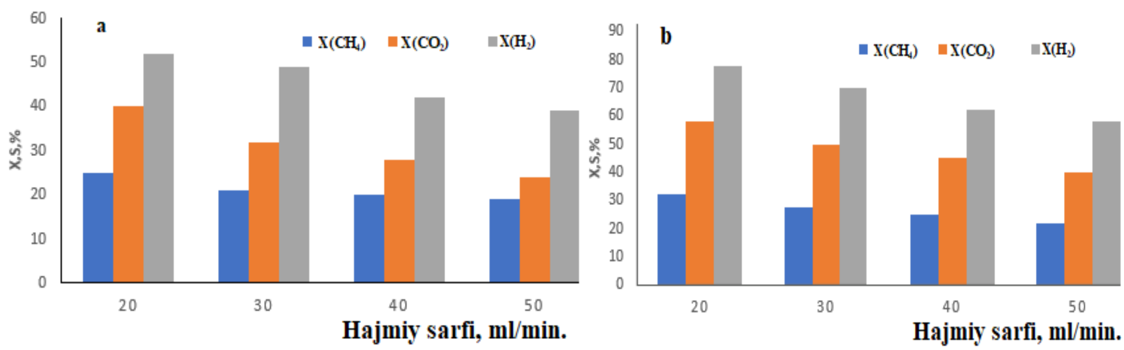

Fig. 3. Dependence of the conversion rate of methane and carbon dioxide on the consumption of the initial mixture for the process of methane conversion with carbon monoxide (IV) in a contactor-type reactor at different temperatures: a-880°C, b-910°C.

The composition of the conversion products, i.e. carbon dioxide and hydrogen, is presented in Table 1 below.

Table 1. The conversion products include carbon dioxide and hydrogen.

T, ^{0}C	Input, ml/min			Product composition, %				
	CH_4	CO_2	general	CH_4	CO_2	CO	H_2	H_2
880	25	25	50	37,37	35.58	18.14	6.17	2.8
	20	20	40	36.24	32.79	20.77	7.39	2.14
	15	15	30	35.55	30.04	24.15	9.05	1.97
	10	10	20	32.92	26.38	28.36	11.61	2.09
910	25	25	50	34.62	27.31	27.35	11.62	0.66
	20	20	40	33.02	24.51	29.96	13.37	0.67
	15	15	30	30.8	21.08	33.13	16.37	0.73
	10	10	20	27.11	17.47	36.46	20.72	0.87

This type is designed for catalytic conversion of methane in the presence of steam and carbon dioxide and under the influence of catalysts, for the conversion of methane with carbonate under the action of carbon monoxide (IV) and steam-carbonate conversion in the presence of steam and carbon monoxide (IV) consideration of the advantages of using the developed membrane reactor, only the main parameters of the conversion (reforming) process of methane with steam and carbon monoxide (IV) are given catalytic conversion of methane in the presence of steam and carbon dioxide and under the influence of catalysts. It is possible to compare with analogs the indicators for other types of reactors intended for np

The "Distributor" class is designed for catalytic conversion of methane in the presence of steam and carbon dioxide and under the influence of catalysts, methane gasification under the influence of carbon monoxide (IV) and steam gasification in the presence of carbon monoxide (IV) using carbonate conversion of methane in a membrane reactor designed for conversion. Fig. 4 shows the principle of using a membrane catalyst in a membrane reactor designed for catalytic conversion of methane with carbon monoxide (IV) in the presence of steam and carbon dioxide and under the influence of catalysts. The initial materials (inputs) are fed from different sides of the membrane catalyst, mixed and interact in the catalyst, and the process products - carbon dioxide and hydrogen - are obtained from the initial methane.

