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Development of Hybrid Materials Combining Biomass as Fique Fibers with Metal-Organic Frameworks, and Their Potential as Mercury Adsorbents

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Abstract : The contamination of water sources with heavy metals such as mercury has been an environmental problem; it has generated a high impact on the environment and human health. In countries such as Colombia, mercury contamination due to mining has reached levels much higher than the world average. This work proposes the use of fique fibers as adsorbent in mercury removal. The evaluation of the material was carried out under five different conditions (raw, pretreated by organosolv, functionalized by TEMPO oxidation, fiber functionalized plus MOF-199 and fiber functionalized plus MOF-199-SH). All the materials were characterized using FTIR, SEM, EDX, XRD, and TGA. Regarding the mercury removal, it was done under room pressure and temperature, also pH = 7 for all materials presentations, followed by Atomic Absorption Spectroscopy. The high cellulose content in fique is the main particularity of this lignocellulosic biomass since the degree of oxidation depends on the number of hydroxyl groups on the surface capable of oxidizing into carboxylic acids, a functional group capable of increasing ion exchange with mercury in solution. It was also expected that the impregnation of the MOF would increase the mercury removal; however, it was found that the functionalized fique achieved a greater percentage of removal, resulting in 81.33% of removal, 44% for the fique with the MOF-199 and 72% for the MOF-199-SH with. The pretreated fiber and raw also showed 74% and 56%, respectively, which indicates that fique does not require considerable modifications in its structure to achieve good performances. Even so, the functionalized fiber increases the percentage of removal considerably compared to the pretreated fique, which suggests that the functionalization process is a feasible procedure to apply with the purpose of improving the removal percentage. In addition, this is a procedure that follows a green approach since the reagents involved have low environmental impact, and the contribution to the remediation of natural resources is high.

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