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## **SEARCH AND EXTRACTION OF UNDERGROUND HYDROGEN DEPOSITS: MODERN TECHNOLOGIES AND ENVIRONMENTAL ASPECTS**

Search and extraction of natural hydrogen became relevant in the context of alternative energy development. Studies of natural hydrogen as an energy source began relatively recently, but today this direction is topical. The search of hydrogen deposits and its efficient extraction can contribute to reducing dependence on fossil hydrocarbons and reducing greenhouse gas emissions. In addition, hydrogen can become an important element of the transition to renewable energy, as it is easy to store and transport. Various technologies are used to effectively detect hydrogen deposits. They include ground-penetrating radar systems, underwater vehicles and modern methods of patent analysis.

This paper is devoted to the main approaches to search and extraction of underground hydrogen, their prospects and challenges. One of the important stages of research is a patent search, which allows evaluating innovative solutions in the field of hydrogen extraction. The main resources for analysis include Google Patent Search [1], USPTO [2] and UKRNOIVI [3]. They contain detailed information on patented technologies. Analysis of key patents indicates the active development of methods for detecting industrial hydrogen deposits, including hydraulic fracturing, gas production from oil fields, and the use of underwater vehicles.

Among modern approaches to detecting underground hydrogen deposits, georadar technologies play an important role. Use of gradiometric georadars allows non-invasive mapping of deposits. It significantly improves the accuracy of research. In addition, remote seismic surveys using underwater vehicles open up new opportunities for searching for hydrogen in deep-sea areas.

Fuel reforming technologies are promising regarding innovative solutions in the field of hydrogen production. Laser systems are used to determine the depth of deposits. Such approaches contribute to increasing efficiency of production and reducing the environmental load.

Exploration and production of underground hydrogen have number of challenges despite the great potential. Geology of hydrogen deposits requires further research for more accurate prediction of deposits and effective planning of production. It is necessary to develop effective production methods that will be competitive in the energy market. An important component is calculation of the costs for exploration, well construction and transportation of hydrogen.

Also, the development of new deposits should be accompanied by an assessment of the impact on the environment and minimizing negative consequences. For example, possible hydrogen leaks can affect gases balance of in the atmosphere. The development of production requires an appropriate legal basis and international cooperation. States should coordinate regulatory acts regulating environmental standards and rights to use subsoil.

The search and production of underground hydrogen is a promising direction for the energy industry development. Modern technologies use (like georadar systems), underwater vehicles and patent analysis allows significant increase of research and production efficiency. Innovative approaches in this area open up opportunities for expanding sources of hydrogen and its widespread use in the future. Underground hydrogen could be an important part of the future energy system, offering a clean and efficient source of energy. However, its large-scale extraction requires further research, technical improvements and appropriate legislative framework.

The combination of modern detection methods, the latest extraction technologies and government support will make hydrogen energy more accessible and efficient on a global scale, contributing to sustainable energy development and reducing greenhouse gas emissions.

### **List of references**

1. Patent base Google Patent. <https://patents.google.com/> Date of access 10.03.2025.
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