Data Article

Data on the alizarin red S adsorption from aqueous solutions on PAC, treated PAC, and PAC/\gamma \approx Fe_2O_3

Bahram Kamarehie, Ali Jafari, Mansour Ghaderpoori, Mohammad Amin Karami, Khadijeh Mousavi, Afshin Ghaderpour

Department of Environmental Health Engineering, School of Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran
Nutritional Health Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran
Student Research Committee, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Abstract

Three types of adsorbents of powdered activated carbon (PAC), treated PAC, and PAC/\gamma \approx Fe_2O_3 nanocomposite were used. The adsorption experiments were performed in batch conditions. pH_{ZPC} of PAC/\gamma \approx Fe_2O_3 was 6.7. As a result, at lower than pH_{ZPC}, acidic pH, the adsorption of alizarin red S on PAC/\gamma \approx Fe_2O_3 was favourable. The maximum of alizarin red S adsorption of PAC, treated PAC, and PAC/\gamma \approx Fe_2O_3 was 24.5 mg/g, 57.8 mg/g, and 112.56 mg/g, respectively. The models of Langmuir and pseudo-first-order were a fit model to describe the adsorption isotherm and the Kinetic, respectively. The PAC/\gamma \approx Fe_2O_3 is a promising class of the adsorbents in the adsorption of various dyes from textile effluents.

© 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
## Specifications Table

| Subject area | Wastewater treatment |
|--------------|----------------------|
| More specific subject area | Adsorption |
| Type of data | Table, figure |
| How data was acquired | Spectrophotometer RD-5000(UV-UVIS, 570 nm) |
| Data format | Analyzed, |
| Experimental factors | The adsorption experiments were performed in batch conditions. The main variables studied were initial dye concentration, pH, reaction time, and treated PAC and PAC/γ ≈ Fe₂O₃ dosage. An adsorbent of PAC, treated PAC and PAC-γ-Fe₂O₃ nanocomposite was added to 100 mL of alizarin red S solution. The residual dye was measured by a spectrophotometer DR-5000 (UV-UVIS, 350 nm). |
| Experimental features | In the first step, in order to prepare treated PAC. After separation, the dark-brown precipitate was washed several times with methanol to remove the residual matter. |
| Data source location | Khorraramabad, Lorestan University of Medical Sciences, Iran (lums.ac.ir) |
| Data accessibility | Data are included in this article |
| Related research article | S. Golmohammadi, M. Ahmadpour, A. Mohammadi, A. Alinejad, N. Mirzaei, M. Ghaderpoori, A. Ghaderpoori. Removal of blue cat 41 dye from aqueous solutions with ZnO nanoparticles in combination with US and US-H₂O₂ advanced oxidation processes. Environmental Health Engineering and Management Journal. 3 (2016) 107-13 |

## Value of the data

- The data from the present study showed that the modification of conventional absorbents can be used to considerably enhance the ability to remove environmental pollutants.
- The data obtained can be used to complete the information in literature on the removal of dye compounds from water environments and industrial effluents.

## 1. Data

The XRD pattern and SEM for treated PAC and PAC/γ ≈ Fe₂O₃ nanocomposite are presented in Fig. 1. Based on BET, the surface area of PAC, treated PAC, and PAC/γ ≈ Fe₂O₃ were found to be 389 m²/g, 550 m²/g, and 400 m²/g, respectively. Fig. 2 shows the effect of solution pH of PAC, treated PAC and PAC/γ ≈ Fe₂O₃ nanocomposite on alizarin red S adsorption. The results of the study showed that the pH of the zero point (pH_ZPC) was 6.5. Fig. 3 shows the effect of adsorbent dose of PAC, treated PAC, and PAC/γ ≈ Fe₂O₃ nanocomposite on alizarin red S adsorption. Fig. 4 depicts the effect of initial concentration of PAC, treated PAC, and PAC/γ ≈ Fe₂O₃ nanocomposite on alizarin red S adsorption. The constants of isotherm models for PAC, treated PAC and PAC/γ-Fe₂O₃ nanocomposite on alizarin red S adsorption are given in Table 1. As illustrated in Table 1, the isotherm model of Langmuir for PAC, treated PAC and PAC/γ-Fe₂O₃ nanocomposite has the highest $R^2$ (e.g. square correlation). Therefore, this model was the most suitable model to express alizarin red S adsorption onto the adsorbents. Also, the constants of kinetics models for PAC, treated PAC and PAC/γ-Fe₂O₃ nanocomposite on alizarin red S adsorption are summarized in Table 2. As illustrated in Table 2, the kinetic model of pseudo-second order for PAC, treated PAC and PAC/γ-Fe₂O₃ nanocomposite has the highest $R^2$. As a result, this model was the most suitable kinetics model for alizarin red S adsorption onto the prepared adsorbents.
2. Experimental design, materials, and methods

2.1. Materials

The chemicals including hydrochloric, hydrochloric, powered activated carbon (PAC), iron chloride tetrahydrate, iron chloride tetrahydrate, and alizarin red S were used. These high purity chemicals were purchased from Merck and Sigma-Aldrich.

