# CHEMICAL AND TECHNOLOGICAL SYSTEMS

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## DETERMINATION OF OPTIMAL PARAMETERS FOR THE PRODUCTION OF COPPER-CONTAINING PARTICLES DURING PLASMA-CHEMICAL TREATMENT OF AQUEOUS SOLUTIONS

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***Sergeyeva Olga,*** *PhD, Associate Professor, Department of Specialized Computer Systems, SHEI «Ukrainian State University of Chemical Technology», Dnipro, Ukraine, e-mail: ov.sergeyeva@gmail.com, ORCID: http://orcid.org/0000-0002-6634-7694*

***Pivovarov Alexander,*** *Doctor of Technical Sciences, Professor, Head of the Department of Inorganic Substances and Ecology, SHEI «Ukrainian State University of Chemical Technology», Dnipro, Ukraine, e-mail: apivo@ua.fm, ORCID: http://orcid.org/0000-0001-7849-0722*

The process of obtaining copper-containing particles from aqueous solutions is considered when using contact non-equilibrium plasma of reduced pressure.

One of the most problematic areas of this technology is the need for the difficulty in choosing the parameters of the plasma-chemical treatment of the solution leading to the production of the desired quality. This is due to the fact that the physical and chemical mechanisms of the reactions are rather complex and when they occur, synergistic effects are observed, the dependencies of which are not entirely clear.

In the course of the analysis, the possibilities of improving the technological scheme are revealed through:

1) control of the inlet pH of the solution, ensuring the optimal yield of copper compounds;

2) use of the spent solution in the tank with the initial solution for its acidification;

3) refinement of the reactor block for the purpose of processing the solution in film or close to it, which should lead to an increase in the yield of copper oxides and a decrease in the particle size.

The characteristics of the process of obtaining sediments are studied. At a concentration of C(Cu)=10–1–10–2 mol/l, the optimum pH range lies in the range 3.5–4.5. Let's note that an increase in the current intensity of the process is accompanied by an increase in both the yield of the sediment and its density. Reducing the Cu concentration at the same current parameters gives more loose sediments. At the same time, a decrease in the liquid layer promotes an increase in the yield of oxide compounds. Also, when the thickness of the processed liquid layer is reduced, the particle size of the sediment decreases. The composition and sizes of the obtained particles are determined. With a thickness of the treated solution layer of 0.25 m, the oxide part is 50 % and 49 % at 0.1 and 0.2 bar, respectively, and at 0.01 m – 86 %, and 87 %. The dimensional characteristics of the particles are in the range 10–100 nm.

**Keywords:** non-equilibrium plasma, aqueous solutions, copper particles of low dimensionality.

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# MEASURING METHODS IN CHEMICAL INDUSTRY

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## MATHEMATICAL MODELING OF THE PROCESS OF FLUID FILTRATION THROUGH A MULTI-LAYER FILTERING ELEMENT

page 9–13

***Vecherkovskaya Anastasia,*** *Senior Lecturer, Department of Software Engineering, National Aviation University, Kyiv, Ukraine, e-mail: post@nau.edu.ua, ORCID: http://orcid.org/0000-0003-2054-2715*

***Popereshnyak Svitlana,*** *PhD, Associate Professor, Department of Software Systems and Technologies, Taras Shevchenko National University of Kyiv, Ukraine, e-mail: fit@univ.net.ua, ORCID: http://orcid.org/0000-0002-0531-9809*

The paper presents a mathematical model of the fluid filtration process in a porous medium. The mathematical model of fluid filtration in a porous medium is based on the equation of continuity and the Darcy law for a hollow porous cylinder. The

porous cylinder consists of three materials having different mechanical and filtration properties, made of polypropylene fibers by extrusion, consisting of seven layers.

Filtration is described by different types of research laws that establish the relationship between a velocity vector of the fluid filtration and the field of pressure. There are several ways to describe mathematically the process of filter colmatation. Present work considers a single-component model of the flow of suspension through a porous medium. An analysis of this model revealed that it can be implemented in the presence of empirical coefficients that take into account porosity of the sediment deposited on the walls of a porous space, linear functions that describe adsorption and desorption of precipitation on the pore walls, as well as functional dependences for the permeability of filter and the viscosity of suspension.

An efficient technique to calculate complex models is to apply parallel programming methods, which make it possible to split calculations into streams performed on the basis of supercomputers, clusters, and other high-performance computing systems.

The proposed method for organizing distributed calculations for a finite-element filter model could be used to construct a hydrodynamic model of the filtration process, as well as its program implementation, which is planned in the future.

**Keywords:** mathematical model of the liquid filtration process, porous medium, Darcy law, distributed calculations.

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# ECOLOGY AND ENVIRONMENTAL TECHNOLOGY

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## INVESTIGATION OF THE FUNCTIONING OF A VORTEX TUBE IN SUPPLY OF DISPERSE FLOW (GAS – DUST PARTICLES) TO THE TUBE

page 14–21

***Shaporev Valery,*** *Doctor of Technical Sciences, Professor, Department of Chemical Technique and Industrial Ecology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, ORCID: http://orcid.org/0000-0003-1652-4688*

***Pitak Inna,*** *PhD, Associate Professor, Department of Chemical Technique and Industrial Ecology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: ipitak5@gmail.com, ORCID: http://orcid.org/0000-0002-5073-2942*

