International Science Group

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XXVI

INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE "TOPICAL ISSUES OF PRACTICE AND SCIENCE"

London, Great Britain

May 18 – 21, 2021

ISBN 978-1-63848-661-9

DOI 10.46299/ISG.2021.I.XXVI

TOPICAL ISSUES OF PRACTICE AND SCIENCE

Abstracts of XXVI International Scientific and Practical Conference

London, Great Britain
May 18 – 21, 2021

Library of Congress Cataloging-in-Publication Data

UDC 01.1
The XXVI International Science Conference «Topical issues of practice and science», May 18 – 21, 2021, London, Great Britain. 835 p.

ISBN - 978-1-63848-661-9

DOI - 10.46299/ISG.2021.I.XXVI

EDITORIAL BOARD

151.	Miroshnikov V. INVESTIGATION OF THE STRESS STATE OF A RIGIDLY FIXED LAYER WITH A CYLINDRICAL CAVITY AT STRESSES SET ON THE CAVITY	664
152.	Polyvanov Y., Karpenko S., Sytnyk K., Kondratiuk N. NEW TYPES OF SPECIALIZED DRINKS BASED ON MICROALGAE	668
153.	Prachyk V., Palona V., Liashenko O. DECISION SUPPORT SYSTEM FOR MITIGATION AND ELIMINATION THE CONSEQUENCES OF NATURAL DISASTERS IN UKRAINE	671
154.	Tvoroshenko I., Koriakin I. ANALYSIS OF METHODS FOR DETECTING AND CLASSIFYING THE LIKENESS OF HUMAN FEATURES	674
155.	Tvoroshenko I., Temchur K. FEATURES OF SOFTWARE APPLICATION DEVELOPMENT FOR FOOD RECOGNITION USING DEEP MACHINE LEARNING METHODS	680
156.	Tvoroshenko I., Kukharchuk V. CURRENT STATE OF DEVELOPMENT OF APPLICATIONS FOR RECOGNITION OF FACES IN THE IMAGE AND FRAMES OF VIDEO CAPTURES	685
157.	Halysh V., Trus I., Vozovych A., Horianoi V. W APPROACH IN WASTEWATER TREATMENT	691
158.	Voietska O., Bordun T., Iegorov B. FEATURES OF TECHNOLOGICAL PROCESSES OF THE PRODUCTION OF PET FOOD	694
159.	Асенов Д.Н., Темырканова Э.К. АНАЛИЗ СОВРЕМЕННЫХ ПОДХОДОВ ПРОГНОЗИРОВАНИЯ ПОТРЕБЛЕНИЯ ЭЛЕКТРИЧЕСКОЙ ЭНЕРГИЕЙ	699
160.	Баранчук О.О., Власюк Г.Г., Попович П.В. ЩОДО УДОСКОНАЛЕННЯ МЕТОДІВ АРХІВУВАННЯ ВІДЕОМАТЕРІАЛІВ НА НОВИННОМУ ТЕЛЕКАНАЛІ	707

W APPROACH IN WASTEWATER TREATMENT

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The presence of different organic and inorganic pollutants in industrial wastewater has hazardous effect on water objects and as a result on the human beings [1, 2]. Biosorption technique is a quite promising technology for the uptake of pollutants from industrial wastewater. From the scientific and economic point of view, it is promising to involve "green technologies" for ecological purpose. This approach can be implemented by the application of solid wastes from agro-industrial complex which annually generated in huge quantities in the world [3, 4].

Each plant material contains organic compounds of various chemical classes and a small part of inorganic substances. Chemical composition determines sorption ability of such materials. However, in the natural form, they are characterized by low sorption properties due to the low-fibrillated structure. To increase the sorption properties of plant materials, it is possible to carry out its chemical modification using different reagents, which allows to give them new properties by increasing the specific surface area or by introducing additional active functional groups.

The aim of this paper is to investigate the approach of potential of walnut shells modification and application as biosorbent. Modification of raw material was performed by treatment with alkaline solution.

The effect of pH on sorption properties towards methylene blue were investigated on initial material and biosorbent, obtained by the treatment of shells with 5% NaOH at 100 ^{o}C during 180 min (Fig. 1). An increase of pH enhances the sorption of dye, as the surface of plant materials becomes negatively charged because of the deprotonation

of carboxylic groups of polysaccharides and extractives [5]. The maximum value of sorption was obtained at pH 6.

