ABSTRACT AND REFERENCES

TECHNOLOGY ORGANIC AND INORGANIC SUBSTANCES. ECOLOGY

DEVELOPMENT OF MATHEMATICAL MODEL OF EXTRACTION STAGE IN THE NITROBENZENE PRODUCTION (p. 4-10)

Serhii Kondratov, Mohammed Jamal al Hamadani

A mathematical model of the countercurrent benzene extraction stage of the spent acid of nitrobenzene production in a steady-state mode was developed. Processes of benzene nitration with nitric acid radicals contained in the spent acid and the transition of nitrobenzene to the organic phase occur during extraction. In the model, the optimal process organization – a two-stage extraction – separation in a countercurrent circuit was revealed.

Decomposition of the research object into "nitration" and "extraction" subsystems was carried out, development of models of subsystems in the form of systems of nonlinear algebraic equations of stationary processes of nitration and extraction was conducted, their analysis was performed. Based on the analysis, the optimal process organization – a two-stage extraction – separation in a countercurrent circuit was revealed.

The synthesis of the combined model in the form of a system of nonlinear equations describing stationary processes of both nitration and extraction was held. In the model, the effect of input parameters was investigated. It was found that the separation efficiency is strongly influenced by the temperature and the concentration of sulfuric acid in the spent acid and weakly – by the benzene: spent acid ratio. The tabular dependence of the residence time in the system to achieve acceptable residual nitric acid concentration at the outlet (0.05 %) on the temperature, concentration of sulfuric and nitric acids in the spent acid was built. Based on this dependence, a process mode was proposed.

The results can be used in the design of industrial nitration schemes and improvement of the nitrobenzene production technology.

Keywords: nitrobenzene, spent acid, benzene extraction, mathematical model, steady state, mode.

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EFFICIENCY EVALUATION OF MANUFACTURING THIN POROUS SHELLS BY EXTRUSION (p. 10-15)

Tomasz Garbacz, Volodymyr Krasinskyi, Oleg Suberlyak, Ludmila Dulebova

The paper presents the results of investigating the porous extrusion process of the polyvinyl chloride (PVC) cable shell in the presence of different-nature blowing agents. The aim was to develop a technological process of manufacturing the porous insulating polyvinyl chloride shell of the power cable by extrusion and explore the structure and performance properties of the resulting shell. Based on experimental data, optimal process parameters of manufacturing the porous insulating polyvinyl chloride shell of the power cable by the extrusion were found. The structure and performance properties of the porous shell were examined. It is shown that using endothermic blowing agents in the amount of 0,2–0,8 % and exothermic blowing agents in the amount 0.4–0.6 % in the extrusion of power cable PVC-shell allows to obtain high-quality product, the cost of which is significantly lower than of the monolithic PVC shell. It is shown that the obtained insulating shell meets national and international requirements.

Keywords: blowing agent, porous shells, extrusion, cable insulation.

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EFFECT OF CHROMIUM COMPOUNDS ON SYNTHESIS OF ALKALI METAL FERRATES(VI) (p. 15-21)

Dmitriy Golovko

The process features of producing alkali metal ferrates (VI) in the presence of chromium and its compounds, which are contained

in the feedstock were investigated. It was found that during the ferrate synthesis, chromium impurities move from iron components to the alkaline solution and crystalline ferrates as oxoanion CrO_4^2.

It is shown that at long-term storage of crystalline ferrates and their solutions in the presence of chromates, their decomposition degree increases.

The influence of chromium impurities on the synthesis effectiveness of ferrate solutions by various methods was determined. It was revealed that during transpassive electrochemical dissolution with increasing chromium content in the anode material >0.8 %, a decrease in the target product yield is observed.

Technological solutions to minimize the accumulation of Cr (VI) compounds in the target product, which lie in a rational feedstock selection, as well as the obligatory inclusion of several crystallization and extraction stages in inorganic (KOH solutions) and organic (methanol) solvents to the production cycle were proposed.

Keywords: ferrate (VI) synthesis, chromium impurities, chromate pollution, Cr (VI) determination.

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IMPROVEMENT OF GETTING SCHEME AND PURIFICATION OF METAL-CARBON COMPOSITIONS PRODUCED BY CARBON MONOXIDE THERMO-CATALYTIC DECOMPOSITION (p. 21-25)

Irina Kulish, Victor Skachkov, Olga Berezhnaya, Nikolay Kolesnik

Today, many researchers have an interest in the development and introduction of new types of carbon-based materials. Dispersion metal-carbon materials got by thermo-catalytic decomposition of carbon monoxide, occupy a special place among the carbon materials. Contaminated materials with the catalyst particles, the amorphous carbon and graphitized carbon particles are received by methods of metal-carbon.

