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## **SUSTAINABLE CHEMICAL TECHNOLOGIES AND THEIR ECONOMIC IMPACT ON MODERN INDUSTRY**

Currently chemical industry is developing very quickly. However, it faces two important challenges: reducing environmental pollution and maintaining economic efficiency. Sustainable chemical technologies help solve both problems. They combine modern scientific approaches with economic benefits and they are becoming an important part of chemical engineering.

One of the key ideas of sustainable technologies is green chemistry. Green chemistry, which was established about two decades ago, has attracted much attention. It reflects the efforts of academia and industry to address the challenges related to sustainable development of the chemical industry, and continuous progress is being made, both in academia and industry. Briefly, green chemistry is the utilization of a set of principles to reduce or eliminate the use or generation of hazardous substances in the design, manufacture and applications of chemical products. Green chemistry is a multidisciplinary field and covers areas such as synthesis, solvents, catalysis, raw materials, products and efficient processes. For example, modern chemical reactors are designed to improve reaction efficiency and reduce by-products. This not only protects the environment, but also lowers production costs (Adam et al, 2020: 472).

Another important concept is process optimization. In chemical engineering this means improving conditions such as temperature, pressure, and reaction time to achieve maximum yield. Higher reaction yield means more useful product and less waste. As a result, companies spend less money on raw materials and waste treatment.

Energy consumption is a major factor in chemical production. Many processes require high temperatures and large amounts of energy. Using catalysis helps speed up reactions and reduce energy consumption. In addition, technologies such as heat exchange systems and energy recovery allow industries to reuse heat, which improves overall energy efficiency.

Sustainable technologies plays a role not only in protecting the environment by preventing pollution before its creation; it is also a way of the firm to increase efficiency and reduce the costs of production, an opportunity for businesses to lighten their environmental burdens and make money. Recycling is one of the concepts in green chemistry and very fundamental in promoting a circular economy, which is a new paradigm of sustainability that is able to reduce environmental implications, and in creating new business opportunities. Instead of chemical waste disposing, companies can process it into useful materials. This reduces environmental impact and creates additional economic value.

Environmental chemistry is crucial for business and economy. It helps in finding methods and techniques to speed up the chemical reactions using small amounts of reactants to deliver the same results and the same price of the product. It also helps in reducing the number of synthetic steps that enable increased production, increase in the plant capacity while saving energy and water consumption. Using fewer chemicals for manufacturing the products results in reduced waste and that results in reduced cost for disposing of chemical waste and toxic waste treatments. The economic benefits of green chemistry are central drivers in its advancement.

From an economic point of view, sustainable technologies have several advantages. They reduce operational costs, improve product quality, and increase competitiveness. Companies that follow environmental standards are more attractive to investors and consumers. They can also avoid fines and meet international regulations.

However, implementing these technologies requires initial investments. New equipment, such as advanced reactors or separation systems, can be expensive. Despite this, in the long term, companies benefit from lower costs and higher efficiency.

Our future challenges in resource, environmental, economical, and societal sustainability demand more efficient and benign scientific technologies for working with chemical processes and products. Green chemistry addresses such challenges by inventing novel reactions that can maximize the desired products and minimize by-products, designing new synthetic schemes and apparatus that can simplify operations in chemical productions, and seeking greener solvents that are inherently environmentally and ecologically benign. Together, such fundamental innovations in chemical sciences will lead us to a new generation of chemical syntheses.

As a result, sustainable chemical technologies play a key role in modern chemical engineering. They help reduce pollution, improve efficiency and support economic growth. The combination of scientific innovation and economic thinking is essential for the future of the chemical industry.

#### REFERENCES:

1. Dini Hariyati Adam, Elvina, MilaNirmala Sari Hasibuan, Rizki Syahputra, Laili Habibah Pasaribu, Suriyani (2020) Green Chemistry: The Economic Impact Perspective. International journal of scientific and technology research. V.9 (1) p. 471 - 473. URL: [\(PDF\) Green Chemistry: The Economic Impact Perspective](#)
2. Chao-Jun Li, Barry M Trost Green chemistry for chemical synthesis. [Electronic resource] URL: Green chemistry for chemical synthesis - PMC