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(57) Abstract :

Abstract The present invention relates to a catalyst system and associated process for the efficient conversion of biomass into biofuels and value-added chemicals. The invention addresses limitations of conventional biomass conversion technologies by providing an advanced catalytic approach that enhances conversion efficiency, selectivity, and catalyst durability while reducing energy consumption and process complexity. The catalyst system is designed to process a wide range of renewable biomass feedstocks, including lignocellulosic materials, agricultural residues, forestry waste, and algal biomass, thereby enabling flexible and sustainable utilization of renewable carbon resources. The catalyst system comprises one or more catalytically active components supported on a stable carrier material and is configured to promote multiple chemical transformations such as depolymerization, dehydration, hydrogenation, deoxygenation, and upgrading of biomass-derived intermediates. The catalyst exhibits high resistance to deactivation caused by coking, poisoning, moisture, and impurities commonly present in biomass feedstocks, allowing stable operation under mild to moderate reaction conditions. This improved stability extends catalyst life and supports continuous or semi-continuous processing. The invention enables integrated or one-pot conversion processes in which multiple biomass components, including cellulose, hemicellulose, and lignin, are converted within a single reactor system. This integration reduces the number of processing steps, capital investment, and operational complexity compared to conventional multi-stage biomass conversion methods. The process yields a broad range of products, including liquid transportation fuels, synthesis gas, hydrogen, and platform chemicals such as alcohols, organic acids, and hydrocarbons. By utilizing renewable and waste biomass resources, the invention promotes carbon-neutral or low-carbon fuel and chemical production and supports green chemistry and circular economy principles. The catalyst system is scalable, economically viable, and adaptable to various reactor configurations, making it suitable for industrial biorefinery applications. Overall, the invention provides a practical and sustainable solution for converting biomass into valuable fuels and chemicals while reducing environmental impact and reliance on fossil resources.

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