From Wastewater to Insulation Panels: A Sustainable Approach to Textile Microfiber Waste

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Abstract: The textile industry is known as one of the most polluting sectors, and in addition to macro-scale waste, micro-scale waste has become critically important today. The release of microfibers into the environment occurs throughout the entire lifespan of textile materials, comprising the stages from manufacturing to disposal. As is well known, a significant portion of the microplastic problem arises from synthetic microfibers. Most of the synthetic microfibers, such as polyester, polyamide, acrylic, and polypropylene, present a notable environmental challenge. Furthermore, despite the seemingly innocent nature of natural fibers, chemicals are used in the dyeing, treatment, and finishing stages of their manufacturing, which can have environmental implications. Although wastewater treatment has the potential to mitigate a certain quantity of microplastic waste, there is currently no proposed solution for managing microplastic waste separated from wastewater. Insulation panels are a frequently preferred end-use area for recycled textile waste; however, there are no academic studies or commercial products evaluating microfiber waste recovered from textile wastewater in this field. This study aims to address this challenge by collecting natural and synthetic microfibers released from the mechanical textile finishing process from wastewater and upcycling them as an alternative raw material for insulation. Nonwoven webs were manufactured by the needle-punching method from microfiber wastes and flame-retardant fibers in varying weight ratios. These webs were subjected to extensive analyses, including chemical, physical, acoustic, thermal, and flame retardancy performance assessments. The findings of this study not only contribute to repurposing microfiber waste but also offer insights into sustainable waste management practices within the textile industry. Additionally, the development of eco-friendly solutions for insulation requirements underscores the importance of innovation and environmental consciousness in modern manufacturing processes.

Keywords: *Textile waste management, microfiber waste, upcycling, insulation panel.*