## CHEMICAL AND TECHNOLOGICAL SYSTEMS

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### ADSORPTION REMOVAL OF COPPER(II) FROM WATER BY ZERO VALENT IRON LOADED DENDRITIC MESOPOROUS SILICA

pages 6–12

***Junjie Yu,*** *PhD Student, Department of Chemical Technology of Ceramics and Glass, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine, ORCID: https://orcid.org/0000-0003-1206-8494*

***Viktoriia Tobilko,*** *PhD, Associate Professor, Department of Chemical Technology of Ceramics and Glass, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine, e-mail: vtobilko@gmail.com, ORCID: https://orcid.org/0000-0002-1800-948X*

The object of research is synthesized dendritic mesoporous nanoscale silica (DMSN) modified with zero-valent iron ($Fe^0$@DMSN). This material exhibits a high adsorption capacity for heavy metal ions, in particular copper, whose increased content in the aquatic environment poses a threat to living organisms. In this regard, the main physicochemical features of the removal of copper cations from the aqueous medium using the obtained sample were investigated.

The morphology of the obtained dendritic silicas was studied by electron microscopy and the presence of a layer of zero-valent iron was confirmed by X-ray diffraction analysis and infrared spectroscopy. The parameters of the porous structure of the synthesized materials were determined. It was found that after modification of mesoporous silica with particles of zero-valent iron, the value of its specific surface area decreased from 504 $m^2/g$ to 312 $m^2/g$. This may be due to the formation of a $Fe^0$ layer not only on their surface but also in the channels of the inorganic matrix, which has a unique dendritic structure characteristic of this type of particles. At the same time, the number of active centers increases due to the enrichment of the silica surface with functional modifier groups that show a high affinity for metal cations.

The adsorption capacity of $Fe^0$@DMSN towards $Cu^{2+}$ ions has been studied and it has been shown that the maximum adsorption value is 39.8 mg/g, which is significantly higher than that of the initial synthesized DMSN sample (0.7 mg/g).

The experimental data obtained indicate that the obtained sorption material based on dendritic mesoporous silica nanoparticles with a layer of reactive zero-valent iron can be used for the purification of water contaminated with metal ions. In addition, the magnetic properties of such materials, known and proven by various scientists, will make it easy to separate the solid phase in the processes of sorption water purification using magnetic separation.

**Keywords:** DMSN, mesoporous silica, modification, adsorption, water treatment, heavy metals.

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## ANALYSIS OF THE FUNCTIONAL ADDITIVES EFFECT ON THE CORROSION RESISTANCE OF PAINT COATINGS

pages 13–17

***Tetiana Yarova,*** *Department of Theoretical and Applied Chemistry, Sumy State University, Sumy, Ukraine, ORCID: https://orcid.org/0009-0002-8297-6965, e-mail: tania3316yarova@gmail.com*

***Roman Khmyzenko,*** *Head of Research Department, Company MC "POLYSAN" LTD, Sumy, Ukraine, ORCID: https://orcid.org/0009-0008-5855-4766*

***Anna Yanovska,*** *PhD, Associate Professor, Department of Theoretical and Applied Chemistry, Sumy State University, Sumy, Ukraine, ORCID: https://orcid.org/0000-0001-8040-7457*

The paper deals with the issue of protecting metals from corrosion, which can damage their structures. Anti-corrosion coatings are widely used to ensure the durability of steel structures. It was described that the durability of the coating depends on the chemical and physical characteristics of the system, such as the type of coating, dry film thickness, water resistance, and adhesion. The importance of artificial aging tests for assessing the durability of coatings is considered, emphasizing that the results of such tests should be interpreted with caution, taking in consideration that artificial aging may not have the same effect as natural exposure. Various anti-corrosion additives for acrylic water-dispersion enamels are also described, which can improve the corrosion resistance of the coating, depending on the service conditions. The object of the research is the properties of enamels with functional additives in salt fog. The study results of the effectiveness of the anti-corrosion additives in acrylic enamels using salt fog from the BGD 881/S chamber are discussed. The research showed that the main requirement for increasing the effectiveness of the anti-corrosion additive in acrylic LPM is a comprehensive approach to improvement of the coating barrier properties, which additionally reduces the aggressive influence of the environment. The advantages of new complex anti-corrosion additives compared to traditional anti-corrosion pigments are multifunctionality – complex additives like Askonium 142 DA contain several active components that affect various coating properties, including anti-corrosion protection, adhesion, and water resistance. Traditional pigments, such as zinc phosphate, usually have only one function – to create a protective film on the metal. The main research idea of the article is to study the influence of anti-corrosion additives in paint coatings for metal protection from corrosion and the extension of the service life of structures.

**Keywords:** anti-corrosion additives, corrosion protection, salt spray, paint coatings, durability of lacquer coatings.