2.2. Preparation of treated PAC and PAC-\(\gamma\)-Fe\(_2\)O\(_3\) nanocomposite

For PAC coatings by \(\gamma \approx \text{Fe}_2\text{O}_3\), the methodology of previous studies were obeyed [1,2]. In the first step, in order to prepare treated PAC, this method was as follows: 20 g of PAC was added to a solution of 5 M nitric acid (Approximately 150 mL). The solution was placed at 70 °C for 1 h. In the next step, in order to prepare activated carbon coated with \(\gamma\)-Fe\(_2\)O\(_3\), this method was as follows: treated PAC [4.2 g], FeCl\(_3\)–6H\(_2\)O [21.6 g, purity > 99%], and FeCl\(_2\)–4H\(_2\)O [8 g, purity > 98%], were added to a solution of 2 M hydrochloric (Approximately 100 mL, purity 37%). The NH\(_3\)·H\(_2\)O solution a solution of 2 M NH\(_3\), H\(_2\)O solution (Approximately 300 mL) was added to the previous solution for 2 h. Finally, the remaining precipitate was separated by a magnet. After separation, the dark-brown precipitate was
Fig. 3. The effect of adsorbent dose of PAC, treated PAC, and PAC/γ-Fe₂O₃ nanocomposite on alizarin red S adsorption.

Fig. 4. The effect of initial concentration of dye on alizarin red S adsorption by PAC, treated PAC, and PAC/γ-Fe₂O₃ nanocomposite.

Table 1
The constants of isotherm models for alizarin red S adsorption by PAC, treated PAC, and PAC/γ-Fe₂O₃ nanocomposite.

|                  | PAC     | Treated PAC | PAC/γ-Fe₂O₃ |
|------------------|---------|-------------|-------------|
| Langmuir         |         |             |             |
| qₘₐₓ             | 24.5    | 57.8        | 112.56      |
| KL               | 1.05    | 1.66        | 2.45        |
| R²               | 0.88    | 0.89        | 0.89        |
| Freundlich       |         |             |             |
| Kᵢ              | 1.43    | 1.68        | 2.04        |
| n                | 1.12    | 1.78        | 2.6         |
| R²               | 0.64    | 0.77        | 0.87        |

Table 2
The constants of kinetics models for alizarin red S adsorption by PAC, treated PAC, and PAC/γ-Fe₂O₃ nanocomposite.

|                  | PAC   | Treated PAC | PAC/γ-Fe₂O₃ |
|------------------|-------|-------------|-------------|
| Pseudo-first-order | K₁    | 0.0164      | 0.0136      | 0.0235      |
| R²               | 0.845 | 0.876       | 0.985       | 0.976       |
| qₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑᵉ ≥ | 28.92 | 47.16 | 61.45 | 90.20 |
| Psudo-second-order | K₂     | 0.0198      | 0.0204      | 0.0435      |
| R²               | 0.845 | 0.876       | 0.985       | 0.976       |
| qₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑᵉ ≥ | 24.36 | 28.41 | 41.45 | 50.45 | 68.95 | 89.78 |
washed several times with methanol to remove the residuals. After washing, the final product was dried at 70 °C for 24 h. After preparation of treated PAC and PAC/γ-Fe₂O₃ nanocomposite, their characterizations were determined using SEM, XRD, and BET techniques [1–16].

2.3. The adsorption experiments

The adsorption feasibility of Alizarin red S was studied by PAC, treated PAC, and PAC/γ-Fe₂O₃ nanocomposite. The adsorption experiments were performed in batch conditions. The main variables studied were initial dye concentration, pH, reaction time, and treated PAC and PAC-γ-Fe₂O₃ dosage. At the first step, a stock Alizarin red S solution (C₁₄H₈O₄, 1000 mg/l, 240.21 g/mol, pKₐ = 6.9) was prepared and stored under standard conditions. An adsorbent of PAC, treated PAC and PAC-γ-Fe₂O₃ nanocomposite was added to 100 mL of Alizarin red S solution. Equation C₁V₁ = C₂V₂ was used to prepare different concentrations of stock solution. The solutions of 0.1 N HCl and NaOH were used to adjust the desired pH. The residual dye was measured by a spectrophotometer DR-5000 (UV-UVIS, 350 nm) [3].

Acknowledgements

The authors of the study thanks Lorestan University of Medical Sciences to support.

Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2018.08.170.

