CHEMICAL AND TECHNOLOGICAL SYSTEMS

DOI: 10.15587/2706-5448.2024.317659

INFLUENCE OF MINERAL FILLER ON THE THERMAL CONDUCTIVITY OF POLYMER COMPOSITES

pages 6–11

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The study focuses on the development of polymer composites based on the Latex 2012 aqueous dispersion with mineral fillers of volcanic (andesite) and technogenic (fly ash from Burshtyn TPP and Kurakhove TPP) origin, aimed at achieving optimal thermal insulation properties. The main problem addressed was determining the influence of the type, concentration, and combination of fillers on the thermal conductivity of composites. High thermal conductivity of polymeric materials significantly limits their application in thermal insulation systems, making it crucial to investigate the mechanisms of interfacial interactions between fillers and the matrix for creating effective compositions.

The sizes of filler crystallites were determined using the Scherrer method: for andesite – 110 nm, fly ash B – 100.4 nm, and fly ash K – 113 nm. These data indicate the fillers' ability to affect phonon scattering in the material, reducing overall thermal conductivity. The thermal conductivity of the fillers is as follows: fly ash B – 0.2072 W/m·K, fly ash K – 0.2241 W/m·K, and andesite – 0.2118 W/m·K. Fly ash B demonstrated the best results due to its low thermal conductivity and high surface energy, which contributes to better interaction with the polymer matrix.

An analysis of the dependence of composite thermal conductivity on temperature and filler concentration showed that increasing filler concentration increases thermal conductivity due to the formation of thermal bridges between particles. However, combining different fillers in optimal proportions can mitigate this effect. Based on the Nielsen model, the composite compositions were optimized to achieve minimum thermal conductivity. The best results were obtained for a binary filler system of fly ash B and andesite in a 53:35 mass ratio, providing the lowest effective thermal conductivity of the composite – 0.173 W/m·K. Other successful combinations include fly ash B with fly ash K (60:40 wt. %) and andesite with fly ash K (45:55 wt. %), which also demonstrate significant improvements in thermal insulation properties.

The proposed compositions can be applied in the field of energy-efficient construction, thermal regulation systems, thermal insulation materials for industrial equipment, and other areas requiring low thermal conductivity. The research results are also valuable for developing materials that operate under significant temperature variations (from –125 °C to +100 °C), providing stable thermal insulation properties.

Keywords: polymer composites, composite thermal conductivity, mineral fillers, fly ash, andesite, Nielsen model.

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MEASURING METHODS IN CHEMICAL INDUSTRY

DOI: 10.15587/2706-5448.2024.319177

DEVELOPMENT OF ELEMENTS OF AN INFORMATIONAL-AND-MATHEMATICAL MODEL OF HYDRODYNAMIC PROCESSES IN A CERAMIC CATALYTIC CONVERTER FOR DEVELOPING AN ENTERPRISE COMPUTER SIMULATION MODEL

pages 12–16

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ISSN-L 2664-9969; E-ISSN 2706-5448

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The object of this study is the hydrodynamic processes in ceramic catalytic converters used in high-temperature petroleum refining. This is essential for improving fuel quality and adhering to environmental regulations. The research addresses the optimization of catalytic converter performance by understanding the interactions within their porous ceramic structures, influenced by fluid flow, heat transfer, and chemical reactions. It advocates for computational modeling to simulate these processes more accurately, overcoming the limitations of traditional methods.

The paper is aimed at developing a robust system integrating computational fluid dynamics (CFD) with experimental data to optimize ceramic catalytic converter performance. A mathematical model was created to combine fluid dynamics within the ceramic's porous structure with the chemical kinetics of catalytic reactions in petroleum refining.

Key findings show that optimizing parameters such as flow velocity and catalyst loading enhances the distribution of reactants across its surface, leading to improved conversion efficiency and reduced energy consumption. The research demonstrates that diffusion and kinetic limitations critically influence catalytic performance. Higher cobalt concentrations in the catalyst layer promoted diffusion-controlled reactions, enhancing efficiency at high flow rates.

The results offer practical applications for the petroleum refining industry, providing a framework to design more efficient catalytic converters. This modeling approach enables engineers to optimize catalytic system designs, improving operational efficiency and compliance with regulatory standards.

Moreover, the study highlights areas for further research, such as expanding the model to include more complex operational conditions and integrating real-time experimental data for better accuracy. This will improve both the design and performance of ceramic catalytic converters in high-temperature refining processes. Future work could also explore scalability for industrial systems, facilitating the integration of optimized catalytic converters into refinery setups to meet performance and environmental standards.

Keywords: ceramic catalysts, mathematical modeling, computer simulation model, hydrodynamics, reaction kinetics, CFD modeling, oil refining.