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# ECOLOGY AND ENVIRONMENTAL TECHNOLOGY

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## CONTRIBUTION TO THE ASSESSMENT OF EFFECT DISTANCES OF ATMOSPHERIC DISPERSION: CASE STUDY

pages 18–24

***Dalila Belaid,*** *PhD, Department of Transportation Engineering, Laboratory of Transports and Environment Engineering, Mentouri Brothers University Constantine1, Constantine, Algeria, ORCID: https://orcid.org/0009-0009-7091-213X*

***Rachid Chaib,*** *Professor, Department of Transportation Engineering, Laboratory of Transports and Environment Engineering, Mentouri Brothers University Constantine1, Constantine, Algeria, ORCID: https://orcid.org/0000-0001-8680-1906*

***Djamel Nettour,*** *Associate Professor, Department of Mining, Metallurgy and Materials Engineering, Laboratory of Resources Valorization and Environment (LAVAMINE), National Higher School of Engineering and Technology, Annaba, Algeria, ORCID: https://orcid.org/0000-0003-0056-5389, e-mail: d.nettour@ensti-annaba.dz*

***Samira Belhour,*** *PhD, Department of Transportation Engineering, Laboratory of Transports and Environment Engineering, Mentouri Brothers University Constantine1, Constantine, Algeria, ORCID: https://orcid.org/0000-0001-9719-4646*

Storage tanks are vital to the oil industry, functioning as essential components in the operation of oil fields. However, their strategic importance is accompanied by significant environmental risks, particularly due to atmospheric dispersion events. These events, characterized by the release and spread of pollutants such as aerosols, gases, and dust into the atmosphere, can stem from both human activities and accidental releases. The consequences are often severe, leading to considerable human, material, and ecological damage. Atmospheric dispersion of pollutants has emerged as a major environmental concern, especially within industries where storage tanks are integral to operations. This concern is magnified by increasingly stringent regulatory frameworks. Industries, particularly those operating within classified facilities subject to environmental protection laws, are now mandated to thoroughly identify, analyze, and assess potential accidental risks associated with their operations. These regulations are designed to mitigate the adverse impacts of such incidents, and this forms the object of this study.

In this study, we concentrated on the T-403A/B/C storage spheres at the ALRAR gas complex. Utilizing dynamic consequence modelling with ALOHA software, it was possible to conduct a comprehensive assessment of potential pollutant releases in the processing area. This approach allowed to meticulously map out the hazardous phenomena linked to these scenarios and to develop targeted preventive and protective measures. The findings from this study highlight the critical need for rigorous risk assessments and the implementation of proactive safety strategies. By doing so, the environmental and operational risks associated with storage tanks in the oil industry can be significantly reduced. This research underscores the imperative of integrating advanced modelling techniques and stringent safety protocols to safeguard both the environment and industry operations.

**Keywords:** environmental risks, spread of pollutants, atmospheric dispersion of storage tanks, safety, modeling, protection and prevention.

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## DISTRIBUTION OF HEAVY METALS IN CORE SEDIMENTS OF SOUTHERN IRAQ WATERWAYS

pages 25–30

***Faris Al-Imarah,*** *Professor, Department of Marine Chemistry and Environmental Pollution, Marine Science Center, University of Basrah, Basra, Iraq, ORCID: https://orcid.org/0009-0008-9463-4464*

***Ghasan Al-Najare,*** *Professor, Department of Marine Vertebrate, Marine Science Centre, University of Basrah, Basra, Iraq, ORCID: https://orcid.org/0000-0003-4763-6906*

***Nawras Al-Faiz,*** *Professor, Department of Natural Marine Sciences, College of Marine Science, University of Basrah, Basra, Iraq, e-mail: nawras.abdulzahra@uobasrah.edu.iq, ORCID: https://orcid.org/0000-0002-2857-7683*

***Kadhim Younis,*** *Professor, Department of Marine Vertebrate, Marine Science Centre, University of Basrah, Basra, Iraq, ORCID: https://orcid.org/0000-0003-3741-0102*

