

II Symposium

**"MODERN
PROBLEMS
OF
NANOCATALYSIS"
*NANOCAT 2017***

September 24-29, 2017



PROCEEDINGS



Kyiv 2017

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OXIDE CATALYSTS FOR REFORMING OF METHANE

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Every year more and more expanding chemical processing of natural gas due to the constant depletion of energy resources and to increase the value of processed products. Therefore, methane is an indispensable raw material for the chemical industry. From methane by catalytic processing can synthesize many commercially important compounds such as, ethylene, hydrogen, synthesis gas [1]. Syngas is a feedstock for the oxygenates (methanol, dimethyl ether, etc.) and for producing liquid and solid hydrocarbons by Fischer-Tropsch synthesis. Syngas from methane can be obtained by partial oxidation, dry reforming and methane steam reforming [2].

In this paper we studied the process of steam reforming of methane over the modified nickel catalysts.

Modified by oxides of molybdenum, zirconium, and lanthanum low percent 3% NiO / Al₂O₃ catalysts were tested in a methane steam reforming reaction at the temperature range 600 to 850° C.

Figure 1 shows the results obtained under optimal process conditions of the process: ratio of CH₄: H₂O = 1: 1, and T_r = 850°C and W = 1000 hr⁻¹. As can be seen from the figure, adding zirconium oxide decreases the activity of the nickel catalyst, methane conversion decreases from 35 to 17%.

The highest methane conversion (41%) is achieved by addition of the molybdenum oxide into the 3% NiO / Al₂O₃ catalyst, while in the reaction products is observed the highest concentration of H₂ (28% vol.), CO concentration - 6 vol.%.

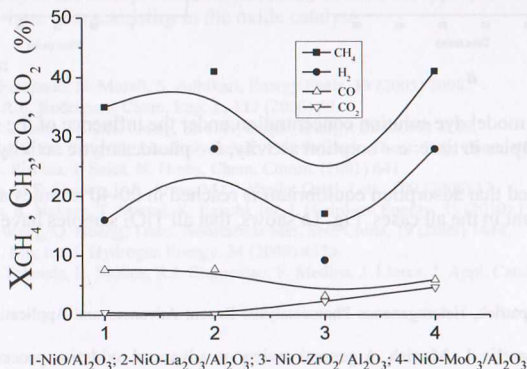


Fig. 1. The activity of catalysts in the methane steam reforming reaction

Next, we study the effect of molybdenum content in the 3% NiO - MoO₃ / Al₂O₃. As seen from the table the addition of molybdenum oxide in an amount of 1 wt. % leads to an increase in the catalytic activity of the nickel catalyst, the hydrogen concentration is increased to 70 vol. %, carbon monoxide (II) to 23 vol. %, and the methane conversion reaches 92%.

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Table. The effect of molybdenum content on the activity of the nickel oxide catalyst in a steam methane reforming reaction, $T=850^{\circ}\text{C}$, $W = 1000 \text{ hr}^{-1}$.

Catalysts supported on Al_2O_3	$X_{\text{CH}_4}, \%$	$\text{C}_{\text{H}_2}, \%$	$\text{C}_{\text{CO}}, \%$
3 % NiO - 0.5 % MoO_3	38	30	13
3 % NiO - 1 % MoO_3	92	70	23
3 % NiO - 2 % MoO_3	41	28	6
3 % NiO - 3 % MoO_3	44	31	5

SEM study is carried out to investigate surface morphology and grain size of the synthesized particles. The SEM images of Ni-Mo/ $\gamma\text{-Al}_2\text{O}_3$ shown in figure 2.

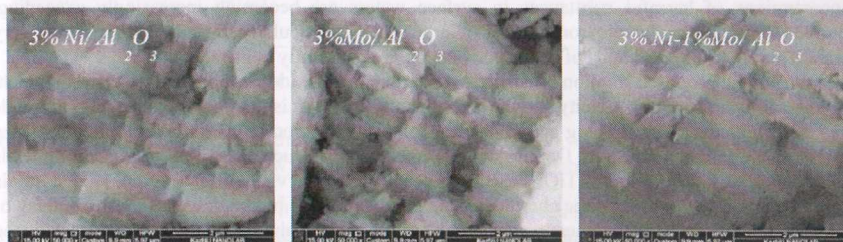


Fig. 2. SEM micrographs of catalysts

As shown in figure, the active 3%Ni-1%Mo/ Al_2O_3 catalyst is dispersity also nanoparticles of catalyst uniform distribution on the surface of the carrier. Addition of molybdenum oxide (1 wt.%) in compound of 3% NiO / Al_2O_3 catalyst leads to increase surface area and dispersity of catalyst that influence positively to its activity for the heterogeneous catalyst in the reaction of reforming of methane to synthesis gas.

It can be concluded that the results of operations was improved oxide composition of 3% NiO / Al_2O_3 catalyst by introduction of promoting additive (MoO_3). It was determined the optimum content of promoting additive of molybdenum oxide (1 wt. %) in the composition of polyoxide 3 % NiO - 1% MoO_3 / Al_2O_3 catalyst in a steam methane reforming reaction. Under the conditions of steam reforming of methane: $\text{CH}_4: \text{H}_2\text{O} = 1: 1$, $T=850^{\circ}\text{C}$ and $W = 1000 \text{ hr}^{-1}$ conversion of methane is 92%, H_2 concentration -72 vol.% and the concentration of CO of 23 vol. %. According to the SEM, due to the modification of the 3%NiO/ Al_2O_3 catalyst with 1 wt. % molybdenum oxide obtained nanoparticles of catalyst uniform distribution on the surface of the carrier.

This work was supported by the Kazakhstan Ministry of Education and Science.

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