



APPLICATION OF CHEMICAL PROCESSES AND ELECTROCHEMICAL TECHNOLOGIES IN ELECTRIC POWER ENGINEERING

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Abstract. Chemical processes and electrochemical technologies play an important role in the development, operation, and maintenance of modern electric power systems. These technologies are widely used in energy storage, battery production, hydrogen generation, corrosion prevention, water treatment, and the improvement of electrical equipment efficiency. Electrochemical systems make it possible to convert chemical energy into electrical energy and support the integration of renewable energy sources into power networks. In addition, chemical methods help maintain the reliability of power plants and extend the service life of electrical equipment. This article examines the main applications of chemical processes and electrochemical technologies in electric power engineering, focusing on their technical significance, environmental benefits, and potential for future development.

Keywords: electric power engineering, chemical processes, electrochemical technologies, energy storage, batteries, hydrogen production, corrosion protection, renewable energy.



Chemical processes and electrochemical technologies play an important role in the development of modern electric power engineering. The increasing demand for electricity, the expansion of renewable energy sources, and the need to improve energy efficiency have encouraged the application of innovative chemical and electrochemical methods. These technologies are used in electricity generation, energy storage, equipment maintenance, corrosion prevention, and environmental protection. Their effective implementation contributes to improving the reliability of power systems and reducing the environmental impact of energy production.

Chemical processes are widely used in thermal power plants, where coal, natural gas, and other fuels undergo combustion to produce the heat required for electricity generation. The efficiency of this process depends on fuel composition, combustion temperature, and the control of chemical reactions. Appropriate combustion management can reduce fuel consumption and limit harmful emissions. Chemical technologies are also essential for water treatment in power plants. Water used in boilers and steam systems must be purified to remove dissolved salts, oxygen, and other impurities that may cause corrosion or scale formation. Chemical treatment methods help protect equipment, improve heat transfer, and extend the service life of industrial installations.

Another important application of chemical processes is corrosion prevention. Metal components in power plants, pipelines, transformers, and other electrical installations may deteriorate because of moisture, oxygen, temperature changes, and aggressive chemical substances. Protective coatings, corrosion inhibitors, and appropriate chemical treatment methods help reduce material degradation. These measures improve operational safety, decrease maintenance expenses, and prevent unexpected equipment failures. Chemical technologies are also used in wastewater treatment and emission control, supporting environmental protection and the sustainable operation of power facilities [1].

Electrochemical technologies are particularly important because they enable the direct conversion of chemical energy into electrical energy and the storage of



electricity in chemical form. One of their most widespread applications is battery technology. Batteries store energy through reversible electrochemical reactions and release it when electricity is required. Lithium-ion batteries are commonly used in electric vehicles, portable devices, and stationary energy storage systems. In electric power networks, they help balance fluctuations in electricity supply and demand, improve grid stability, and facilitate the integration of solar and wind energy. Other technologies, including lead-acid, sodium-ion, and flow batteries, also offer potential solutions for different energy storage requirements.

Fuel cells represent another significant application of electrochemical technology. They generate electricity through electrochemical reactions between a fuel, such as hydrogen, and an oxidising agent, usually oxygen. Unlike conventional combustion systems, fuel cells convert chemical energy directly into electrical energy. When hydrogen is used as the fuel, water is the principal direct reaction product. Fuel cells can be applied in distributed electricity generation, backup power systems, and specialised industrial facilities. Their efficiency and environmental performance depend on the fuel source, system design, and operating conditions.

Hydrogen production through electrolysis is also gaining importance in modern energy systems. Electrolysis uses electrical energy to separate water into hydrogen and oxygen. When the electricity comes from renewable sources, the hydrogen produced can provide a means of storing surplus energy for future use. It can subsequently be used in fuel cells, industrial processes, or suitable power-generation systems. However, the overall efficiency of hydrogen production, storage, transportation, and conversion remains an important technical and economic consideration.

Electrochemical methods are also used to protect metal structures from corrosion. Cathodic protection reduces the corrosion rate by controlling the electrochemical potential of the protected material. This method is particularly valuable for pipelines, underground tanks, and selected structures associated with energy infrastructure. By reducing corrosion damage, electrochemical protection



improves equipment durability, decreases repair costs, and supports the reliable operation of energy systems.

Future developments in electric power engineering will increasingly depend on improvements in chemical materials, electrochemical systems, and digital monitoring technologies. Advanced battery materials may increase energy density, improve safety, and extend service life. More efficient electrolyzers and catalysts may reduce the cost of hydrogen production. Meanwhile, sensors, automated control systems, and predictive maintenance technologies can help monitor equipment conditions, detect corrosion, and optimise operating processes. These innovations can improve energy efficiency and reduce unplanned interruptions [3].

In conclusion, chemical processes and electrochemical technologies are essential to the development of modern electric power engineering. Chemical methods contribute to efficient fuel utilisation, water purification, corrosion prevention, and environmental protection, while electrochemical technologies support electricity storage, fuel-cell operation, hydrogen production, and infrastructure protection. Although economic, technical, and environmental challenges remain, continued scientific research and technological innovation can improve the efficiency and sustainability of these applications.

REFERENCES

1. Liu C. P., Pagliaro M., Semenova A., et al. Rethinking alkaline water electrolysis under industrial conditions // *Nature Reviews Electrical Engineering*. — 2026. — Vol. 3. — P. 510–522.
2. Hurtado L., Leonide A., Ulmer U. Efficiency, Cost and Sustainability: Electrocatalysts for State-of-the-Art and Emerging Electrolysis Technologies // *Sustainability*. — 2026. — Vol. 18, No. 6. — Article 2866.
3. Alshammari et al. A Comprehensive Review of Fuel Cell Technologies for Renewable Power Systems: Fundamentals, Materials, System Integration, Techno-Economics, Standardisation, and Middle Eastern Stationary Deployment // *IET Renewable Power Generation*. — 2026. — Vol. 20, No. 1. — Article e70380.