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ECOLOGY AND ENVIRONMENTAL TECHNOLOGY

DOI: 10.15587/2706-5448.2024.318925

IMPROVING MONITORING OF WATER QUALITY CHARACTERISTICS IN ARTIFICIAL WATER STORAGE FACILITIES IN UKRAINE

pages 17–24

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The object of research is the hydroecological situation in the surface waters of Ukraine, indicated by the data of modern monitoring of surface waters, especially in the part of the Dnipro basin that forms the Kremenchuk Reservoir. Ukraine has not formed a holistic

system of measures for monitoring and maintaining the quality of surface waters and state supervision over diseases associated with drinking water. The qualitative characteristics of drinking water are determined by the ecological state of the surface water bodies that are sources of drinking water. Therefore, this work is devoted to determining the need and ways to improve the state monitoring of the qualitative characteristics of waters in artificial water-accumulating objects and parts of the river basins that form them.

The work uses scientific methods of systemic analysis, generalization and systematization, takes into account synergistic approaches in hydroecology and consideration of possible development scenarios based on the autopsy method. It is shown that diagnostic water monitoring covers only a small part of water bodies in Ukraine, and the modern hydrological monitoring network of Ukraine has up to 400 posts, including chemical pollution in half of the points, which is not enough. The state of the legal field of development of the water strategy of Ukraine, the monitoring mission of the state and the implementation of the legislative framework of Ukraine to EU requirements are analyzed, but the state of surface waters in Ukraine encourages to study the experience of water protection in European and world countries. This experience indicates that in the field of monitoring and protection of surface waters in Ukraine, a much higher and more accurate level of monitoring and a more stringent level of state regulation of water relations towards greening are needed.

The work develops a structural and logical scheme of factor analysis, including systems of hydro-ecological monitoring of the formation of the aquatic environment of part of the Dnipro basin in the Kremenchuk Reservoir area. The need for systematic improvement of monitoring of water quality characteristics in artificial water storage facilities, which is the Kremenchuk Reservoir, and the need for a significant concentration of monitoring points, both in the reservoir and in the Dnipro basin that forms it, has been identified. A change in monitoring points and systematic diagnostics of reservoirs using modern capabilities of satellite sounding of water bodies within the framework of the greening of water relations in Ukraine has been proposed.

Keywords: hydroecological situation, surface waters, artificial water storage facilities, water directives, Kremenchuk Reservoir.

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ISSN-L 2664-9969; E-ISSN 2706-5448

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DOI: 10.15587/2706-5448.2024.319856

ASSESSMENT OF THE EFFICIENCY OF MODERN TECHNOLOGIES FOR REDUCING GREENHOUSE GAS EMISSIONS IN INDUSTRIAL ENTERPRISES OF UKRAINE

pages 25–30

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The object of this research is the problem of greenhouse gas (GHG) emissions, which are one of the main factors of global climate change, which necessitates the creation and implementation of innovative technologies for their reduction. Greenhouse gas emissions have been found to significantly affect ecological and socio-economic systems, creating a number of challenges, such as increased risk of natural disasters, deterioration of public health and increased mortality. This causes significant economic, environmental and social losses. Leading approaches to reducing GHG emissions are analyzed, including carbon capture and storage (CCS), use of renewable energy sources (RES), energy efficiency developments, and biotechnologies for waste reuse. The advantages and limitations of these technologies are studied, as well as their potential for adaptation to the conditions of industrial enterprises of Ukraine. The importance of CCS for reducing emissions at large industrial facilities, such as power plants and cement plants. is assessed, and the important role of RES in reducing dependence on fossil fuels is determined fuel and increasing energy efficiency. The expediency of applying a comprehensive approach to the implementation of these technologies, which covers the improvement of the regulatory and legal framework, the attraction of investments in environmental protection projects, the implementation of international experience and the creation of climate funds to finance the most effective solutions, is substantiated. A new computational mathematical model is proposed, which takes into account the factors of saving resources, reducing costs for environmental protection and obtaining profits from trading carbon quotas. A three-level mechanism for the implementation of measures to reduce GHG emissions is proposed, which includes the development of regional emission reduction strategies, the implementation of programs at the local level, and the creation of centers of environmental and climate culture to coordinate actions between stakeholders. The prospects for the application of innovative technologies in Ukrainian industry as an effective tool for achieving climate goals, reducing the negative impact on ecosystems, and increasing the competitiveness of enterprises have been assessed.

Keywords: industrial enterprise, greenhouse gases, innovative technologies, capture and storage technologies, energy system.

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DOI: 10.15587/2706-5448.2024.314931

