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Influence of Membrane Reactor on Methane Conversion

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Annotation

Kinetic regularities of the process, recorded under the conditions of a differential reactor (rate of change of the initial substances, kinetic model of the process, influence of various factors on the rate of transformation and selection of the optimal process mode). Optimal conditions for the process were also studied (CH4:H2O:CO2=1:1:0,4; P=0,1 MPa; Vo = 1000 h-1; T = 900°C and τ cont = 0,88 s).

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

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

In the membrane reactor for methane reforming with steam and carbon monoxide (IV), both the chemical process and the membrane process occur simultaneously. In recent years, many methods have been proposed to use membranes in combination with the chemical process to accelerate the overall process. Depending on the function of the membrane in the membrane reactor for methane reforming with steam and carbon monoxide (IV), the methane intended for methane reforming with steam and carbon monoxide (IV) is processed in carbonized reactors and membrane reactors. Intended for steam-carbonate reforming in the presence of steam and carbon monoxide (IV), are divided into three main types:

1) In the extractor, the membrane selectively separates one or more products of the process, i.e. carbon dioxide and hydrogen, from the mixture of the substance undergoing the primary reaction and the substances formed as a result of the process;
2) In the distributor, the membrane controls the addition of the primary reactant to the mixture of primary reactant and process product;

3) The contactor membrane accelerates the interaction of the initially reacting substances with the catalyst.

The Extractor type membrane reactor is designed for steam reforming of methane and carbon monoxide (IV). The productivity of the membrane reactor designed for the conversion of methane with steam and carbon monoxide (IV) into carbonate under the action of carbon monoxide (IV) and steam-carbonate reforming in the presence of water vapor and carbon monoxide (IV) The most common type operates on the extractor principle. In some reactors designed for the conversion of methane into steam and carbon monoxide (IV), only one of the products can pass through the membrane - carbon dioxide and hydrogen, and selective separation occurs, while in others, the catalyst is retained, that is, the membrane is permeable to all components of the mixture of substances formed as a result of the process, with the exception of the catalyst.

Selective separation of products. One of the components formed during the chemical process is selectively removed from the mixture of the initial substance entering into the reaction and the substance formed as a result of the process. If one of the products - carbon dioxide and hydrogen - acts as an inhibitor, its removal can significantly increase the productivity of the reactor designed to convert methane into steam and carbon monoxide (IV). Also, a membrane reactor designed to convert this type of methane with steam and carbon monoxide (IV) allows increasing the concentration of the initial substances.

Membrane catalysts of the "Distributor" type. The second membrane reactors, designed for the conversion of methane with steam and carbon monoxide (IV) into carbonate under the action of carbon monoxide (IV) and steam-carbonate conversion in the presence of steam and carbon monoxide (IV), belong to the reactors of the type Designed for the conversion of steam, methane and carbon monoxide (IV), operates on the distributor principle. One of the reagents is added to the mixture of reagents and process products through the membrane in a certain way. Membranes of this type are designed for the conversion of methane with steam and carbon monoxide (IV) into carbonate under the action of carbon monoxide (IV) and steam-carbonate conversion with steam and carbon monoxide (IV). Membranes are used in. The reactor can perform various functions. On the one hand, a membrane reactor designed to convert methane into water vapor and carbon oxide (IV) evenly distributes the initial rate of the reagent process along its length, thereby eliminating local overheating and side processes. Secondly, the membrane can function as a separating curtain through which one of the components of the mixture is directed. Both tasks can be combined in one device.

The membrane reactor of the "Contactor" type is designed for the conversion of methane with water vapor and carbon dioxide. Reactors of this type are designed for the conversion of methane into water vapor and carbon oxide (IV) in the form of a contactor with a forced flow through the membrane, i.e. a flow-catalytic methanolizer designed for the conversion of water vapor and carbon oxide (IV) into carbon (It is interesting to use it as a membrane reactor and an interphase contactor for steam-carbonate conversion in the presence of carbonate vapor and water under the influence of IV) oxide and carbon oxide (IV).

The reactors are designed for the conversion of methane into steam and carbon dioxide with a flow-through catalytic membrane. The methane membrane reactor is designed for the conversion of methane under the action of steam and carbon dioxide in the presence of catalysts into carbonate under the action of carbon monoxide (IV) and steam-carbonate conversion under the action of steam and carbon monoxide (IV) in this type, the initially mixed reagents are passed through a special porous catalytic membrane. The function of the reactor, designed for the conversion of methane under the action of steam and carbon dioxide in the presence of catalysts, is to provide the reaction space with a short controlled exposure time and high catalytic activity. The purpose of using reactors designed for the conversion of methane with a flow-through

catalytic membrane under the action of water vapor and carbon dioxide in the presence of catalysts is to achieve complete conversion in the shortest possible time and in a minimum reaction space, or for this process the catalyst with the substance entering into the initial reaction must achieve maximum specificity due to a narrow distribution of the exposure time between the active centers.