References

[1] E. Darezereshki, F. Bakhtiari, A.B. Vakylabad, Z. Hassan, Single-step synthesis of activated carbon/γ-Fe2O3 nanocomposite at room temperature, Mater. Sci. Semicond. Proc. 16 (2013) 221–225.
[2] M. Fayazi, M. Ghanei-Motlagh, M.A. Taher, The adsorption of basic dye (Alizarin red S) from aqueous solution onto activated carbon/γ-Fe₂O₃ nano-composite: kinetic and equilibrium studies, Mater. Sci. Semicond. Proc. 40 (2015) 35–43.
[3] A.D. Eaton, L.S. Clesceri, E.W. Rice, Standard Methods for the Examination of Water and Wastewater, American Water Works Association (AWWA), Washington D. C, 2012.
[4] A. Jafari, Ah Mahvi, Reactive dyes (R. Blue 19 And R. Red 120) removal by a natural coagulant: Moringa oleifera, Environ. Eng. Manag. J. (Eemj) 14 (2015).
[5] M.R. Samarghandi, M. Zarrabi, A. Amrane, M.N. Sepehr, M. Noroozi, S. Namdari, A. Zarei, Kinetic of degradation of two azo dyes from aqueous solutions by zero iron powder: determination of the optimal conditions, Desalination Water Treat. 40 (2012) 137–143.
[6] B. Kamarehie, A. Jafari, H.A. Mahabadi, Dechlorination and decomposition of Aroclor 1242 in real waste transformer oil using a nucleophilic material with a modified domestic microwave oven, J. Mater. Cycles Waste 16 (2014) 711–720.
[7] A.A. Mohammad, A. Alinejad, B. Kamarehie, S. Javan, M. Ghaderpouri, M. Ahmadpour, M. Ghaderpouri, Metal organic framework UiO-66 for adsorption of methylene blue dye from aqueous solutions, Int. J. Environ. Sci. Technol. 14 (2017) 1959.
[8] M. Ghaderpouri, A. Jafari, A. Ghaderpouri, Heavy metals analysis and quality assessment in drinking water–Khorramabad city, Iran, Data Brief 16 (2018) 685–692.
[9] S. Golmohamadi, M. Ahmadpour, A. Mohammad, A. Alinejad, N. Mirzaei, M. Ghaderpouri, A. Ghaderpouri, Removal of blue cat 41 dye from aqueous solutions with ZnO nanoparticles in combination with US and US-H₂O₂ advanced oxidation processes, Environ. Health Eng. Manag. J. 3 (2016) 107–113.
[10] A. Yazdanbakhsh, Y. Hashempour, M. Ghaderpouri, Performance of granular activated carbon/nanoscale zero-valent iron for removal of humic substances from aqueous solution based on Experimental Design and Response Surface Modeling, Glob. NEST J. 20 (2018) 57–68.
[11] A. Mohsenibandpei, A. Alinejad, H. Bahrami, M. Ghaderpouri, Water solution polishing of nitrate using potassium permanganate modified zeolite: parametric experiments, kinetics and equilibrium analysis, Glob. Nest J. 18 (2016) 546–558.
[12] H.N. Saleh, M.H. Dehghani, R. Nabizadeh, A.H. Mahvi, F. Hossein, M. Ghaderpouri, et al., Data on the acid black 1 dye adsorption from aqueous solutions by low-cost adsorbent-Cerastoderma lamarckii shell collected from the northern coast of Caspian Sea, Data Brief 17 (2018) 774–780.
[13] M.H. Dehghani, A. Zarei, A. Mesdaghinia, R. Nabizadeh, M. Alimohammadi, M. Afsharnia, Response surface modeling, isotherm, thermodynamic and optimization study of arsenic (V) removal from aqueous solutions using modified bentonite-chitosan (MBC), Korean J. Chem. Eng. 34 (2017) 757–767.

[14] M.H. Dehghani, A. Zarei, A. Mesdaghinia, R. Nabizadeh, M. Alimohammadi, M. Afsharnia, Adsorption of Cr(VI) ions from aqueous systems using thermally sodium organo-bentonite biopolymer composite (TSOBC): response surface methodology, isotherm, kinetic and thermodynamic studies, Desalination Water Treat. 85 (2017) 298–312.

[15] R. Khosravi, A. Zarei, M. Heidari, A. Ahmadfazeli, M. Vosoughi, M. Fazlizadeh, Application of ZnO and TiO2 nanoparticles coated onto montmorillonite in the presence of H2O2 for efficient removal of cephalaxin from aqueous solutions, Korean J. Chem. Eng. 35 (2018) 1000–1008.

[16] S.M. Ghasemi, A. Mohseni-Bandpei, M. Ghaderpoori, Y. Fakhri, H. Keramati, M. Taghavi, B. Moradi, K. Karimyan, Application of modified maize hull for removal of Cu(II) ions from aqueous solutions, Environ. Prot. Eng. 43 (2017) 93–103.