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PRODUCTION TECHNOLOGY OF METHANOGELS FOR PRESSURE REGULATION

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Abstract: The use of high-pressure gases in modern industrial, transport and energy systems is developing on a large scale. In particular, the processes of transporting, storing and delivering compressed gases to consumers using gas cylinders are an integral part of industrial technologies. Effective and safe control of gas pressure in these systems, its reduction to the required level is one of the important problems. It is in such conditions that the use of special substances - methanegels, which are chemically active, structurally stable and highly efficient, is of great scientific and practical importance. In recent years, methanegel materials have been gaining great attention in science and industry. Their unique properties make them important materials for solving highly efficient bioengineering, medicine, energy and environmental problems. This article discusses modern research on methanegels, new stages of the production of methanegel materials and their practical significance.

Keywords: Methanegel, bioengineering, ecology, energy, industry, structure, pressure, chemical stability, thermodynamics, thermal stability, porosity.

Introduction: High-pressure gases contained in gas cylinders can pose a negative threat to human health, the environment and technological devices. To reduce these risks and keep the system under control, pressure-reducing agents, in particular, methanegels based on chemicals, are used. Methanegels are distinguished by their molecular structure, physicochemical stability and thermodynamic properties. They allow for a slow and controlled reduction of pressure in a high-pressure gas environment. Due to such functional capabilities, methanegels have become the central topic of scientific research in recent years.

An important scientific task is to synthesize methanegels in laboratory conditions, study their structural properties and determine the possibilities of practical application. By studying their structure, assessing their thermal stability, and understanding the mechanism of pressure reduction, it will be possible to develop not only theoretical but also practical approaches. The use of methanegels will serve to improve pressure regulators, create a new generation of safe cylinder systems, and increase the reliability of technological processes.

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Synthesis of methanogels in laboratory conditions, study of their structural properties and identification of the possibilities of practical application are important scientific tasks. By studying their structure, assessing thermal stability and understanding the mechanism of pressure reduction, it will be possible to develop not only theoretical but also practical approaches. The use of methanogels will serve to improve pressure regulators, create a new generation of safe cylinder systems, and increase the reliability of technological processes.

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The relevance of this study is that research in this area in Uzbekistan is insufficient. Also, existing pressure-reducing technologies are based more on mechanical regulators, which cannot fully meet modern technological requirements. Chemical-based approaches, in particular the use of methane gels, provide more accurate, reliable and stable pressure control.

The purpose of the research: To obtain methanegels used to reduce pressure in gas cylinders, to study their physicochemical properties and to evaluate them practically.

The objectives of the research are: To study the general problems of reducing pressure in gas cylinder systems, to determine the chemical structure and synthesis methods of methanegels, to obtain methanegels in laboratory conditions and to analyze their properties, to scientifically substantiate the mechanism of reducing pressure based on the obtained methanegels, to evaluate the practical possibilities of technological solutions developed based on methanegels.

Object of research: Compressed gas system in gas cylinders and pressure-reducing methanegels used in it.

Subject of research: Physicochemical properties of methanegels, synthesis conditions and their effectiveness in reducing pressure.

Research methods: The research uses experimental chemistry, physicochemical analysis, theoretical calculations and practical tests.

Scientific novelty: A new innovative method for obtaining pressure-reducing methanegels is proposed. Their properties are analyzed in depth. New theoretical and experimental results that can be used in practical technologies are obtained.

Practical significance of the research: Based on the results obtained, it is possible to develop safe, effective and environmentally friendly pressure control systems for gas cylinders. The use of methane gels in real industrial conditions will help increase the reliability of technological processes.

Research methodology: Methanogels are a class of special sorbent materials created on a silicon-organic basis with high porosity, capable of absorbing methane using physicochemical methods. They are usually synthesized using sol-gel technology based on silicon oxide. This technology is based on the conversion of silicon-organic precursors into a gel structure through hydrolysis and condensation reactions. The resulting gel structure forms pores at the nano and micro levels, which makes it capable of effectively absorbing and retaining methane molecules.

Methanegels are special sorbent materials synthesized on the basis of silicon-organic compounds, capable of absorbing methane and re-emitting it under controlled conditions. They are one of the innovative and environmentally friendly methods of gas storage. These materials are in the form of nano- and microstructured gels with high porosity, large internal surface area and the ability to effectively retain methane molecules. They are obtained as a result of hydrolysis and condensation of silicon-based compounds. In this process, silicon-oxide bonds are formed, creating a three-dimensional gel network.