The process of methane conversion into carbon monoxide (IV) was compared with the operational characteristics of their material in a reactor designed for the conversion of methane into steam and carbon monoxide (IV) on membrane catalysts in a contactor and distributor.

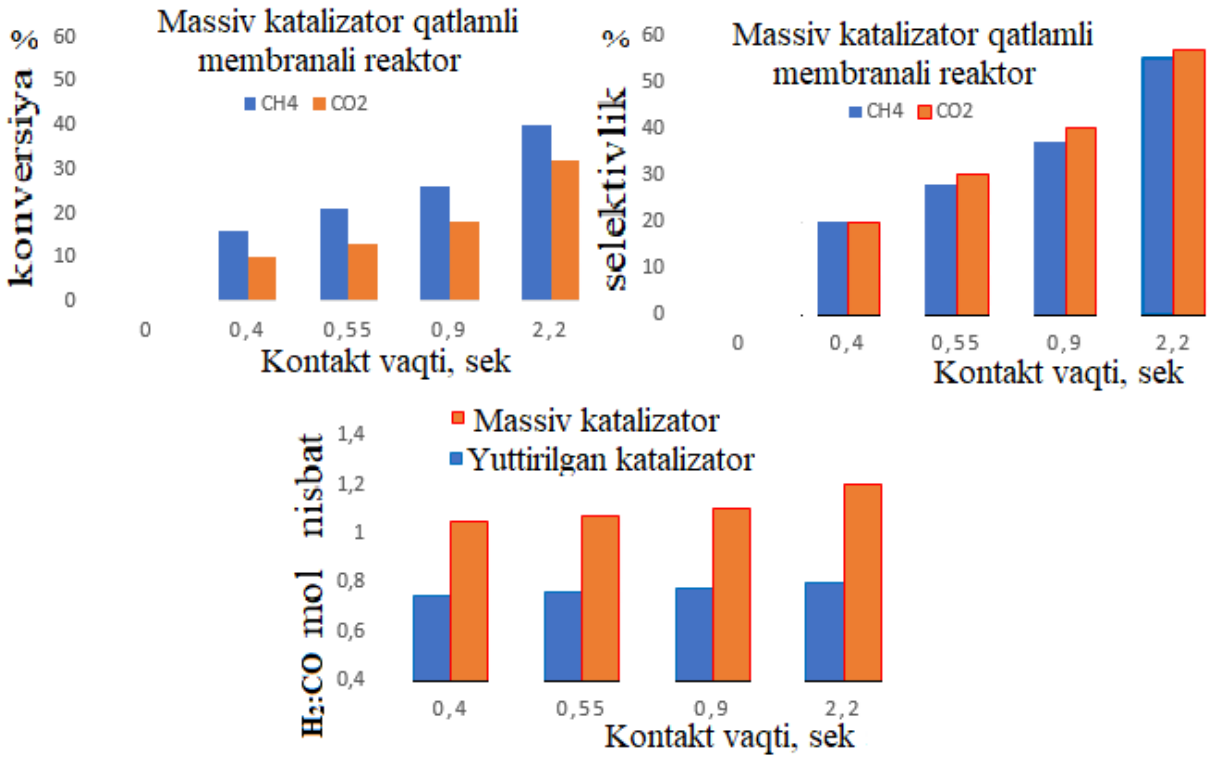

Fig. 1. Comparison of membrane catalysts at 900°C in a distributor with an absorbed catalyst bed in the process of producing synthesis gas by carbonate conversion of methane in the presence of carbon dioxide and water vapor and carbonate conversion

As the main parameters of the process of catalytic conversion of methane with carbon monoxide (IV), steam and carbon monoxide (IV) of conversion (reforming) of methane, the main indicators are the change in the concentration of components in the products - carbon dioxide and hydrogen, the degree of change in gaseous substances entering the original process, and the ratio of the components of the mixture of hydrogen and thermal gas depending on the time of interaction of the substance entering the original process. reaction and the active center of the catalyst.

In this case, the structure of the membrane catalyst influences the degree of change and selectivity of the process of conversion (reforming) of methane with water vapor and carbon monoxide (IV) (Fig. 1).

Kinetic regularities of the process, recorded under the conditions of a differential reactor (rate of change of the initial substances, kinetic model of the process, influence of various factors on the rate of transformation and selection of the optimal process mode). Optimal conditions for the process were also studied (CH_4:H_2O:CO_2=1:1:0,4; P=0,1 MPa; V_0 = 1000 h^{-1}; T = 900°C and τ cont = 0,88 c).

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