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Nanocatalysts: What Are the Different Types of Them in Biodiesel Production?

Behnam Hatami [1*], *Bibi Farideh Zarabi Safari* [1]

[1] *Environmental Science and Technology Research Center, Department of Environmental Health Engineering, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.*

A R T I C L E I N F O

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****Corresponding Author:***
Behnam Hatami

Email:
bhatami88@yahoo.com

Tel:
+98 3531492299

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In recent years, continuous population growth and express industrialization have led to an over-consumption of energy and a global energy crisis [1]. Fossil fuels, with harmful environmental effects and many problems for human health, are the major source of world energy over the past decade [2]. Therefore, scientists focus on developing renewable energies to solve the mentioned problems. Accordingly, biodiesel is one of the most attractive energy sources to satisfy global energy needs. It is mainly produced from a lipid fraction by catalytic esterification or transesterification reactions [3]. Selecting an appropriate lipid source and catalyst for these chemical reactions is the most influential factor associated with the commercialization of biodiesel synthesis [4].

Typically, the catalysts used for biodiesel production are classified into homogeneous and heterogeneous categories [5]. The use of homogeneous catalysts has drawbacks such as low reaction rate, non-reusability, and difficulty in product isolation. These types of catalysts also are not much applicable for commercial purposes [6]. On other hand, heterogeneous catalysts possess some disadvantages including sensitivity to water, mass transfer resistant, and loss of catalytic sites [7].

Nanocatalysts as a class of new trend catalysts have recently attained special attention in biodiesel production. They are made of nanoparticles with a cross-section of less than 100 nm and a variety of shapes and morphologies, which have the advantages of both heterogeneous and homogeneous catalysts in terms of activity, separability, and reusability. Size, geometry, surface functionality, surface composition, aggregation attitude, and the physical and chemical environments all have an impact on nanocatalysts catalytic activities. Alkaline metal oxides, supported metal oxides, nano-hydrotalcite, basic zeolites, and magnetic nano-catalysts are the five categories of nanocatalysts with different efficiency [8]. Among them, supported metal oxide nanoparticles have received much attention in biodiesel production reactions due to their catalytic properties. However, the loss of selectivity and catalytic activity at temperatures above 500 °C is one of their critical challenges. Using magnetic nanocatalysts is another promising catalyst in the effective conversion of lipids into biodiesel due to their strong magnetic characteristics. They can be recovered and used again after multiple reaction cycles, which ultimately lowers the cost of producing biodiesel. Anionic clays are a type of nano hydrotalcite that have received a lot of attention in biodiesel studies. They can be an appropriate alternative for homogeneous alkaline catalysts.

Nanocatalysts are essential for enhancing product quality and achieving optimal operating conditions in the production of biodiesel. Nanocatalysts can deliver biodiesel at ambient conditions and subsequently, the utilization of nanocatalysts becomes simpler and more advantageous.

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