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Biomass Pyrolysis Vapor is Advanced Catalytically Transformed into Bio-Aromatics Hydrocarbon

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Description

The production of bio-aromatics from renewable biomass resources has emerged as an efficient method for addressing the energy crisis and environmental pollution. However, the conversion mechanism of bio-aromatics is relatively complex due to the complexity of biomass resources' composition and structure. As a result, its further application is limited by issues like low target product yield, poor selectivity, and deactivation of catalysts. As a result, gaining a thorough understanding of how biomass is converted into highly selective bio-aromatics is essential. Even though bio-aromatics made from biomass have made a lot of progress, there is still no comprehensive summary of the intricate process and reaction mechanism. Synergistic catalysis on aromatics selectivity, catalysts, hydrogen-rich reagents, and the most recent advancements in the development of biomass to bio-aromatics are all examined in this paper. Other topics covered include biomass-derived model compounds, biomass raw materials, and catalysts. The advantages and disadvantages of various catalysts, as well as product characteristics, were thoroughly compared, and the effects of process conditions on the yield of bio-aromatics were also discussed. Through various catalysts and hydrogen-rich reagents, the bio-aromatic mechanism and pathways were discussed in detail. An important theoretical foundation was provided for the preparation of high-value-added bio-aromatics in the field of biomass catalytic pyrolysis in the future, along with some challenges and prospects for the technology's current issues.

Basic organic chemical raw materials like light aromatic hydrocarbons like benzene, toluene, and xylene (BTX) are widely utilized in the plastics, pesticide, medicine, and fuel industries. These aromatic hydrocarbons are currently primarily produced using fossil fuels. The scarcity of raw materials is now the primary constraint on the production of fossil fuels, which will run out of reserves before they are exhausted. During the process of converting and using fossil fuels, a significant amount of SOx and NOx emissions pollute the environment. As a result, in order to produce BTX, it is urgent to expand the source of raw materials and locate suitable renewable energy raw materials. Organic carbon makes up biomass, a resource produced by plants. Biomass is currently the only renewable resource capable of preparing liquid fuel and the most extensive carbon-rich raw material source. The process of making aromatic chemicals from biomass is very important. In addition to conserving a limited supply of fossil fuels, it can effectively promote the sustainable growth of the national economy and reduce environmental pollution. Biomass has emerged as the most important sustainable alternative to petroleum fuel because of its abundant raw materials, low cost, quick pyrolysis process, ease of continuous production, ease of storage and transportation, high energy density, and low cost. However, the immiscibility of bio-oil with conventional liquid fuels, its high oxygen content (35 to 45 percent), high water content (15 to 30 percent), high viscosity, strong acidity, and strong instability limit its application. Biomass energy research is also centered on upgrading bio-oil because it is the key to improving the quality of oil and replacing oil.

Biomass catalytic fast pyrolysis technology has been the subject of extensive research due to its excellent results and relatively straightforward operating conditions, making it one of the options available to address the issue of bio-oil's high oxygen content and improve its quality and stability. The catalyst is the most important one for catalytic conversion. One of the most important aspects of biomass catalytic fast pyrolysis is choosing the right catalyst based on what you know about the characteristics of the catalyst. By altering the secondary reaction path of volatile pyrolysis, the appropriate catalyst can improve the output of ideal products, remove oxygen from bio-oil using H^2O, CO, or CO^2, and improve the quality of bio-oil by selectively enhancing a specific reaction. Due to its high biological aromatics selectivity, balanced acid center, small appropriate pore size, and high specific surface area, the HZSM-5-based catalyst is widely used in the conversion of biomass to bio-aromatics. In addition, the pore size, total number of acidic sites, MAHs yield, and coke deposition were all improved through the incorporation of modified metal elements and dual-stage catalysis. As a result, metal-modified HZSM-5 zeolite offers a promising synthetic method for transforming oxygenated compounds into MAHs compounds in pyrolysis steam.

Free radical reactions like homolysis and heterolysis will take place during the rapid pyrolysis of biomass, resulting in unstable free radical intermediates. After that, a variety of competitive reactions will occur to these fragment free radicals. In the pyrolysis system, unstable free radical intermediates can combine with hydrogen donors to form more stable products when hydrogen donors, such as hydrogen free radicals, are present. In the absence of a hydrogen donor in the pyrolysis system, these intermediates are susceptible to coupling, rearrangement, polymerization, and other reactions that result in the formation of oligomers and coke, both of which can decrease the yield of bio-oil or specific target products. Biomass contains little hydrogen and a lot of oxygen. Polycondensation and coking are easy ways to make unstable primary pyrolysis products, which makes it harder to convert into volatile products. The oxygen enrichment and hydrogen deficiency issues are effectively resolved by including a hydrogen supply reagent. Under the synergistic action of the catalyst, hydrogen donor can provide a sufficient source of hydrogen for the biomass pyrolysis reaction system, stabilize unstable radical fragments, enhance the selectivity of target products, and address the bottleneck problem of serious coking as well as the low yield and quality of pyrolysis oil. Because its main component is hydrogen-rich polymerization, cheap plastic waste is currently a better hydrogen source for biomass pyrolysis. Co-pyrolysis of biomass and plastics not only has the potential to significantly enhance the structure and quality of biomass pyrolysis liquid products, but it also has the potential to reduce solid wastes like biomass and plastics, maximize their energy use, and convert them into "resource substitution."

Despite the fact that numerous excellent research studies on biomass catalysis were discussed. Bio-aromatic's reaction mechanism and production distribution, on the other hand, were unclear and inadequate. The current review places a greater emphasis on the catalytic transformation of biomass into bio-aromatics with added value. Biomass raw materials and biomass-

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derived model materials, catalysts (metal oxides, metal salt catalysts, microporous catalysts, mesoporous catalysts, carbon-based catalysts, dolomite, monolithic catalysts, etc.), and the state-of-the-art in bio-aromatics production are all examined. waste plastics, hydrogen supply alcohols, waste oils and fats, waste rubber, tetralin, methane, food waste, lignite, scum, and other hydrogen-rich reagents and the conditions of the process on the amount of bio-aromatics that are produced, to explain how zeolite and the hydrogen-rich reagent in lignocellulosic biomass play a crucial role in revealing the reaction mechanism and production distribution in order to provide a crucial theoretical foundation for the subsequent production of biological aromatics with a high value added in the field of biomass catalytic pyrolysis [1-5].

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Conflict of Interest

None.

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