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eoconf.com - from 2024

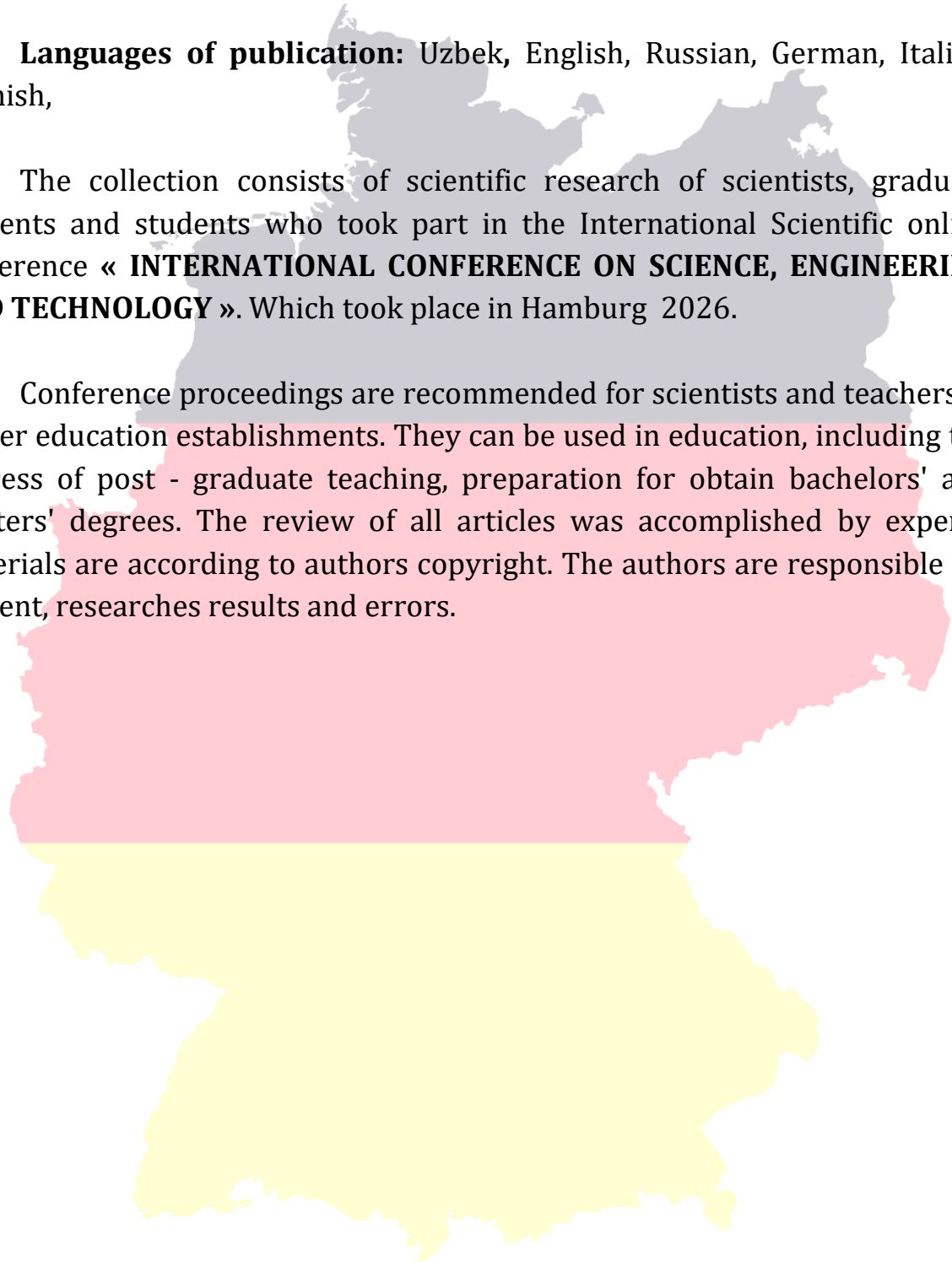


INTERNATIONAL CONFERENCE ON SCIENCE, ENGINEERING AND TECHNOLOGY:
a collection scientific works of the International scientific conference –
Hamburg, Germany, 2026 Issue 6

Languages of publication: Uzbek, English, Russian, German, Italian,
Spanish,

The collection consists of scientific research of scientists, graduate students and students who took part in the International Scientific online conference « **INTERNATIONAL CONFERENCE ON SCIENCE, ENGINEERING AND TECHNOLOGY** ». Which took place in Hamburg 2026.

