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Lignin-Silica Sorbent: An Environmentally Friendly Approach to Water Purification

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Introduction

The proper purification of wastewater is a pressing environmental concern, given the wide range of pollutants it can contain. In this study, a groundbreaking approach utilizing lignin-silica bio-composite as an effective and sustainable sorbent for removing cationic-type contaminants from wastewater is presented. The research team conducted a comprehensive characterization of the proposed sorbent using SEM, FTIR, XPS, and adsorption methods, ensuring its structural integrity and functionality. This attention to detail instills confidence in the efficacy and reliability of the lignin-silica bio-composite. One of the key strengths of this sorbent is its high sorption capacity. The lignin-silica bio-composite demonstrates an impressive ability to attract and retain heavy metal cations, dyes, and cationic medicines, thereby effectively reducing their presence in wastewater. This feature is particularly noteworthy as it addresses a diverse array of cationic pollutants commonly found in both industrial and domestic wastewater. Furthermore, the sorption kinetics of the lignin-silica bio-composite are commendably rapid. Its efficient adsorption process allows for the removal of contaminants within a short period, ensuring swift and effective treatment of wastewater. This attribute is of utmost importance when considering large-scale implementation and practical application.

Experimental & Results

Characterization of modified silica gel

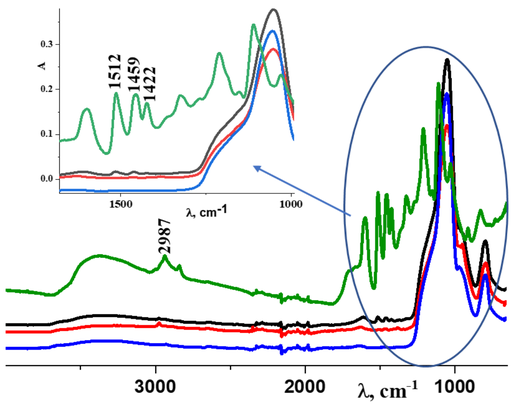


Figure 1. *FTIR spectra of KH (green) and QAS-SG before (blue) and after KH adsorption ($q_{aKH,}$ mg/g: 5.0 red line, 55 black line)*

Table 1*. The pHpzc values of the samples*.

	SG	QAS-SG	aKH	aKH-QAS-SG $q_{aKH,}$ mg/g		
				140	55	5
pH_{PZC}	3.42	8.55	2.95	4.02	5.00	7.26

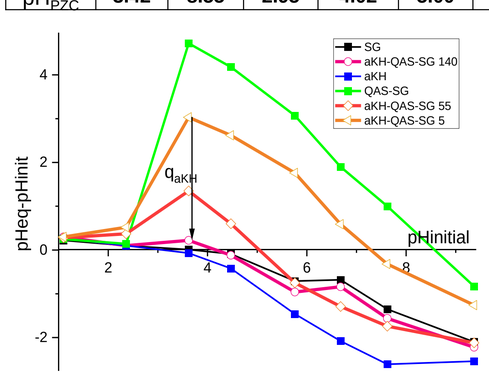


Fig. 2. *Change in pH of the solution upon contact with the sorbents*

Using of modified silica gel

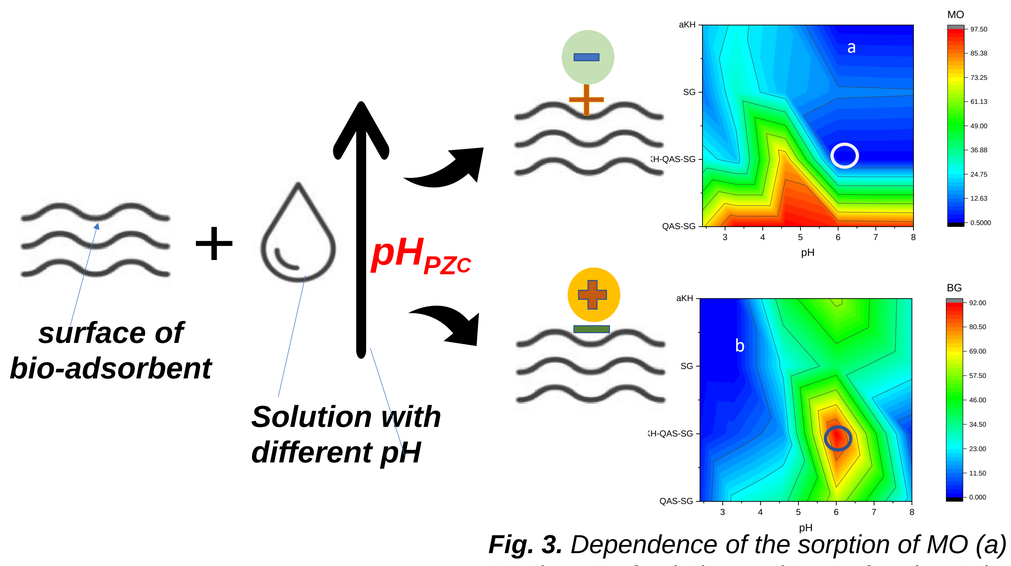
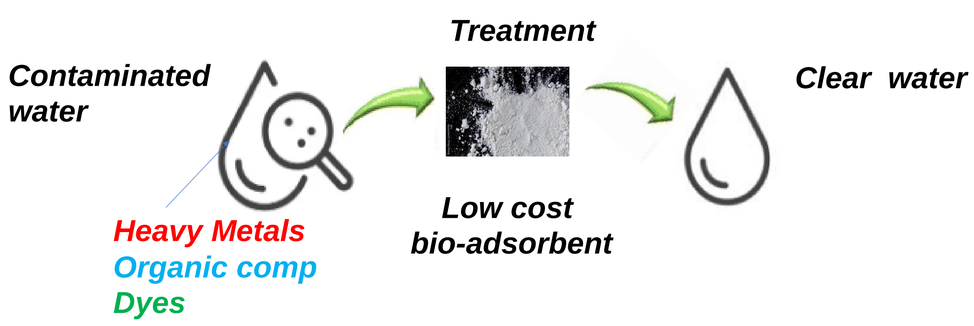


Fig. 3. *Dependence of the sorption of MO (a) and BG (b) On the pH of solution and type of sorbent. ($q_{aKH,}$ 55 mg/g)*



Adsorption of heavy metal cations

$$n\overline{SG\ QAS^{+}KL^{-}Na^{+}} + M^{n+} \leftrightarrow \overline{SG\ QAS^{+}KL^{-}}_{n}\overline{M^{n+}} + nNa^{+}$$

M^{n+} - cations Cr^{3+}, Cu^{2+}

Conclusions

- ✓ A new method of obtaining a bio-composite based on lignin, a by-product of the pulp and paper industry, and silica gel is proposed.
- ✓ The properties of the obtained material were thoroughly investigated by reliable spectral and sorption methods. It is shown that the immobilization of lignin on the surface of silica gel helps to increase its sorption capacity for heavy metal cations. The possibility of changing the properties of the biomaterial depending on the amount of lignin immobilized on the surface of the SG and the pH of the solution is shown on the example of the sorption of cationic and anionic dyes.
- ✓ These facts, together with the rapid kinetics of establishing sorption equilibrium, low cost and environmental friendliness, make it a promising candidate for large-scale wastewater treatment. In addition, its ecological nature is consistent with the growing need for environmentally friendly solutions.

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