World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:17, No:10, 2023

Fly Ash Derived Zeolites as Potential Sorbents for Elemental Mercury Removal from Simulated Gas Stream

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Abstract : The fly ash produced as waste in the process of conventional coal combustion was utilized in the hybrid synthesis of zeolites X and A from Faujasite (FAU) and Linde Type A (LTA) frameworks, respectively. The applied synthesis method included modification together with the crystallization stage. The sorbent modification was performed by introducing metals into the zeolite structure in order to create an ability to form stable bonds with elemental mercury (Hg0). The use of waste in the form of fly ash as a source of silicon and aluminum, as well as the proposed method of zeolite synthesis, fits the circular economy idea. The effect of zeolite modification on Hg0 removal from a simulated gas stream was studied empirically using prototype installation designed to test the effectiveness of sorption by solid-state sorbents. Both derived zeolites X and A modified with silver nitrate revealed significant mercury uptake during a 150-minute sorption experiment. The amount of elemental mercury removed in the experiment ranged from 5.69 to 6.01 µg Hg0/1g of sorbent for zeolites X and from 4.47 to 4.86 µg Hg0/1g of sorbent for zeolites A. In order to confirm the effectiveness of the sorbents towards mercury bonding, the possible re-emission effect was tested as well. Derived zeolites X and A did not show mercury re-emission after the sorption process, which confirms the stable bonding of Hg0 in the structure of synthesized zeolites. The proposed hybrid synthesis method possesses the potential to be implemented for both fly ash utilization as well as the time and energy-saving production of aluminosilicate, porous materials with high Hg0 removal efficiency. This research was supported by National Science Centre, Poland, grant no 2021/41/N/ST5/03214.

Keywords : fly ash, synthetic zeolites, elemental mercury removal, sorption, simulated gas stream
Conference Title : ICAZM 2023 : International Conference on Advances in Zeolite Materials
Conference Location : Bali, Indonesia
Conference Dates : October 23-24, 2023