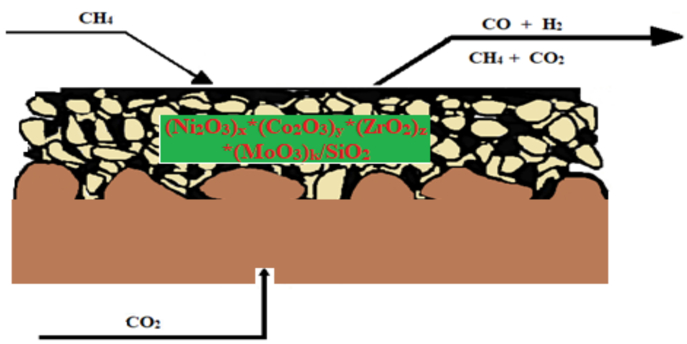

Fig. 4. Operating principle of a membrane catalyst in a membrane reactor designed for catalytic conversion of distributor methane in the presence of water vapor and carbon dioxide and under the influence of catalysts.

The "Distributor" class is designed for catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the influence of catalysts, gasification of methane under the influence of carbon monoxide (IV) and carbonate vapor in the presence of water vapor and carbon (IV), oxide conversion (reforming) of methane with carbon monoxide (IV) in a membrane reactor designed for conversion.

Table 2. The conversion products are carbon dioxide and hydrogen.

T, ^{0}C	Input, ml/min			Product composition, %				
	CH_4	CO_2	general	CH_4	CO_2	CO	H_2	H_2
880	25	25	50	36.32	37.09	16.34	8.62	2.04
	20	20	40	26.15	30.84	22.36	20.31	1.74
	15	15	30	12.7	18.36	33.15	36,38	1.77
	10	10	20	8.67	12.56	37.46	42.31	2.08
910	25	25	50	24.11	31.58	23.04	22.49	1.22
	20	20	40	9.44	16.59	33.07	42.68	1.14
	15	15	30	6.02	12.56	35.29	47.55	1.38
	10	10	20	4.49	10.72	37.17	48.68	1.9

In the process of methane conversion with carbon monoxide (IV), the "distributor" type is designed for the catalytic conversion of methane in the presence of water vapor and carbon dioxide and under the action of catalysts into carbon dioxide and water vapor under the action of carbon monoxide (IV) and carbon monoxide (The principle of using a membrane reactor designed for steam-carbonate conversion in the presence of IV) is explained in Fig. 5.

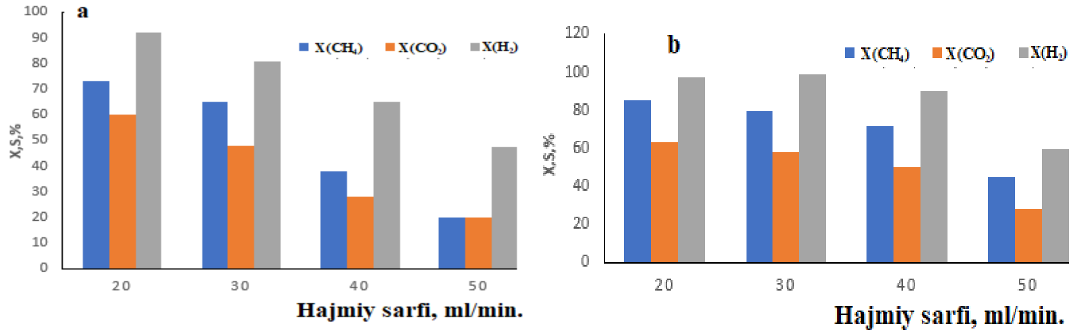

Fig. 5. Conversion of methane into carbon in a membrane reactor designed for catalytic conversion (reforming) of methane and carbon dioxide in the presence of water vapor and carbon dioxide and under the action of distribution class catalysts at different hydrogen specificity temperatures (IV), dependence of the flow rate of the initial mixture for the oxide conversion process: a - 880°C, b - 910°C

Membrane reactors designed for carbonization conversion of methane under the action of carbon monoxide (IV) and steam and steam-carbonate conversion in the presence of carbon monoxide (IV), extractor, distribution and contactor membrane reactors. Possibilities of use in synthesis gas. Extraction processes with carbonate conversion have been studied and it has been proven that the process is carried out in a membrane apparatus.

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