

Editorial

Foreword to the Special Issue on Sorption of Environmental Pollutants: Thermodynamic and Kinetic Aspects

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Although new technologies are continuously proposed for water pollutant removal, sorption is still a very effective process used today for this purpose, largely due to its relatively low cost, tunability, and ease of use. The study of the thermodynamics and kinetics of a sorption system is not only crucial for finding the optimal operational conditions for the abatement of water pollutants but also for understanding the reaction mechanism. In the present Special Issue, these aspects are addressed from both the experimental and theoretical points of view.

A critical review of recent literature on hexavalent chromium (Cr(VI)) sorption from aqueous solutions was conducted by Fenti et al. [1]. It was discovered that Cr(VI) uptake mainly occurs via electrostatic interactions that are established between chromium species and the sorbent matrix. The pH strongly affects the extent of Cr(VI) water removal, as it regulates the relative Cr(VI) species' distribution and the net charge on the sorbent surface. In most of the work analyzed, the sorption of Cr(VI) was found to be endothermic and the sorption kinetic data conformed to the pseudo-second-order model. Notably, some inconsistencies concerning the thermodynamic and kinetic aspects of Cr(VI) sorption are recurrent in the literature under investigation; this includes erroneous calculations of the equilibrium constant, applications of regression models in linearized forms, and misleading interpretations of the spontaneity of the sorption process.

On the basis that tannins have the ability to form stable complexes with metal ions and that microporous membranes have low pressure drop and high flux characteristics, Luo et al. [2] combined the two materials to form a tannin–membrane sorbent material that was tested for UO_2^{2+} water removal. The results indicate that the introduction of tannins increases the hydrophilicity of the original membrane, resulting in a greater water flux and higher UO_2^{2+} sorption capacity. The equilibrium and kinetic sorption data were well-fitted by the Langmuir model and the Elovich model, respectively.

Other sorbent membrane materials were investigated by Bejanidze and co-workers [3]. They used MA-40 and MK-40 ion-exchange membranes for the sorption of organic electrolytes and surfactants. It was found that the sorption of organic electrolytes prevalently occurs via ion-exchange; during the organic electrolyte uptake, the membrane becomes increasingly brittle. In the presence of the surfactant, MK-40 completely loses its electrochemical activity. The rate of sorption decreases with the increasing size of the hydrophobic part of the organic electrolytes.

The lower sorption ability of natural sorbent materials compared to synthetic ones is sometimes compensated by their lower cost and environmental impact. In the study by Márquez et al. [4], red clay (a naturally occurring clayey composite) was used for sorbing Basic Navy Blue 2RN (CNB, cationic dye) and Drimaren Yellow CL-2R (ADY, anionic dye). As expected, the results showed that the cationic and anionic dyes have an opposite sorption behavior as a function of pH. The CNB and ADY equilibrium isotherm data were well-modeled by the Langmuir and Temkin model, respectively. The pseudo-second-order



Citation: Salvestrini, S. Foreword to the Special Issue on Sorption of Environmental Pollutants: Thermodynamic and Kinetic Aspects. *Appl. Sci.* **2023**, *13*, 242. <https://doi.org/10.3390/app13010242>

Received: 17 December 2022

Accepted: 22 December 2022

Published: 25 December 2022



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model adequately described the sorption kinetics of both CNB and ADY onto red clay. Thanks to its heterogeneous composition, red clay is a versatile sorbent material that may open up an avenue into the field of separation applications.

The rate of sorption is very often limited by diffusion phenomena. For example, a study by Bufalo et al. [5], investigating the removal of Cr(VI) ions from aqueous solutions with wet pomace treated with laponite, showed that intraparticle diffusion plays an important role in the rate of the sorption process. A kinetic model was presented and applied to the experimental data, indicating that the diffusion lifetime of Cr(VI) linearly increases with the mass of the sorbent.

The sorption ability of zeolites can be extended through surface modifications. In the work of de Gennaro et al. [6], natural zeolites superficially modified by the surfactants hexadecyltrimethylammonium chloride (HDTMA-Cl) and hexadecyltrimethylammonium bromide (HDTMA-Br) were prepared and tested for the sorption of arsenic As(V). The presence of Br as counterion favors the formation of a compact and complete surfactant micellar structure. The Langmuir isotherm and the pseudo-second-order model provide a good prediction of the As(V) sorption equilibrium and kinetics, respectively.

Undoubtedly, the Freundlich isotherm is, together with the Langmuir isotherm, the most-used model for modeling sorption equilibrium data. The main disadvantage of the Freundlich model is that it does not envisage the saturation of the sorbent's sorption capacity. Hence, Vigdorowitsch and co-workers [7] presented an algorithm-driven method to extend the use of the Freundlich isotherm near the saturation level.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Fenti, A.; Chianese, S.; Iovino, P.; Musmarra, D.; Salvestrini, S. Cr(VI) sorption from aqueous solution: A review. *Appl. Sci.* **2020**, *10*, 6477. [[CrossRef](#)]
2. Luo, W.; Lin, H.; Wu, Z.; Chen, J.; Chi, R.; Ye, X.; Chen, J. Preparation and physicochemical properties of tannin-immobilized membrane adsorbent. *Appl. Sci.* **2021**, *11*, 9684. [[CrossRef](#)]
3. Bejanidze, I.; Petrov, O.; Pohrebennyk, V.; Kharebava, T.; Nakashidze, N.; Didmanidze, N.; Davitadze, N.; Petrov, A. Sorption of Organic Electrolytes and Surfactants from Natural Waters by Heterogeneous Membranes. *Appl. Sci.* **2020**, *10*, 7383. [[CrossRef](#)]
4. Márquez, C.O.; García, V.J.; Guaypatin, J.R.; Fernández-Martínez, F.; Ríos, A.C. Cationic and Anionic Dye Adsorption on a Natural Clayey Composite. *Appl. Sci.* **2021**, *11*, 5127. [[CrossRef](#)]
5. Bufalo, G.; Di Nezza, F.; Perna, M.; Salvestrini, S.; Ambrosone, L. The Diffusion Role in Adsorption of Hexavalent Chromium on Solid Olive Mill Waste. *Appl. Sci.* **2021**, *11*, 3096. [[CrossRef](#)]
6. de Gennaro, B.; Aprea, P.; Liguori, B.; Galzerano, B.; Peluso, A.; Caputo, D. Zeolite-Rich Composite Materials for Environmental Remediation: Arsenic Removal from Water. *Appl. Sci.* **2020**, *10*, 6939. [[CrossRef](#)]
7. Vigdorowitsch, M.; Pchelintsev, A.; Tsygankova, L.; Tanygina, E. Freundlich isotherm: An adsorption model complete framework. *Appl. Sci.* **2021**, *11*, 8078. [[CrossRef](#)]

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