Modern technologies suggest the use of high-quality, corrosion-resistant steel, aluminum alloys, titanium-containing compositions, and sometimes high-temperature ceramic-based materials in the production of methanegels. In addition, it is possible to continuously monitor the pressure level through automated monitoring systems. These technological approaches ensure the reliability, long service life and safety of methanegels.

Physicochemical properties: Methanegels are special sorbent materials synthesized on the basis of organic silicon compounds, capable of absorbing methane and releasing it under controlled conditions. They are one of the innovative and environmentally friendly methods of gas storage. These materials are in the form of nano- and microstructured gels with high porosity, large internal surface area and the ability to effectively retain methane molecules. They are obtained as a result of hydrolysis and condensation of silicon-based compounds. In this process, silicon-oxide

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bonds are formed, creating a three-dimensional gel network. In terms of physical properties of methanegels, it is first of all worth paying attention to their high internal surface area. This parameter can be in the range of 500–1500 m²/g, which allows methane molecules to adsorb on the surface. The porosity of the gel forms a structure at the micro and meso levels: micropores (<2 nm), mesoporous (2–50 nm) and macropores (>50 nm). It is the micropores that play the most important role in the absorption of methane molecules. Also, the physical strength of methanegels determines the degree of their practical application. They must be relatively stable to compression, shock and temperature, and be resistant to deformation under external pressure. As for their chemical properties, methanegels interact with methane molecules based on physical adsorption. This process occurs through van der Waals forces, that is, methane molecules bind to active centers on the surface of the methanegel. In organic-silicon-based materials, these active centers are formed by -OH groups or partially hydrophobic moieties (for example, $-CH_3$). Therefore, during the synthesis of methanogels, their chemical functionality, i.e. the nature of the groups on their surface, directly affects the adsorption capacity.
Methanegels are usually prepared in the form of aerogels or xerogels. Aerogels have high porosity and high adsorption capacity. In this case, the gel drying process is carried out under supercritical conditions, which ensures the preservation of the gel structure. Xerogels, on the other hand, are dried under natural conditions or at low temperatures, which sometimes reduces porosity, but is cheaper and more convenient from a production point of view.

Methanegels are also thermally stable materials. Their decomposition temperature is usually in the range of 300–600°C. This allows them to be used as a methane gas retention agent in high-temperature environments, for example, in automobiles, industrial processes, and heat sources. In addition, the regeneration property of methanogels is also important. That is, after they absorb methane, they can re-release it when the pressure or temperature changes without damaging their structure.

One of the most important physicochemical parameters of methanegels is their sorption isotherm. The sorption isotherm shows how much gas the gel absorbs when the gas pressure changes. This parameter is described using Langmuir or BET models. The adsorption capacity depends not only on the structure of the gel, but also on factors such as the choice of silicon compound, the conditions of the sol-gel process, the components in the liquid phase, and the drying method.

Practical significance and areas of application: Based on modern scientific achievements, methanegels are widely used in the following areas. In particular, they are used in pharmaceuticals, ecology, industry and energy, chemistry and manufacturing. In the field of ecology, they are used as filters that absorb pollutants in water purification systems. In the industry and energy sector, we use methanegels in the production of supercapacitors, batteries and ion-exchange membranes. Environmental protection - used in polluted water purification, waste disposal and filtration systems.

CONCLUSION

Safe and effective regulation of high-pressure gases in gas cylinders is one of the main directions of modern technology. The introductory section indicated the relevance of this issue, the object and subject of the study, as well as the goal of scientifically substantiating the capabilities of methanegels in reducing pressure. At the same time, the methodology, research methods and practical significance of the scientific work were determined.

Methanegels are one of the advanced materials that are causing revolutionary changes in various fields of science. Due to their biological compatibility, chemical stability and physical properties, major changes can be expected in the pharmaceutical, environmental, medical and

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energy sectors in the future. Therefore, scientific research on these materials is becoming more and more intensive. Methanegel materials play an important role in the development of modern science. Due to their unique physicochemical properties, their widespread use in various fields is an impetus for further development of research on these materials in the future. Thus, methanegels are of great importance in solving new technologies and environmental problems. Methanegels are of great importance for scientific research. They are creating new opportunities in the fields of nanomaterials, biomimetic materials, and advanced medical technologies. At the same time, the creation of artificial tissues and biocompatible materials based on methanegels is of great importance.

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