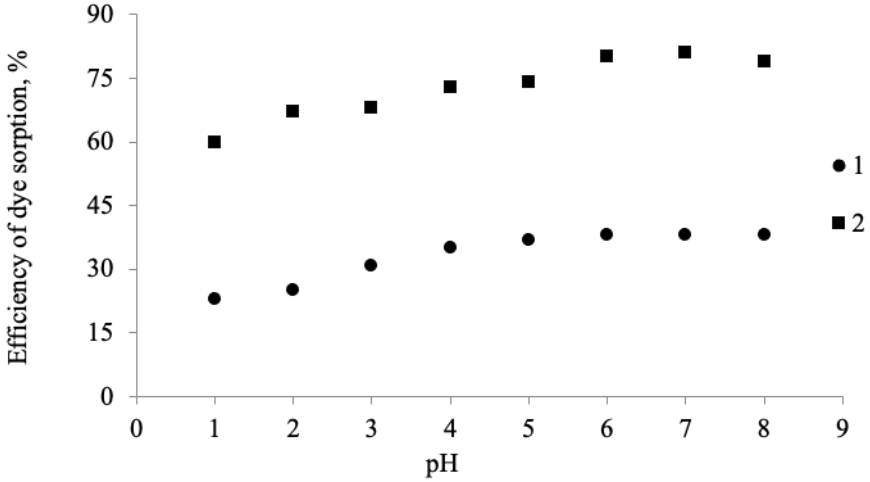

Figure 1. The effect of pH on the efficiency of methylene blue sorption:
1 - walnut shells; 2 – biosorbent.

Study of the kinetics of the dye sorption shows that the maximum sorption rate obtained within the first 30 minutes of sorption, as shown in Fig. 2. For biosorbent, the concentration of dye in the aqueous solution was decreased by more than half if compared to original material. Full sorption equilibrium was reached within 240 minutes.

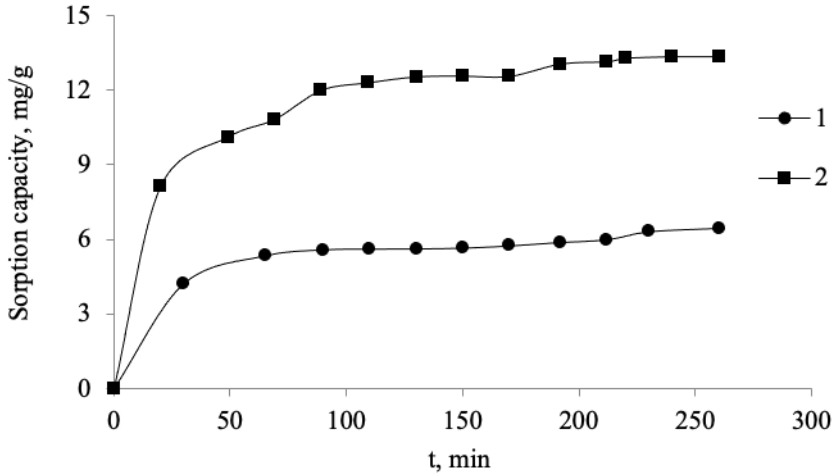

Figure 2. Methylene blue uptake as a function of time:
- walnut shells; 2 – biosorbent.

The values of the coefficients of the kinetic models were calculated (Table 1). Data indicate that the pseudo-first-order kinetic model doesn't accurately fit sorption and the values of sorption capacity, which was calculated from the plot do not correspond to the experimental value. The R^2 of the pseudo-second-order models was more than 0.99, which was greater than for pseudo-first-order, indicating the applicability of the model of the adsorption processes. The low value of R^2 for the intraparticle diffusion models testify that the sorption of dye is a multi-step process, which include cationic dye adsorption on the surface and its diffusion into the interior [6].

Table 1.

Parameters of kinetic models for methylene blue adsorption process.

Type of kinetics	Parameters	Samples	
		Original shells	Biosorbent
-	q_{exp}, mg g^{-1}	6.5	13.3
Pseudo-first-order	k_1, min^{-1}	$6.90 \cdot 10^{-3}$	$1.88 \cdot 10^{-2}$
	q_e, mg g^{-1}	2.0	7.3
	R^2	0.8678	0.9429
Pseudo-second-order	k_2, mg $(g\ min)^{-1}$	$8.72 \cdot 10^{-3}$	$4.36 \cdot 10^{-3}$
	q_e, mg g^{-1}	6.5	14.2
	R^2	0.9948	0.9987
Intraparticle diffusion	k_2, mg $(g\ min^{1/2})^{-1}$	0.1682	0.4104
	C	3.7	7.3
	R^2	0.8734	0.8932

As a result of the conducted research work, it can be concluded that modified walnut shells possess valuable properties, which allows to apply it as a biosorbnt for water treatment.

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