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## Combinedoxidation of methane to synthesis gas

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Biogas is a promising source of hydrocarbons capable of providing the current and future needs of mankind for energy and hydrocarbon feedstocks [1]. The main components of biogas obtained in anaerobic bioreactors are methane and carbon dioxide, as impurities can contain carbon monoxide and oxygen [2]. Biogas obtained in this way can be converted to synthesis gas by dry ( $\text{CH}_4 + \text{CO}_2$ ) or steam reforming ( $\text{CH}_4 + \text{H}_2\text{O}$ ) using appropriate catalysts [3-5]. In the present work, a modified nickel catalyst supported on alumina was used as catalysts for the combined oxidation of methane. Experiments on testing the efficiency of catalysts were carried out on an automated flow catalytic unit (PKU-1). The reaction products were identified chromatographically on a device of "CHROMOS GC-1000". The figure shows the results of the effect of promoting additions of lanthanum ( $\text{La}_2\text{O}_3$ ), molybdenum ( $\text{MoO}_3$ ) and cerium ( $\text{CeO}_2$ ) oxides on the catalytic activity of the nickel catalyst in the combined methane oxidation reaction involving oxygen, carbon dioxide and water vapor, under process conditions:  $\text{CH}_4 : \text{CO}_2 : \text{O}_2 : \text{H}_2\text{O} = 2 : 2 : 1 : 0.5$ ,  $T_r = 850^\circ \text{C}$  and  $W = 1000 \text{ h}^{-1}$ . As can be seen from the figure, the promotion of nickel catalyst with cerium, lanthanum or molybdenum oxides results in an increase in the activity and selectivity of nickel catalyst. The highest activity and selectivity of the nickel catalyst is observed when oxides of cerium and molybdenum are promoted. On the promoted 3% NiO-1%  $\text{MoO}_3 / \text{Al}_2\text{O}_3$  catalyst, the selectivity for hydrogen was 66%, for carbon monoxide 47%. At the same time, the concentration of  $\text{H}_2$  reaches 52 vol. %, CO up to 33.9 vol. % and methane conversion 95%. For a catalyst of 3% NiO-1%  $\text{CeO}_2 / \text{Al}_2\text{O}_3$ , the selectivity for hydrogen is 50% and for carbon monoxide 60%. In this case, the concentration of  $\text{H}_2$  obtained reaches 41 vol.%, CO up to 42.8 vol.% and methane conversion 98%. Thus, the activity and selectivity of oxide-supported nickel-containing catalysts promoted by  $\text{MoO}_3$ ,  $\text{CeO}_2$  and  $\text{La}_2\text{O}_3$  oxides during methane reforming into synthesis gas was tested. It is determined that the promotion of nickel catalyst with cerium or molybdenum oxides leads to an increase in the selectivity and activity of the catalysts for the desired products.

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