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The Role of Green Chemistry in Sustainable Development

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Abstract. This article discusses the role of green chemistry in sustainable development. Green chemistry is an important scientific approach that focuses on designing chemical products and processes that reduce or eliminate hazardous substances. The study shows that green chemistry helps minimize environmental pollution, reduce waste, save energy, and support the use of renewable resources. It also contributes to human health, industrial safety, and economic efficiency. The article analyzes the main principles and applications of green chemistry in different fields, including industry, agriculture, medicine, water treatment, and energy technologies. The results indicate that green chemistry is closely connected with sustainable development because it promotes environmental protection, economic growth, and social well-being. Therefore, green chemistry can be considered an essential strategy for creating a cleaner, safer, and more sustainable future.

Keywords: green chemistry, sustainable development, environmental protection, pollution prevention, renewable resources, chemical processes, waste reduction, energy efficiency.

Green chemistry plays an important role in achieving sustainable development by reducing the harmful effects of chemical processes on human health and the environment. In recent years, the rapid growth of industry, agriculture, and technology has increased the use of chemicals, which has led to environmental pollution, waste generation, and the depletion of natural resources. Green chemistry offers safer and more environmentally friendly methods by designing chemical products and processes that minimize hazardous substances, save energy, and use renewable resources. Therefore, the principles of green chemistry are closely connected with sustainable development, as they support ecological balance, economic efficiency, and social well-being. This article discusses the role of green chemistry in sustainable development and highlights its importance in creating a cleaner and safer future.

Green chemistry has been widely discussed by researchers as an important scientific approach for reducing environmental problems and supporting sustainable development. According to Anastas and Warner, green chemistry is based on the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Many studies emphasize that traditional chemical industries often cause air, water, and soil pollution because they use toxic materials and produce large amounts of waste. In contrast, green chemistry promotes the use of renewable raw materials, safer solvents, energy-efficient reactions, and biodegradable products. Researchers also highlight that green chemistry is closely connected with the principles of sustainability because it helps protect natural resources, reduce environmental risks, and improve human health. Recent literature shows that green chemistry is applied in many fields, including pharmaceuticals, agriculture, polymer production, water treatment, and renewable energy technologies. Therefore, previous studies confirm that green chemistry is not only an environmental concept but also a practical strategy for developing cleaner technologies and achieving long-term sustainable development.



This study uses a qualitative research method to analyze the role of green chemistry in sustainable development. The research is based on the review and analysis of scientific articles, books, reports, and online academic sources related to green chemistry, environmental protection, and sustainability. The collected materials were examined to identify the main principles, applications, and benefits of green chemistry in different fields, such as industry, agriculture, medicine, energy, and waste management. A descriptive approach was used to explain how green chemistry helps reduce pollution, minimize hazardous substances, save energy, and support the use of renewable resources. The study also compares traditional chemical processes with green chemistry approaches in order to show their environmental and economic differences. Through this methodology, the research aims to provide a clear understanding of how green chemistry contributes to sustainable development and why it is important for modern science and society.

The results of this study show that green chemistry has a significant role in supporting sustainable development by reducing environmental pollution, improving resource efficiency, and promoting safer chemical practices. The analysis of the reviewed sources indicates that green chemistry principles can be applied in many areas, including industrial production, agriculture, medicine, water treatment, and energy technologies. One of the main findings is that green chemistry helps reduce the use of toxic substances and the generation of hazardous waste. This is especially important because traditional chemical processes often create harmful by-products that negatively affect air, water, soil, and human health.

The discussion also shows that green chemistry contributes to sustainable development through energy-saving methods and the use of renewable raw materials. For example, environmentally friendly solvents, biodegradable polymers, and catalytic processes can make chemical production cleaner and more efficient. Compared with traditional chemistry, green chemistry focuses not only on producing useful products but also on preventing pollution before it occurs. This preventive approach is more effective than cleaning pollution after it has already been created.

Furthermore, green chemistry has economic and social benefits. By reducing waste, saving energy, and using safer materials, industries can lower production costs and improve workplace safety. At the same time, society benefits from cleaner technologies, healthier living conditions, and better protection of natural resources. Therefore, the results suggest that green chemistry is an essential scientific and practical strategy for achieving sustainable development. It connects environmental protection, economic growth, and human well-being, which are the main goals of sustainability.

In conclusion, green chemistry plays a vital role in sustainable development by promoting safer, cleaner, and more efficient chemical processes. It helps reduce environmental pollution, minimize the use of hazardous substances, save energy, and support the use of renewable resources. The study shows that green chemistry is important not only for protecting nature but also for improving human health, industrial safety, and economic efficiency. By applying the principles of green chemistry in industry, agriculture, medicine, and energy technologies, society can move toward a more sustainable and environmentally friendly future. Therefore, green chemistry should be



considered an essential approach for solving modern environmental problems and achieving long-term sustainable development.

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