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IMPLEMENTATION OF GREEN CHEMISTRY IN BIOGAS PRODUCTION INDUSTRIES

Biogas production is one of the most sustainable ways to obtain energy without significant damage to the environment. The most popular way of biogas production is utilizing organic remains of urban and agricultural activities. Production facilities may be present on a small scale such as the implementation of biogas production on a small farm with a few decades of cattle, or huge specialized farms focused on energy crops growing for energy needs and cities with millions of people that produce hundreds of tons of organic waste.

Regardless of the source and the type of biomass, everyone faces the same challenges in biogas production, such as the long decomposition time of waste, low activity of methanogenic bacteria, a high percentage of undesirable byproducts (CO_2, H_2S, N_2, NH_3), or some problems with biogas treatment [1, c. 277]. Green chemistry can help solve these problems by focusing on the most effective, waste-free and sustainable chemical processes.

Green chemistry can help enhance biogas production at each stage of the methanogenesis process. At the beginning, we deal with raw materials such as domestic, organic waste, specialized organic, waste from water treatment plants etc. We mainly deal with unshredded materials that require more time for decomposing and are less available for bacteria. When the waste particle size is shredded up to 25 µm, methane yield increases, so the particle size of the material is directly related to the difference in the total number of microbes exposed [4, c. 23]. Accessibility can be increased by chemical treatment using acidic or alkaline chemicals for instance, using potassium ferrate (K_2FeO_4) leads to increased hydrolysis and the elimination of antibiotics in activated waste sludge, or using highly corrosive substances can increase decomposition of lignin-containing materials by damaging the lignocellulosic cell walls [5, c. 45].

Another approach to implementing green technology is mixing raw materials with some additives that are able to decrease undesired byproducts and improve biogas and methane yield. A good example of implementation of this method is shown in a study by Farghalia (2019) about impacts of iron oxide and titanium dioxide nanoparticles on biogas production. This study shows that iron and titanium oxide can prevent formation of H_2S by 62% compared with control group. To reach these results fresh cattle manure was taken and mixed with concentration of Fe_2O_3 20 mg/L and TiO_2 500 mg/L. This study also shows that this method increases biogas and methane yield by 1.1 times. These additives do not negatively impact the biogas production process and enhance the anaerobic decomposition of cow manure by reducing H_2S concentration while increasing biogas and methane yield [2, c. 165].

Green chemistry techniques can be used in biogas treatment. It can be implemented in processes of removing any type of pollutant. Innovations in green chemistry allow for the removal of VOCs, which are mainly present in biogas from sewage treatment plants and landfills. Removal occurs through the use of DES compounds which are composed of syringol and levulinic acid. For instance, 1 gram of DES may adsorb approximately 420 milligrams of Chloroform ($CHCl_3$) with capacity up to 10 absorption–desorption cycles without losing effectivity [3, c. 4825].

Green chemistry plays a crucial role in improving biogas production by introducing innovative and sustainable technologies that enhance efficiency and product quality. Implementing these technologies is attractive to industries involved in chemical processes, due to the global trend in green technology, which helps enhance the process, minimize raw material consumption and waste generation. Additionally, implementing green technology can provide companies with various benefits, such as preferential lending, grants or other forms of economic support.

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