



Co-pyrolysis of medical protective clothing and oil palm wastes for biofuel: Experimental, techno-economic, and environmental analyses

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ABSTRACT

The ongoing global pandemic of COVID-19 has devastatingly influenced the environment, society, and economy around the world. Numerous medical resources are used to inhibit the infectious transmission of the virus, resulting in massive medical waste. This study proposes a sustainable and environment-friendly method to convert hazardous medical waste into valuable fuel products through pyrolysis. Medical protective clothing (MPC), a typical medical waste from COVID-19, was utilized for co-pyrolysis with oil palm wastes (OPWs). The utilization of MPC improved the bio-oil properties in OPWs pyrolysis. The addition of catalysts further ameliorated the bio-oil quality. HZSM-5 was more effective in producing hydrocarbons in bio-oil, and the relevant reaction pathway was proposed. Meanwhile, a project was simulated to co-produce bio-oil and electricity from the co-pyrolysis of OPWs and MPC from application perspectives. The techno-economic analysis indicated that the project was economically feasible, and the payback period was 6.30–8.75 years. Moreover, it was also environmentally benign as its global warming potential varied from −211.13 to −90.76 kg CO₂-eq/t. Therefore, converting MPC and OPWs into biofuel and electricity through co-pyrolysis is a green, economic, and sustainable method that can decrease waste, produce valuable fuel products, and achieve remarkable economic and environmental benefits.

1. Introduction

Nowadays, massive medical waste is generated with the recurring waves of COVID-19. The pandemic has wreaked havoc on the global economy, society, and the environment. The constant evolution of the highly infectious coronavirus from delta to omicron has enhanced the transmissibility and deleteriousness of the virus, changed clinical manifestations, and increased the difficulty of epidemic prevention [1]. Various countries have taken many mandatory policies and measures to suppress the transmission of the virus and alleviate the severe situation of the epidemic. Physical defense is an effective and direct measure, and personal protective equipment (PPE), such as face masks, protective

suits, gloves, and goggles, has been widely introduced to cut off the contagion of the virus physically. Accordingly, the demand for PPE has grown dramatically, and the extensive use of PPE during the pandemic has driven a sharp growth in medical waste. 17.5 billion pieces of PPE were consumed by health and social care services in England between February 2020 and December 2021 [2]. The existing healthcare capacity and waste management system are facing the danger of being overwhelmed. More importantly, hazardous medical waste takes hundreds of years to complete natural degradation and exhibits enormous risks to terrestrial and marine ecosystems without proper management [3].

Accordingly, several disposal methods, such as incineration, microwave disinfection, chemical disinfection, plasma, autoclaving, and landfill, have been employed to treat hazardous medical waste, but still

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