Brief information about the project

Name of the project	AP19678248 «Development of Fundamental Aspects of Development of Composite Carbon Dioxide Sorbents and Modified Catalysts for Its Utilization by Bioethanol into Syngas»
Relevance	This project is aimed at the development of regenerable sorbents and catalysts for capturing greenhouse gas (CO_2) and its utilization into synthesis gas. Synthesis gas is a source of clean energy fuel - hydrogen, as well as a valuable semi-product of petrochemistry. The production of synthesis gas by carbon dioxide conversion of bioethanol simultaneously solves two urgent problems - the utilization of greenhouse gas and the production of environmentally friendly energy sources.Lithium-containing (Li_4SiO_4) compounds are the most effective sorbents for capturing CO_2 in the high temperature range of 450°C <. Lithium-based compounds are more expensive than others; in addition, the synthesis of Li_4SiO_4 requires a higher temperature (900°C) and a long calcination time (4 hours), which leads to an increase in energy consumption and the cost of preparation. The theoretical ability of Na_4SiO_4 to absorb CO_2 is not inferior to the ability of Li_4SiO_4. However, the main problem is the deactivation of Na_4SiO_4 due to sintering as the number of sorption cycles increases. Nickel-based catalysts are widely used as a catalyst for the carbon dioxide conversion of bioethanol (CDCE) due to their high activity and lower cost compared to noble metals. However, the main disadvantage of Ni-based catalysts is their rapid deactivation due to coke deposition. The copper-based catalyst is similar to the nickel based catalyst which requires a support to prolong activity. The CDCE process is laboratory scale, so further research is needed to develop high activity, durable and inexpensive copper-based catalysts to commercialize this process.
Purpose	Develop new, inexpensive, scientifically based CO_2 sorbents and effective catalysts for the carbon dioxide conversion of ethanol, their use in sorption-catalytic process of capturing CO_2 and producing synthesis gas by interacting carbon dioxide with bioethanol. Physicochemical characteristics of sorbents and catalysts on sorption and catalytic activity in processes under study.
Objectives	To achieve the goal, it is necessary to increase the stability of the sodium-based sorbent to high temperatures and increase the sorption capacity, the rate of CO_2 sorption, as well as increase the activity and stability of copper-containing catalysts in the CDCE reaction. Experimental approaches to the synthesis of new, inexpensive, stable CO_2 sorbents, proposed by us, are original, since the sorbents will be prepared by methods that allow controlling the porosity and mechanical properties of the

	sample in a wide range. The sorption properties of sorbents will be studied in a dynamic mode with periodic regeneration, and the dependence of the value of the sorption capacity of composites on the process parameters will be established. All synthesized composite sorbents will be studied by a complex of physicochemical methods before and after sorption experiments with their participation. On the basis of the results obtained, the optimization of the method of purposeful synthesis of massive and applied CO_2 sorbents will be carried out, and the scientific foundations for the synthesis of regenerated CO_2 sorbents in an efficient way will be developed. The most effective composite sorbents will be tested in a cyclic sorption-catalytic process, consisting of the following stages: 1) CO_2 capture using synthesized sorbents; 2) in the presence of a catalyst, the interaction of desorbed CO_2 with ethanol to obtain synthesis gas.
Expected and achieved results	During the implementation of this project, the following main results will be obtained: new, inexpensive sorbents based on sodium oxide have been synthesized, an effective method for the synthesis of the sorbent has been chosen, which makes it possible to control its porosity and mechanical properties in a wide range, the main patterns of structure formation and morphology of CO_2 sorbents have been established depending on the nature of the carrier and synthesis conditions. The kinetics of isothermal sorption of carbon dioxide from a model mixture will be studied, the process of thermal desorption of CO_2 will be studied to determine the temperature of regeneration of composite sorbents. Copper catalysts will be synthesized for CDCE, and the effect of the nature of the substrate, modifying additives, synthesis methods, and technological regimes of the process on the activity of the catalyst will be established. Under laboratory conditions, a cyclic sorption-catalytic process will be implemented, which will allow capturing CO_2 from a model mixture using the developed sorbents and converting it into synthesis gas with the participation of a catalyst. The developed fundamental principles for the synthesis of effective sorbents and catalysts for the conversion of CO_2 and renewable bioethanol into synthesis gas form the scientific basis for choosing effective new processes for producing synthesis gas with an optimal $CO:H_2$ ratio for obtaining petrochemical products from it. **Results** A scientifically based synthesis of a new composition of composite sorbents based on alkali metals (Na and Mg) and their testing in the process of CO_2 sorption at the same technological regime is proposed. Determined influence of nature of carriers and alkali metal content on sorption properties of composite sorbents (3A, 5A, Al_2O_3, SiO_2,

