Volume 3, Issue 2, February - 2025 ISSN (E): 2938-3811

METHODS OF CATALYTIC CONVERSION OF METHANE, CURRENT STATUS AND PROSPECTS

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Abstract
Currently, the world's natural gas reserves are 144 trillion. m3, and in Uzbekistan - 2 trillion. m3. Currently, many important products in industry (chlorine-containing solvents, carbon sulfide, cyanide acid, etc.) are synthesized from methane. Catalytic conversion of methane with water vapor is the main method for obtaining hydrogen and synthesis gas. The shortage of oil and oil products requires the creation of alternative methods for obtaining motor fuels, lower olefins and aromatic hydrocarbons. As is known, the synthesis of substances that can replace oil products from natural and associated gases, low molecular alcohols, coal gas and biogas is environmentally and economically feasible. At a time when oil reserves are decreasing, natural gas is of great interest as an alternative fuel in petrochemical production. The current traditional method of converting natural gas into liquid fuels is multi-stage and occurs at high temperatures and high pressures. Currently, promising methods for processing natural gas are its catalytic aromatization and oxycondensation reactions. These processes occur in one stage and at normal atmospheric pressure.

Introduction

Until recently, petroleum tail gases and gases released during oil refining were burned. In recent years, the process of converting methane contained in natural gas and petroleum tail gases to synthesis gas and environmentally friendly motor fuels based on it has been rapidly developing.

Currently, a number of research works are being carried out on the production of motor fuels and aromatic hydrocarbons from natural gas, petroleum tail gases and gas condensates with the participation of zeolite catalysts. The reaction proceeds with the participation of a zeolite-containing catalyst. No oxidant is involved in this process.

Methods of methane processing: first, synthesis gas production and production of chemical products based on it; second, oxycondensation of methane (natural gas) to ethylene; third, direct catalytic oxidation of methane (natural gas) to oxygen-containing products.

We will focus on three alternative methods of converting methane to synthesis gas.

1) Conversion with copper steam: $CH_4 + H_2O \leftrightarrow CO + 3H_2$; ΔH_{298}=206 кж/моль; T = 700-900°C; кат: Ni

The disadvantages of steam reforming hydrocarbons include: high cost of superheated steam; excessive CO2 production.

2) Partial oxidation with oxygen $CH_4 + 1/2O_2 \leftrightarrow CO + 2H_2$ ΔH_{298}=-35,6 кж/моль

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The disadvantages of oxygen conversion are: the high cost of oxygen; the formation of excessive CO2.

3) Carbonate conversion

$CH_4 + CO_2 \leftrightarrow 2CO + 2H_2$ $\Delta H_{298} = 247$ кж/моль

Carbonate conversion poses the following challenges: high exothermicity of the process; coking of the catalyst:

1. $CH_4 \leftrightarrow C + 2H_2$ $\Delta H_{298} = -83{,}3$ кж/моль

Carbonate conversion has not yet been introduced into industry due to the lack of a long-lasting catalyst, but it is effective in terms of CO2 removal. Carbonate conversion of methane to synthesis gas is a promising method for the production of hydrocarbons by the Fischer-Tropsch process using the starting reagents. Carbonate conversion of methane is also a promising method for the simultaneous beneficial use of two greenhouse gases, which have important environmental and economic benefits. One of the advantages of this method is that the methane conversion process is carried out in an atmospheric process (0.1 MPa) at 650-800 ° C [4]. Hydrocarbons are produced from synthesis gas in two stages:

$CO + 2H_2 \rightarrow CH_3OH$ $\Delta H = -90{,}73$ кж/моль

1. $CO + 3H_2 \rightarrow CH_3OH + H_2O$ $\Delta H = -49{,}53$ кж/моль

Also dimethyl ether $3CO + 3H_2 \rightarrow CH_3OCH_3 + CO_2$

The product of the reaction is also. In the development stage, methanol is processed into gasoline or lower olefins.

The process consists of three consecutive stages:

$CH_3OH \leftrightarrow CH_3–O–CH_3 \leftrightarrow C_2–C_5$ olefins $\leftrightarrow$ aromatic hydrocarbons +alkanes.

The reaction of obtaining hydrocarbons from the interconversion of anhydride and water vapor in the current atmospheric carbon flux from time to time has aroused great interest among scientists. What kinetic reaction equation can be used to represent the conversion process: $CH_4 + CO_2 \rightarrow 2CO + 2H_2$

$CO + 3H_2 \rightarrow CH_4 + H_2O$

$2CO + 5H_2 \rightarrow C_2H_6 + 2H_2O$

$CO_2 + H_2 \rightarrow CO + H_2O$

In general $nMe + 3CO_2 + 5H_2O \rightarrow CH_4 + C_2H_6 + nMeO$

The implementation of this reaction is important not only from an energetic but also from an ecological point of view.

All the reactions of the mentioned process have been thermodynamically studied and it has been established that the reaction proceeds at 600-700°C.

Another way to solve energy and ecological problems is to use combinations of carbonate and oxygen conversions (CH4 + CO2 + O2). When using this combined method, it is possible to obtain a mixture of CO + H2 in any ratio. In addition, when using this method, the problem of coke formation is also solved.

1.5-2.0% of natural gas is chemically processed. The annual global demand for ethylene is 150 million tons, propylene 120 million tons, vinyl chloride 24 million tons, vinyl acetate 3.8 million tons, and styrene 19.2 million tons. Therefore, it is necessary to process natural gas and

Web of Scientists and Scholars: Journal of Multidisciplinary Research

Volume 3, Issue 2, February - 2025 **ISSN (E):** 2938-3811

associated petroleum gases based on local raw materials to produce import-substituting, export-oriented chemical products, including environmentally friendly liquid fuels, ethylene, propylene, styrene, vinyl chloride, vinyl acetate, etc. It is relevant from the point of view of satisfying the republic's needs for organic synthesis products, synthetic resins and plastics, mineral fertilizers, achieving independence of our country in oil and gas products, and increasing its export potential [1; 575-581-b]. Currently, there is a catalyst with high activity and selectivity for the single-stage oxycondensation of methane with atmospheric oxygen (dimerization of methane) to obtain ethylene. Methods for obtaining ethylene from methane [2; 634-641-b

Summary

Another way to solve energy and ecological problems is to use combinations of carbonate and oxygen conversions ($CH_4 + CO_2 + O_2$). When using this combined method, it is possible to obtain a mixture of $CO + H_2$ in any ratio. In addition, when using this method, the problem of coke formation is also solved.

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