The object of the study is heavy metals in the Shatt Al-Arab River. Shatt Al-Arab River is considered one of the most important internal rivers in Iraq due to its multiple economic and social importance. In addition, this river has an important strategic location. Despite its importance mentioned above, the Shatt Al-Arab River suffers from various wastes from many and varied sources, which have directly affected the quality of its water and consequently the quality of the community of living organisms that live in it. Levels and distribution of certain heavy metals, Cd, Cu, Fe, Mn, Ni, and Pb, were determined in core sediments from Southern Iraq Waterways. Six sites were investigated, two in the lower reaches of Al-Hammar Marsh, 1) El-Barka, 2) El-Garmah, and four sites along Shatt Al-Arab River, 3) Al-Ashar, 4) Abu Al-Khaseeb, 5) Abu Floos Port, and 6) Al-Faw. The results indicate that Al-Faw station was distinguished by the fact that the highest values of heavy elements were obtained at this station and all depths, except Cd at Al-Ashar station at a depth of 25 cm (26.1375 μ/gm), Cu at a core depth of 50 cm (4.9635 μ/gm), Ni at a core depth of 25 cm (5.2483 μ/gm), and surface water (2.9021 μ/gm) and Pb in surface water at Abu Floos Port station (3.5001 μ/gm). The lowest concentrations of heavy elements for Cu, Mn, and Ni are in all depths of core sediments. Other elements, Cd, Pb, and Fe, were higher; on the other hand, higher levels of concentrations for all studied heavy metals were recorded at a depth of 100 cm. Iron was the highest in all depths of core sediments.

**Keywords:** sediments, heavy metals, atomic absorption, Southern Iraq Waterways, Shatt Al-Arab River.

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# FOOD PRODUCTION TECHNOLOGY

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## STUDY OF THE EXTRACTION KINETICS OF FLAVONOIDS FROM THE FRUITS OF *SOPHORA JAPONICA L.* WITH SUNFLOWER OIL

pages 31–35

***Liubov Pelekhova,*** *Engineer-Methodist, ANALYT SYSTEMS UKRAINE LLC, Kyiv, Ukraine, ORCID: https://orcid.org/0009-0005-1309-2017*

***Svitlana Usatiuk,*** *PhD, Associate Professor, Department of Food Expertise, National University of Food Technologies, Kyiv, Ukraine, ORCID: https://orcid.org/0000-0001-7554-0827*

***Olena Tyshchenko,*** *Senior Lecturer, Department of Hotel and Restaurant Business, National University of Food Technologies, Kyiv, Ukraine, e-mail: olena.m.tyshchenko@gmail.com, ORCID: https://orcid.org/0000-0001-9383-1898*

***Viacheslav Honcharov,*** *Deputy Chairman of the Board, PJSC "Kyiv Margarine Plant", Kyiv, Ukraine, ORCID: https://orcid.org/0009-0002-5970-9973*

Among the large number of biologically active substances contained in the fruits of *Sophora japonica L.*, the extraction of flavonoids, substances of medium polarity, is particularly important. The process of extracting them with vegetable oil from fruits is quite complicated. The object of research is the kinetics of the process of extracting flavonoids from *Sophora japonica L.* fruits with sunflower oil. The influence of temperature, duration, and hydraulic modulus on the extraction process, as well as on the derivation of the equation of the mathematical model, is studied.

Mathematical modeling methods are used in the research. Processing of experimental data for the study of extraction kinetics in the vegetable oil:vegetable raw material system is carried out using the Statistica statistical package. In order to derive the equation of the mathematical model of the process of extracting flavonoids from *Sophora japonica L.* with sunflower oil, the influence of temperature, duration and hydromodulus on the process of transition of the target component – flavonoids to the extract – is investigated. A mathematical model of the dependence of flavonoids on the hydromodulus ($H$=10–25), temperature ($t$=25–45 °C) and the duration of the extraction process of *Sophora japonica L.* ($\tau$=2–10 h) is obtained, which makes it possible to calculate the content of flavonoids with an average relative with an error within 5 %.

On the basis of the conducted experimental studies, basic technological schemes for obtaining unrefined sunflower oil of increased biological value are developed, which includes the following stages: preparation of raw materials, treatment of prepared raw materials with sunflower oil during dilution and mixing, separation of oil from raw materials by filtering. The proposed technology is promising, as its implementation is possible not only in food industry enterprises, but also in restaurant establishments, as it does not require expensive equipment, additional production premises and special training of personnel.

The mathematical models of the extraction process of *Sophora japonica L.* with unrefined sunflower oil proposed in the work allow to select the extraction parameters with a high degree of probability and offer the consumer flavonoid-enriched sunflower oil of increased biological value.

**Keywords:** *Sophora japonica L.*, sunflower oil, extraction, flavonoids, biologically active substances, kinetics, temperature, hydromodule.