The main aim of the research is to develop the technological scheme for production purified metal-carbon materials (MCM) by carbon monoxide thermo-catalytic decomposition.

First, Fe_2O_3 particles were reduced to iron at the temperature of 1173 K. Amorphous carbon became reducer. It was established that a reduced metal from Fe_2O_3 was 18.7%. The experimental process of iron pentacarbonyl formation was performed at a temperature of 463 K and with a pressure of 16 MPa. Total $Fe(CO)_5$ was 36 % by weight metal-carbon materials. Iron pentacarbonyl recovered from metal-carbon materials by temperature-vacuum processing.

The oxidation of the amorphous carbon was carried out at a temperature of 843 K and the CO_2 concentration of 62×10^{-4} kg /m^3. The purified metal-carbon materials were used as filler of polyurethane marks Eracast RT - 70A on the base of isocyanate and polyol.

It was established that metal-carbon materials content within 2 % increases the ultimate tensile strength almost twice and reduces limit narrowing of 14 %.

Proposed and tested scheme allows you to receive MCM physicochemical methods with enough good cleaning MCM of catalyst particles and amorphous carbon.

Keywords: amorphous carbon, thermo-catalytic decomposition, selective oxidation, carbon dioxide, polyurethane marks Eracast RT - 70A.

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DEVELOPMENT OF ELECTRO-CHEMICAL SENSOR FOR DETERMINATION OF MOLYBDENUM (VI) CONTAIN IN BIOLOGICAL FLUIDS (p. 25-31)

Kateryna Matorina

The electro-chemical sensor for determination of molybdenum (VI) concentration with the using of the triple metal – polymeric complex bromopyrogallol red – polyvinylpyrrolidone – molybdenum (VI) as electrode – active substance of film plasticized membrane had been elaborated. The electrode-analytical characteristics of constructed sensor had been fixed: dynamic range (2–5 pC); the slope of electrode function – 27 mV/pC detection limit $C_{min}=8\cdot10^{-8}$ mol/l; the optimal range of pH sensor operation is 6,0–8,0; conditioning time – 48 h; response time – 1-2 minutes; lifetime – 12 months. The effect of the inorganic electrolytes presence in internal and external solutions on electrode – analytical characteristics of proposed sensor had been determinated. The selectivity coefficients (K_{sel}) of made sensor on relationships for inorganic (Pb^{2+}; Ni^{2+}; Cu^{2+}; Cd^{2+}; Zn^{2+}; Ba^{2+}; Fe^{3+}; Bi^{3+}; PO_4^{3-} ($1,0\cdot10^{-3}$); Mg^{2+}; Be^{2+}; NO_3^-; SO_4^{2-} ($3,2\cdot10^{-3}$); Cl^- ($5,0\cdot10^{-3}$); K^+, Mn^{2+}, Br^-, I^- ($1,0\cdot10^{-2}$); Al^{3+} ($2,2\cdot10^{-2}$) Na^+ ($3,3\cdot10^{-2}$)) and organic components (citric acid ($1,0\cdot10^{-3}$); thiourea ($1,0\cdot10^{-2}$); urea; oxalic acid; succinic acid; glucose ($3,0\cdot10^{-2}$)) of biological fluid were determinated by method of separated solutions. The determination of molybdenum (VI) contain in whole blood (s_r=5,9 %) and urine (s_r=5,9 %) samples was conducted by method of additions. The correctness of the obtained results was tested by alternative spectrophotometric technique. The reproducibility of proposed ionometric and alternative spectrophotometric techniques for Cochran's Q – test ($G_{exper} < G_{tabl}$) is the same. The proposed sensor can be used in clinical analyze of biological fluids, in particular in the whole blood and urine samples of patients.

Keywords: potentiometry; sensor; molybdenum; triple metal-polymeric complex; biological fluid; urine; blood.

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FACTORS AFFECTING THE CHARACTER OF PLASMA DISCHARGE WITH ELECTROLYTIC CATHODE AT A FIXED PRESSURE (p. 31-35)

Olga Sergeyeva, Alexander Pivovarov

The influence of process parameters of plasma chemical treatment of aqueous solutions on the plasma discharge behavior at different values of the current, fixed pressure and the interelectrode gap was investigated in the paper. This was done to identify additional factors that affect the characteristics of the discharge – fluid system. As an electrolytic cathode, distilled and tap water, as well as $CuSO_4$ and $AgNO_3$ solutions in distilled water, were used. It was found that one of the factors affecting the gas-plasma discharge are charged bubbles in the electrolytic cathode layer, in the case when the metal electrode is put down in it. It was determined that bubbles could play a significant role in the delivery of charged particles to the gas-plasma discharge zone. In addition, microdischarges, emerging at a current I>125 mA in gas bubbles are an additional source of charged particles. The results will be used to create a refined mathematical model of plasma chemical treatment of liquid media.

