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PERFORMANCE OF ALUMINA-DOPED COMPOSITE FILMS ON CARBON MONOXIDE ADSORPTION: A REVIEW

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Abstract. *Carbon monoxide negatively results in the fatality of humans, ozone depletion, climate change, acid rain; therefore, when restoring destroyed regions, the existence of a proper gas purification technique is vital to reduce the amount of CO concentration. Hence, the progress of adsorption technology for CO capture is required. This report aims to overview the performance of alumina-doped composite films on CO adsorption. Determined that the maximum percentage of adsorption efficiency for alumina-zeolite, alumina-nickel, alumina-tin oxide, and alumina-tin oxide-nickel is 97.89%, 94%, 94.67%, and 96.7%, respectively.*

The release of CO possesses severe impacts on the environment, namely ozone depletion, climate warming, and acid rain [1]. Besides, humans' dizziness, naupathia, asthma, and death arise from CO emission in the atmosphere with high concentrations [2]. Consequently, the evolution of effective techniques to adsorb CO toxic gas is a principal worldwide.

In order to report the performances of prepared adsorbents conducted by Mozaffari et al. [2, 3], the diagrams of concentration of adsorbed CO gas, adsorption efficiency, and adsorption capacity were provided. In this matter, the concentration of adsorbed CO gas diagrams for alumina-doped adsorbents have shown an increasing tendency over time until reaching saturation level, confirming that contact surface area between molecules of CO, as well as particles of every adsorbent, has been enhanced [2, 3]. In works [2, 3] have revealed that adsorption efficiency versus time diagram for all adsorbents demonstrated an increment trend until it reached a saturation level, verifying that all sites in every adsorbent were occupying molecules of CO with passing time [4]. Alumina-zeolite, alumina-nickel, alumina-tin (IV) oxide, and alumina-tin oxide-nickel reached saturation levels at 289 s, 202 s, 222 s, 214 s, respectively, which means that all sites in adsorbent have become filled with molecules of gas. The adsorption capacity of alumina-zeolite, alumina-nickel, alumina-tin (IV) oxide, and alumina-tin oxide-nickel has been also increased with passing time. In this regard, the maximum adsorption capacity of alumina-zeolite, alumina-nickel, alumina-tin (IV) oxide, and alumina-tin oxide-nickel is 213.9 mg g^{-1}, 162.15 mg g^{-1}, 163.3 mg g^{-1}, and 111.17 mg g^{-1}, respectively [2, 3]. Adsorption parameters were tabulated in Table.

Table. **Adsorption parameters of alumina-zeolite, alumina-nickel, alumina-tin (IV) oxide, and alumina-tin oxide-nickel**

Adsorbents	Saturation time (s)	Maximum adsorption efficiency (%)	Maximum adsorption capacity (mg g^{-1})	Reference
Alumina-zeolite	289	97.89%	213.90	[3]
Alumina-nickel	202	94%	162.15	[2]
Alumina-tin (IV) oxide	222	94.67%	163.30	[2]
Alumina-tin oxide-nickel	214	96.7%	111.17	[2]

To make a comparison with other adsorbents to capture CO gas, it is observed that the amount of maximum adsorption capacity of palladium-activated carbon (Pa-Ac), palladium-silicon (Pa-Si), Zeolite, Silicon, and Activated carbon reported by Yeom et al. [5] was 77.60, 34.60, 28.30, 26.80, 25.20 mg g^{-1}, respectively; so, the maximum adsorption capacity of alumina-doped adsorbents are notably larger than comm ercial adsorbents, confirming that alumina-doped films can be considered as effective adsorbents. Figure 1 presents the remarkable amount of adsorption capacity for alumina-doped composite films compared with commercial ones.

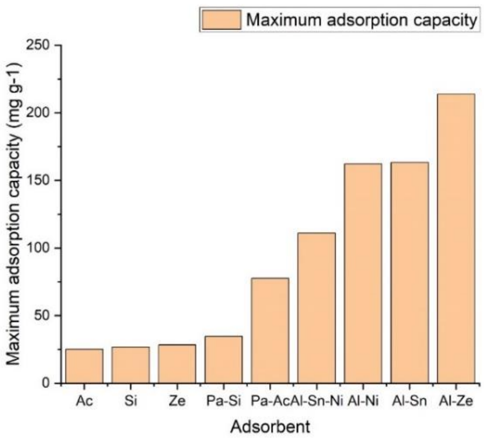

Fig. Maximum amount of adsorption capacity for various adsorbents

It is well known that CO has lots of serious effects on the environment as well as human health. It is known that green spaces represent a natural protection of atmospheric air [6], however, in conditions of significant technogenic impact, such as emergency situations and the consequences of hostilities, additional protection in the form of adsorbing filters is necessary. The current article sets out to review the performance of alumina-doped nanoadsorbents to capture CO gas. Alumina-zeolite, alumina-nickel, alumina-tin (IV) oxide, and alumina-tin oxide-nickel composite films were prepared by roll coating methods, and the gas adsorption experiment set-up was designed and fabricated by a research team. It was shown that the adsorption efficiency of all alumina-doped adsorbents had an increasing trend over time, and the maximum adsorption efficiency of all was more than 94%. Besides, the concentration of adsorbed gas and also adsorption capacity were enhanced with passing time until it reached saturation level, confirming that all sites of adsorbents were filled by molecules of CO. Moreover, it was shown that alumina-doped composite films could be considered efficient adsorbents for CO removal in comparison with common commercial adsorbents.

Used information sources:

[1] Bobbitt N. S., Mendonca M. L., Howarth A. J., Islamoglu T., Hupp J. T., Farha O. K. & Snurr R. Q. (2017). Metal–organic frameworks for the removal of toxic industrial chemicals and chemical warfare agents. Chemical Society Reviews, 46(11), 3357–3385.

[2] Mozaffari N., Solaymani S., Achour A., Kulesza S., Bramowicz M., Nezafat N. B. ... & Rezaee S. (2020). New insights into SnO2/Al2O3, Ni/Al2O3, and SnO2/Ni/Al2O3 composite films for CO adsorption: building a bridge between microstructures and adsorption properties. The Journal of Physical Chemistry C, 124 (6), 3692–3701.
[3] Mozaffari N., Mozaffari N., Elahi S. M., Vambol S., Vambol V., Khan N. A., & Khan N. (2021). Kinetics study of CO molecules adsorption on Al2O3/Zeolite composite films prepared by roll-coating method. Surface Engineering, 37(3), 390–399.
[4] Saber-Samandari S., Gulcan H. O., Saber-Samandari S., & Gazi M. (2014). Efficient removal of anionic and cationic dyes from an aqueous solution using pullulan-graft-polyacrylamide porous hydrogel. Water, Air, & Soil Pollution, 225(11), 1–14.
[5] Yeom C., Selvaraj R. & Kim,Y. (2018). Preparation of nanoporous alumina using aluminum chloride via precipitation templating method for CO adsorbent. Journal of Industrial and Engineering Chemistry, 67, 132–139.
[6] Smoliar N., Bredun V. & Toronchenko O. (2018). Urban green zones planning concept and ecological functionality (through the example of Poltava, Ukraine). International Journal of Engineering and Technology (UAE), 7(3), 522–527.