ANALYSIS OF THE ENVIRONMENTAL IMPACT OF PHOSPHATE MINING ON THE EXAMPLE OF DJEBEL ONK DEPOSIT (TEBESSA), ALGERIA

pages 31–41

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The object of the study is natural phosphates, which play a major role in various industrial sectors, ranging from agriculture to pharmaceuticals, via the metallurgy and chemistry. In Algeria, their importance in the international market is significant, thanks to the deposits of Djebel Onk, located in the south-eastern part of the region of Tebessa. However, the mining and processing of these phosphates lead to waste significant, both in liquid form than in solid, raising significant environmental concerns. In this perspective, a thorough analysis is necessary for a rational and hard reliable, ensuring the preservation of the environment. This research was undertaken to quantify and analyze the distribution of various heavy metals in the phosphate waste generated by Djebel Onk plant (Kef Essennoun deposit). These wastes are crucial to achieve the objectives of sustainable development in relation to public health and the environment. The work focuses on the study of samples of the different releases of the treatment processes. These latter were subjected to a characterization of different analysis techniques, qualitative and quantitative, namely: XRD, IR, XRF, SEM and AAS. The results obtained distinguish differences are notable between the levels recorded by the raw phosphate and those samples wastes of treatment processes. Thus, the waste produced consists of 59.2 % dolomite, 20.5 % calcite, and 19.8 % fluorapatite. The presence of kaolinite was also noted in these residues, though in a small proportion (0.5 %). It has also been noted that these concentration of the elements in trace metal increases relatively with the decrease of the diameter of the grain size, in particular in the mud. This shows that the efficiency of the modes of treatment will allow for some cases, reduce the concentration of elements in the phosphate studied. This opens up promising research opportunities for scientists and engineers to develop more efficient and advanced treatment methods.

Keywords: sustainable exploitation, phosphate tailings, mineral processing, heavy metals, environmental impact.

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DOI: 10.15587/2706-5448.2024.319850

STUDY OF LYOPHILIC PROPERTIES OF NATURAL CLINOPTILOLITE AS A SORBENT OF OIL AND OIL PRODUCTS

pages 42–46

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The object of research is natural clinoptilolite as a potential sorbent in the processes of water and soil purification from oil, petroleum products (A-95 gasoline, kerosene), industrial oil, benzene, toluene, hexane, water-gasoline emulsions, as well as water-organic condensate. It is known that this material has a high adsorption capacity for various organic media. Therefore, the lyophilic properties of different fractions of clinoptilolite in relation to the specified environments were investigated.

The lyophilic properties of clinoptilolite were studied using the lying drop method to measure the marginal wetting angle of different zeolite fractions using the specified media. The data obtained determined the suitability of clinoptilolite for cleaning soils and waters from these liquids.

The dependence of the wetting of clinoptilolite on the dispersion of clinoptilolite was established. All clinoptilolite fractions are characterized by high lyophilicity in all media except oil. The wettability of clinoptilolite with oil and the corresponding work of adhesion significantly depends on its dispersion. It was established that with an increase in the size of clinoptilolite particles from 0.1 to 2.5–3.0 mm, the work of adhesion increases from $13.5 \cdot 10^{-3}$ to $51.2 \cdot 10^{-3}$ J/m^2. The influence of the surface morphology of clinoptilolite may cause this. An increase in temperature in the clinoptilolite-oil system contributes to the wetting of small fractions of zeolite with oil.

The obtained experimental data show that natural clinoptilolite with a wide fractional composition can be used to purify natural and wastewater waters and soils from the indicated organic and water-organic environments. At the same time, only clinoptilolite fractions over 1 mm are suitable for oil sorption.

Keywords: zeolite, clinoptilolite, oil, oil products, natural and wastewater treatment, lyophilic properties, marginal wetting angle.

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ISSN-L 2664-9969; E-ISSN 2706-5448

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DOI: 10.15587/2706-5448.2024.319822

REMOVAL OF METHYLENE BLUE FROM WATER BY NiO-MODIFIED SILICA GEL

pages 47–52

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The objects of the study are sorption materials based on commercial silica gel and nickel (II) oxide with different mass ratios of NiO to SiO_2: 1:1 and 0.5:1. To obtain such materials, expensive reagents and complex synthesis schemes are not required. In addition, they are distinguished by chemical stability, controlled morphology and have a significant number of reactive functional groups, which contributes to high adsorption capacity for various types of contaminants.

The morphology of composite sorbents was studied using the electron microscopy method, the presence of a crystalline phase of nickel oxide on the amorphous surface of silica gel was investigated by X-ray phase analysis, and the successful application of a layer of nickel-containing compounds was confirmed by infrared spectroscopy.

The main parameters of the mesoporous structure of the samples were determined by the method of low-temperature nitrogen adsorption/desorption. It was found that with an increase in the amount of the deposited oxide layer, the specific surface area and pore volume of the obtained sorbents decrease by 1.5–2 times compared to the original silica gel.

The physicochemical features of the extraction of methylene blue dye by nickel-containing composites based on silica gel were studied. It was found that modification of the SiO_2 surface with nickel (II) oxide leads to an increase in the sorption capacity of materials in relation to cationic dyes. It was shown that the highest sorption capacity is possessed by a sample with a mass ratio of NiO to SiO_2 equal to 0.5:1. The maximum sorption value is 21 mg/g, which is almost 2 times higher than that for the original silica gel. The adsorption kinetics is adequately described by pseudo-first and pseudo-second order models, which indicates a high affinity of methylene blue with the surface of such samples.

The results obtained indicate that the obtained sorption materials based on commercial silica gel and nickel (II) oxide can be used in the purification of water contaminated with organic cationic dyes.

Keywords: adsorption, organic dyes, modification, nickel (II) oxide, water purification, silica gel.

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