Keywords: non-equilibrium plasma, discharge, liquid cathode, low pressure, an aqueous solution.

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CHROMIUM-MODIFIED MONTMORILLONITE DISPERSIONS IN STABIBLIZING DERMA COLLAGEN STRUCTURE (p. 36-42)

Vera Palamar, Maria Maruhlenko, Olena Mokrousova

We have studied how chromium-modified montmorillonite dispersions impact the stabilization of derma collagen structure and registered a high rate of absorbing chromium-based compounds. Chromium-modified montmorillonite dispersions used in

tannage would reduce the share of chromium oxide in the exhaust ooze by 30.0 %. Since montmorillonite has a highly adsorbing surface, it increases the efficiency of chromium-based compounds absorption. As a result derma acquires additional active centers for fixing chromium-based compounds, which increases the share of bound chromium oxide in derma and raises the leather welding temperature. The experimental leather has high physical and mechanical characteristics. Owing to montmorillonite dispersion, the leather lengthens by 1.5–7.0 % less and becomes softer. The findings of chemical analysis show that the experimental leather contains more mineral substances, and this index in test samples does not exceed 5.0 %. Chromium-modified montmorillonite dispersions used in tanning hides would extend the leather output piece by up to 4.7 %, raise the leather thickness by 3.5 %, and increase its output volume by 18.0 %. An optimal tanning would reduce the consumption of chromium-based tanning agents by 16.0 %.

Keywords: tanning, hide, montmorillonite, chromium-based tanning agent, collagen structure, stabilization/stabilizing, forming.

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PRODUCTION TECHNOLOGY OF COMPLEX FERTILIZERS BASED ON DISPERSED ACTIVATED SLUDGE (p. 43-47)

Alexandra Belianskaya, Anna Ivanchenko, Nikolay Voloshin

Nowadays there is a Ukraine's resource dependence on external sources of nitrogen-phosphorus-potassium raw material for fertilizers production, so there is the need to create a technology for using these substances from waste. The source of nitrogen, phosphorus and potassium formation is the excess activated sludge that is accumulated for years in the wastewater treatment plant territory and overfills sludge drying beds. However, the activated sludge contains up to 99.8 % of moisture, which prevents its widespread use in the fertilizers production technology. One way to reduce the moisture content in the sludge is its pre-machining, namely dispersion. It was proved in the paper that during machining with the disperser on the disperser rotor speed $17s^{-1}$ ($Re=42{,}4\cdot10^3$) there is the partial destruction of the activated sludge microorganism cells, sludge structure becomes denser. It was found that when using dispersion processes, sludge swelling in the further settling is delayed by 40 minutes. A technological production scheme of complex fertilizers, which first uses dispersion process that accelerates activated sludge settling (sludge residual volume is decreased by 50 %, and the humidity is reduced from 99.8 to 92 %) was developed. The research has allowed to expand the raw material base to produce complex fertilizers on the example of Dniprodzerzhynsk city due to using the activated sludge, sludge of calcium nitrate production and create a technology with a complex fertilizer output of 932.75 tons/year (68 %) of dry matter.

Keywords: complex fertilizer, activated sludge, dispersion, settling.

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DEVELOPMENT OF RISK ASSESSMENT METHODOLOGY FOR EMERGENCY LOSSES IN THE REGIONS OF UKRAINE (p. 48-53)

Sergiy Ivanyuta

Assessment of actual natural and man-made threats to regional security in Ivano-Frankivsk, Lviv, Zakarpattia and Chernivtsi regions was performed. Basic risk factors of emergencies in the regions of Western Ukraine were analyzed. The risk assessment methodology for losses from natural and man-made emergencies at the regional level that allows to increase the effectiveness of comparative analysis of natural and technogenic safety in the administrative regions of Ukraine was developed. This will allow more reasonably determine the acceptable risk level of emergencies for each of them, effectively allocate the available material and financial resources among regions to prevent the negative consequences of emergencies, which generally provides tangible safety improvement of the person, production facilities and environment under different emergencies that may occur in Ukraine. The evaluation and analysis of the risk dynamics of losses from different emergencies in the regions of Western Ukraine were carried out. The results of the risk assessment of losses from natural and technogenic emergencies in the regions of Western Ukraine, indicating the dominant nature of natural threats, which is also an integral factor in the ecological security deterioration were analyzed. The data show that the economic risk of natural emergencies significantly exceeds the risk of man-made emergencies. In general, this indicates the insufficient level of readiness of the natural emergency prevention and response system not only in western regions, but also in Ukraine on the whole.

Keywords: regional security, natural and man-made threats, risk, emergencies, sources of threats, economic losses.