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## SUBSTANTIATION OF SAFETY AND QUALITY INDICATORS OF NATURAL MINERAL AND SPRING WATERS IN UKRAINE FOR THE PREPARATION OF FOOD FOR INFANTS

pages 36–42

***Alona Kysylevska,*** *PhD, Department of Biomedical Engineering, Odesa Polytechnic National University, Odesa, Ukraine, e-mail: kisilevskaya07@gmail.com, ORCID: https://orcid.org/0000-0002-5577-528X*

***Ihor Prokopovych,*** *Doctor of Technical Sciences, Department of Biomedical Engineering, Odesa Polytechnic National University, Odesa, Ukraine, ORCID: https://orcid.org/0000-0002-8059-6507*

***Svitlana Kokhan,*** *Research Department for the Development and Technical Verification of Standards of the National and International Standardisation Department of the Institute of Standardisation, State Enterprise "Ukrainian Research and Training Centre for Standardisation, Certification and Quality", Kyiv, Ukraine, ORCID: https://orcid.org/0009-0000-1636-7868*

The object of the research is regulatory support for the use of natural mineral waters and spring waters for the preparation of food for infants. Along with drinking water, natural mineral water is used for the preparation of food for infants, which is more protected from contamination. Currently, there are no approved safety parameters for natural mineral waters and spring waters in Ukraine, as well as requirements for markings on packaging or labeling that relate to the suitability of these waters for feeding infants. In this work, based on the results of the analysis of the current legal documents of European countries (Poland, Bulgaria, the Czech Republic, France, Germany) on the use of natural mineral waters in the preparation of food for infants, the indicators of the safety and quality of natural mineral and spring waters in Ukraine in the preparation of food are substantiated food for infants. Because of the specific physiological needs of children at an early age, water for cooking is an important factor in their normal psychophysical development. Water for preparing infant food must meet stricter criteria for total mineralization (suggested: ≤500 mg/l), the content of certain macro-components, nitrites (suggested: ≤0.1 mg/l), nitrates (suggested: ≤10 mg/l), ammonium (sug-

gested: ≤0.1 mg/l), fluorides (suggested: ≤0.7 mg/l), sanitary and microbiological indicators (suggested normalization of the indicator of the total microbial number in the finished product). The peculiarities of the technology of industrial packaging of natural mineral waters and spring waters for the preparation of infant food are outlined. These waters are packaged only non-carbonated, without the addition of any preservatives or disinfectants. Packaging of these waters should take place near water points, which should be reliably protected from biological and chemical contamination. The obtained results can be used for the development and approval of a normative legal act in Ukraine on the regulation of the use of natural mineral waters and spring waters for the preparation of infant food.

**Keywords:** natural mineral water, spring water, infant food, safety indicators, Directive 2009/40/EC, Directive 2003/40/EC.

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## DETERMINATION OF THE POSSIBILITY OF USING A FUNCTIONAL APPARATUS FOR THE PRODUCTION OF MULTI-COMPONENT SEMI-FINISHED PRODUCTS WITH A HIGH DEGREE OF READINESS

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***Andrii Zahorulko,*** *PhD, Associate Professor, Department of Equipment and Engineering of Processing and Food Production, State Biotechnological University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0001-7768-6571, e-mail: zagorulko.andrey.nikolaevich@gmail.com*

***Nataliia Tytarenko,*** *Department of Equipment and Engineering of Processing and Food Production, State Biotechnological University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-9745-883X*

***Eldar Ibaiev,*** *Independent Researcher, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0003-3090-3553*

***Lyudmila Chuiko,*** *PhD, Head of the Research Department, State Biotechnological University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0003-2377-7501*

***Vitaly Zahorulko,*** *Independent Researcher, Kharkiv, Ukraine, ORCID: https://orcid.org/0009-0000-4794-4621*

The object of research is a functional apparatus for the production of paste-like and powdered vegetable semi-finished products. The problem of combined heat and mass exchange treatment of vegetable raw materials are solved by using a functional apparatus for concentration and drying for processing and production complexes, farm lands. The expected effect during the approbation of the device is predicted under the condition of a functional approach combining the processes of concentration and drying with precise control of the temperature regime due to the use of a film-like resistive electronic heater of the radiating type.

In the study, the approbation of a functional device for the production of multi-component vegetable semi-finished products of a high degree of readiness, with concentration and drying in the field of infrared heating at a temperature of 50 °C, was performed. Real-time temperature measurement was carried out by an automatic unit based on TRM, which ensured the accuracy of control at each stage. The temperature of the mashed mass during processing increased from 20.3 °C to 23.2 °C, reaching optimal conditions for forming a film with a thickness of 0.5 mm. In the rotary reboiler, the temperature in height varied from 25.7 °C to 50.1 °C, which contributed to the preservation of the properties of thermolabile raw materials. In the lower part of the apparatus, the temperature of the finished product was 49.8 °C, maintaining the necessary temperature regime for drying. The device creates a convective air flow (0.01 m/s) with the help of Peltier elements, which stabilizes the heat exchange at a temperature of 51.3 °C on the technical partition.

The practical use of the functional apparatus will allow its use at processing and production complexes and directly at the places of collection of plant raw materials for resource-efficient production of semi-finished products with a high degree of readiness. These semi-finished products can act as independent functional products for people in extreme conditions or as recipe ingredients for the recipes of various food products.

**Keywords:** functional apparatus, vegetable multi-component semi-finished products, combined heat and mass exchange processing, drying in the field of infrared heating.

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