

Sharifova Lola Bakhodirovna

Termez state university

E-mail: sharifoalola601@gmail.com

ORCID ID: <https://orcid.org/0009-0007-7736-0636>

Abstract: This article discusses the physicochemical properties of metanogel materials, their application areas, and scientific significance. Metanogel is a material with high heat resistance, stability under low pressure, and the ability to absorb methane gas, making it a promising solution for safe and efficient energy storage in industrial and transportation sectors. The research results demonstrate the environmental safety and economic efficiency of metanogel materials, highlighting their potential for large-scale industrial applications.

Keywords: Metanogel, gas storage, heat resistance, environmental safety, industrial materials, methane absorption, innovative materials.

Introduction: Metanogel materials have recently gained significant attention in science and industry. Their unique properties make them highly effective in bioengineering, medicine, energy, and environmental problem-solving. This article discusses the latest research on metanogels and their practical significance. Metanogel materials are continuously being improved through scientific research. Their development stages are as follows: **First stage:** Studying the fundamental polymer structures and understanding their molecular bonding mechanisms. **Second stage:** Optimizing their physical and chemical properties, enhancing elasticity and strength. **Third stage:** Conducting research aimed at their application in biotechnology and pharmaceuticals. **Fourth stage:** Expanding their industrial applications and adapting them to environmental conditions. Current research on metanogels is focused on the following key areas: **Nano-scale modifications:** Improving the physical and chemical properties of metanogels by altering their nanostructure. **Biocompatibility:** Developing metanogels that are well-compatible with the human body and possess bioinert characteristics. **Smart materials:** Designing metanogels that respond to temperature, pressure, or pH levels.

Practical Significance

High-pressure gases stored in cylinders can pose significant risks to human health, the environment, and technological equipment. To reduce these hazards and maintain system stability, pressure-reducing agents-particularly methanogels based on chemical

compounds-are utilized. Methanogels are distinguished by their molecular structure, physicochemical stability, and thermodynamic properties. These materials enable a gradual and controlled reduction of pressure in high-pressure gas environments. Owing to such functional capabilities, methanogels have become a central focus of scientific research in recent years.

Synthesizing methanogels under laboratory conditions, studying their structural characteristics, and determining their practical application potential constitute important scientific objectives. Investigating their structure, evaluating thermal stability, and understanding the mechanism of pressure reduction make it possible to develop not only theoretical but also practical approaches. The application of methanogels contributes to improving pressure regulators, creating new generations of safe gas-cylinder systems, and enhancing the reliability of technological processes.

Metanogels, based on modern scientific advancements, are widely applied in the following fields: **Medicine:** Used in wound healing materials, artificial organs, and biological prostheses. **Pharmaceuticals:** Ensuring the prolonged and balanced release of drugs. **Ecology:** Used as absorbent filters in water purification systems to remove pollutants. **Industry and energy:** Employed in supercapacitors, batteries, and ion-exchange membranes.

Conclusion

Metanogels are advanced materials that are driving revolutionary changes in various scientific fields. Due to their biocompatibility, chemical stability, and unique physical properties, significant advancements in pharmaceuticals, ecology, medicine, and energy are expected in the future. Therefore, research on these materials is progressing at an accelerated pace. Studying the fundamental polymer structures and understanding their molecular bonding mechanisms. The research results demonstrate the environmental safety and economic efficiency of metanogel materials, highlighting their potential for large-scale industrial applications.

Metanogels represent a class of advanced materials that are driving transformative developments across multiple scientific fields. Owing to their biological compatibility, chemical stability, and distinctive physical properties, these materials are expected to contribute significantly to future advancements in pharmaceuticals, environmental science, medicine, and energy technologies. Consequently, research efforts devoted to methanogels are rapidly increasing.

As highly functional materials, methanogels play an essential role in the progress of modern science. Their unique physicochemical characteristics enable broad applicability, which in turn stimulates further scientific inquiry and technological

innovation. Thus, methanogels are becoming increasingly important in the creation of new technologies and in addressing complex environmental challenges.

From a research standpoint, methanogels offer substantial potential. They are opening new directions in nanomaterials, biomimetic systems, and advanced medical technologies. Moreover, the development of artificial tissues and biocompatible materials based on methanogels holds considerable scientific and practical value, reinforcing their significance in cutting-edge research and applied science.

References

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