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CRITERIA FOR NPP INDUSTRIAL SITE FLOODING BY COMBINED IMPACT OF TORNADOES AND EARTHQUAKES IN THE COOLING POND (p. 53-58)

Igor Kozlov

The results of analysis of the impact of extreme natural phenomena on safety of nuclear power plants in Ukraine, held in the "pre" and "post-Fukushima" periods have shown that tornadoes and earthquakes are the most likely events. However, the results are contradictory in relation to probability assessment of security-critical tornadoes, and do not take into account the possibility of the NPP industrial site flooding under the combined effect of tornadoes and earthquakes in the station reservoirs.

Hydrodynamic model of NPP industrial site flooding wave during tornadoes and earthquakes, based on the assumption of the flooding wave formation under the influence of tornado lift and seismic shock, as well gravity and internal dissipation forces; cylindrical shape of the flooding wave; conservative isothermal exposure of the flooding wave near the coast was developed. The flooding wave emergence and development process is conventionally divided into two different time-scale phases: the initial phase of the combined (in general) earthquake and tornado, the final stage of the tornado impact.

Based on the developed hydrodynamic model, deterministic criteria of possible NPP industrial site flooding at the combined (in general) impact of the tornado and earthquake in the cooling pond were defined. The analysis was performed on the example of the Zaporizhzhya NPP, due to which it was found that there was no flooding under tornadoes below the 2-intensity grade and earthquakes with response acceleration at the cooling pond bottom of less than 10 m/s^2 and duration of about ten seconds.

Keywords: nuclear power plants (NPP), flooding, earthquake, tornado, cooling pond, hydrodynamic model, NPP industrial site.

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INTEGRATED EXPRESS-EVALUATION OF AIR QUALITY UNDER CHANGING INDUSTRIAL INFRASTRUCTURE OF THE REGION (p. 58-63)

Dmitry Plyatsuk

As a result of the research, the relationship between the ecological condition of the urban environment and fluctuating changes in the foliage asymmetry of trees, most common in the study area was revealed. The most appropriate urban air pollution indicator plants in accordance with the bioindicative sensitivity set of tree crops were identified. The dependence between the ecological condition of the urban environment and fluctuating changes in foliage asymmetry of trees, most common in the study area was found. The maximum asymmetry index of white birch was observed in the north-eastern pilot section, which is caused by emissions from the chemical industry. This allows to trace the trend of the environmental quality transition from the "pre-critical" condition to "critical". The integral asymmetry index of the leaf blade for areas with different anthropogenic impact levels under a changing industrial infrastructure of the city was designed. Within three years, the integral index increased (in 2012 - 0,048; 2013 - 0,058; 2014 - 0,059). To view the distribution of toxic substances in the city, the study of pH values of bark of trees, related in their properties to the species with a poor bark, which showed that there is a rise in the tree bark pH in most of the study city area was conducted.

The resulting data of bioindicative research will allow to develop a number of administrative decisions and measures to reduce the value of the environmental risk indicator with increasing anthropogenic impact.

Keywords: air, industrial infrastructure, pollutants, express-evaluation, bioindication, asymmetry, leaves, bark.

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ENHANCING EFFICIENCY OF NITROGEN REMOVAL FROM WASTEWATER IN CONSTRUCTED WETLANDS (p. 63-68)

Oleksa Shved, Romana Petrina, Veronika Chervetsova, Volodymyr Novikov

This study contributes to the enhancement of nitrogen removal, as well as to the understanding of internal nitrogen transformation processes in horizontal subsurface flow constructed wetlands. Constructed wetlands of this type are able to efficiently remove polluting organic materials, total suspended solids and pathogens from sewage, but nitrogen removal is usually of relatively low efficiency. However, constructed wetlands are a competitive sustainable alternative for conventional wastewater treatment technologies. The primary objective was to evaluate the influence of plants and anaerobic ammonium oxidation (anammox) bacteria on the treatment performance of the wetlands in order to improve the management of these systems. Laboratory-scale horizontal subsurface flow wetland mesocosms were set up in the specialized reactors. The experimental system consisted of three planted fixed bed reactors with a volume of 19.5 L and a surface area of 0.040 m^2 each. Two of the reactors were planted with Juncus effusus and one was kept unplanted. All systems were fed with synthetic wastewater containing ammonium (NH_4^+) as a main contaminant. Hydraulic loading rate was fixed at 45 mm d^{-1}. In accordance with the varying operational conditions, the total experimental period was divided into three phases. During the last phase of the experimental period one of the planted reactors was inoculated with an enrichment culture of anammox bacteria. In summary, experimental results have shown that prompting of anammox process by inoculation of externally enriched biomass could be of tremendous importance for increasing the effectiveness of nitrogen removal in horizontal subsurface flow constructed wetlands.

Keywords: wastewater treatment, constructed wetlands, nitrogen removal, process intensification, anammox.

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