Removal of aqueous Hg(II) using ZIF (Zeolitic Immidalozate Framework) derived Co@NC

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Mercury is a hazardous metal that may harm human health, including neurological and renal problems [1]. The World Health Organization states it is one of the "ten leading chemicals of major public health concerns." As a result, 1 ppb was established as the maximum permissible Hg(II) content in drinking water for this contaminant [2]. This chemical's repeated anthropogenic emissions into water bodies are considered a serious environmental issue.

Several sorption, reduction, and filtration-based treatment methods for this contamination were created. Although using sorbents is a promising strategy, it has the drawback of requiring subsequent therapy [2]. Similarly, the fundamental problem with membrane filtration is clogging, plugging, and high operational costs. In this sense, catalytic reduction technologies have addressed many of the abovementioned concerns and limitations. Recently, In-ZVI has shown 99% removal of all Hg species in an aqueous state at neutral conditions [3]. Also, the Zeolitic Imidazolate Framework derived Co@NC has demonstrated high affinity towards gaseous elemental Hg(0) with 85% removal by adsorption on average over 30-240 C [4].

In this work, we have synthesized Co@NC (carbonized ZIF-67) and metal (Ru and Pt) impregnated carbonized ZIF-67 (M-Co@NC) catalysts and tested them for the removal of aqueous Hg(II). The synthesized catalyst was then checked for characterization using the X-ray diffraction (XRD) analysis, scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDS), and transmission electron microscopy (TEM). The test of Co@NC has shown the complete removal of all Hg species at t=2.5 min without the formation of headspace Hg. Then, the Co@NC was tested with Ru and Pt impregnation to identify the best combination of Hg removal and effective reuse. Pt-Co@NC effectively removed all Hg species with a solid Hg(0) portion of about 8% (with 92% Hg(II) adsorbed). After impregnating Ru to Co@NC and reducing the catalyst with NaBH4 before the reaction, the Hg was removed entirely from the aqueous solution with the Hg(0) sorption of 20% and solid Hg(II) as 80%, showing the best results in terms of reuse of the catalyst.

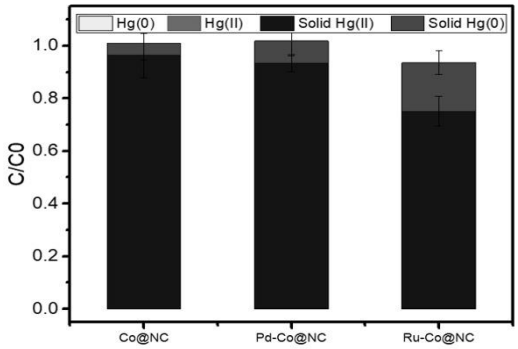

Figure 1. The mass balance results in the speciation of solid Hg on the surface of Co@NC, Pt-Co@NC, and Ru-Co@NC at t=30 min.

The experimental results show that the Co@NC and Ru-Co@NC are very effective materials for removing aqueous Hg(II) using reductive sorption. The catalyst offers high efficiency in completely removing Hg in the aqueous phase without Hg(0) and headspace formation. Also, the catalyst has the potential for its reuse, and future work will be focused on optimizing the necessary parameters to increase the solid Hg(0) concentration on the catalyst's surface to increase its feasibility to further the thermal desorption method at 150 ºC.

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