	HZSM-5, AC). The most effective substrates such as 5A, HZSM-5, AC were selected for the preparation of composites based on alkali metals. Synthesized composite sorbents 10 wt.% Na_2O/5A, 10 wt.% MgO/HZSM-5, 10 wt.% MgO/5A, 10 wt.% MgO/AC by capillary impregnation method. The optimal technological mode of carrying out the process of sorption and desorption of CO_2 on the composite at the optimal temperature of adsorption of 500°C and desorption of 750°C for 30 minutes has been established. The composite with 10 wt.% Na2O applied to the substrate 5A prepared by the capillary impregnation method showed the highest sorption capacity (25.4%) for CO_2.
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List of publications with links to them	
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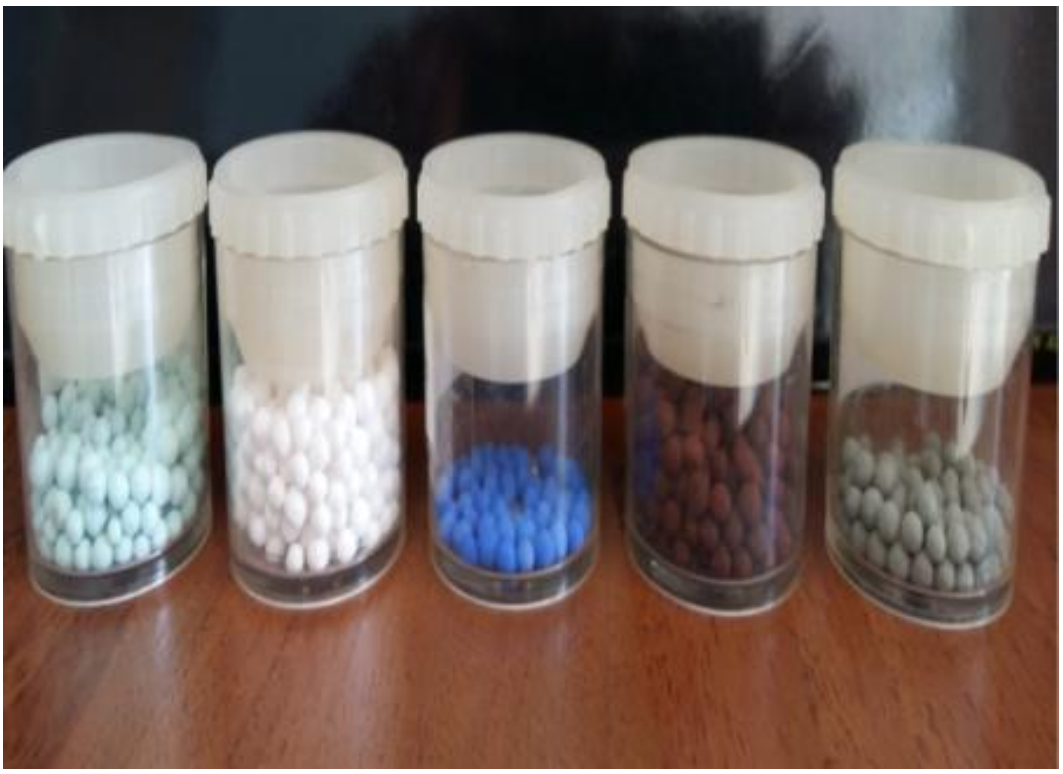

Synthesized samples of catalytic sorbents

Project director, PhD Anisova M.M. - The process of synthesizing composite sorbents

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Conducts testing of synthesized samples in the process of CO2 adsorption/desorption