***Pitak Oleg,*** *PhD, Associate Professor, Department of Labour Protection and the Environmental, National Technical University «Kharkiv Polytechnic Institute», Ukraine, ORCID: http://orcid.org/0000-0001-5912-4604*

***Briankin Serhii,*** *Head of Course of the Faculty of Military Training, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: serzh2082@ukr.net, ORCID: https://orcid.org/0000-0003-0444-9107*

The process of dry dust removal of exhaust gases from the production of zinc white after melting furnaces of metallic zinc in a vortex tube under aerodynamic conditions is studied, which leads to the occurrence of Rank effect. It is proved that the behavior of the gas-dispersed flow under investigation during flow in a vortex tube is the same as for a gas flow without an aerosol. It is experimentally established that agglomeration of aerosol particles due to high-speed collisions of particles is observed in the vortex tube in the zone of quasi-solid rotation, where the most intense redistribution of energy and temperature is observed. The resulting agglomerates are almost 10 times larger than the dust particles that are fixed at the inlet to the vortex tube. The purification efficiency achieved is 97.8–99.9 %, depending on the gas flow rate at the inlet to the tube. The possibility of catalytic destruction of gas impurities (CO, $NO_x$, $SO_2$) is proved when

adding water vapor to the gas flow at the inlet of the tube as a catalyst. The dependence of the vortex tube utilization efficiency as a separator on various factors is studied. It is proved that in the vortex tubes, in comparison with the existing centrifugal cyclone ЦН-11, a significant (up to 6–9 %) increase in the efficiency of fine dust collection in the proposed dust-purification system. This opens up prospects for the introduction of vortex tubes and vortex chambers and helps to reduce the industrial negative impact on the atmosphere.

**Keywords:** dry purification of exhaust gases from aerosol, Rank effect, exhaust tube.

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## DEVELOPMENT OF METHODOLOGICAL APPROACHES TO ENVIRONMENTAL EVALUATION OF THE INFLUENCE OF MAN-MADE MASSIFS ON THE ENVIRONMENTAL OBJECTS

page 22–26

***Pavlychenko Artem,*** *PhD, Head of the Department of Ecology and Technologies of Environmental Protection, State Higher Educational Institution «National Mining University», Dnipro, Ukraine, e-mail: pavlychenkoa@nmu.org.ua, ORCID: http://orcid.org/0000-0003-4652-9180*

***Buchavyy Yuriy,*** *Assistant, Department of Ecology and Technologies of Environmental Protection, State Higher Educational Institution «National Mining University», Dnipro, Ukraine, e-mail: e-mail: yurique@3g.ua, ORCID: http://orcid.org/0000-0003-3282-2810*

***Fedotov Vyacheslav,*** *Assistant, Department of Ecology and Technologies of Environmental Protection, State Higher Educational Institution «National Mining University», Dnipro, Ukraine, e-mail: e-mail: vaclavdnepr@i.ua, ORCID: http://orcid.org/0000-0003-3521-815X*

***Rudchenko Andriy,*** *Senior Lecturer, Department of Ecology and Technologies of Environmental Protection, State Higher Educational Institution «National Mining University», Dnipro, Ukraine, e-mail: e-mail: rudchenko125@i.ua, ORCID: http://orcid.org/0000-0003-3952-3303*

Man-made wastes generated as a result of development of mineral deposits negatively affect the components of the environment and the health of the population, therefore the object of research is environmental safety of the functioning of mining enterprises.

To analyze the impact of man-made massifs on the environment, the Leopold matrix is used, which is formed for a typical bulk man-made massifs (rock dump and sludge depository) at various stages of their life cycle. For the complex multifactorial evaluation of the consequences of the influence of rock dumps and sludge depositories on the components of the environment, Harrington's logistic function is used.

Environmental consequences of waste disposal of mining enterprises in rock dumps are investigated. The most dangerous types of impact on the components of the environment during the operation of rock dumps are geomechanical changes in the relief, pollution of aquifers and the atmosphere. The total impact on environmental objects during the exploitation of man-made massifs in the form of rock dumps is estimated at 115 points, and after completion of their operation, significantly less – in 66 points.

An evaluation of environmental condition of the areas adjacent to the sludge depositories of waste from mining and processing of minerals is made. The greatest danger to the components of the environment during the operation of sludge depositories is the contamination of aquifers and anthropogenic eutrophication of surface water bodies. The total impact on environmental objects during operation of slurry storage is estimated at 107 points, and after their operation – 98 points.

A methodological approach to the environmental evaluation of mining sites is developed, which includes the following stages:

– collection, processing and systematization of information on volumes and component composition of waste;

– compilation of checklists of environmental consequences of waste disposal at various stages of the life cycle of man-made massifs;

– environmental evaluation of danger levels of man-made massifs;

– identification of environmental components that are most affected by waste sites;

– development of environmental decisions and effectiveness evaluation of their implementation.

The implementation of the proposed methodology will make it possible to comprehensively evaluate the environmental risks of certain technological links of mining enterprises, and develop ways to minimize them. This will reduce the levels of environmental pollution and increase the comfort of living in the mining regions.

**Keywords:** mining waste, man-made massifs, environmental evaluation, Leopold matrix, Harrington function.

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# FOOD PRODUCTION TECHNOLOGY

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## RESEARCH OF INFLUENCE OF TECHNOLOGICAL PROCESSING PARAMETERS OF PROTEIN-FAT BASE FOR SUPPLY OF SPORTSMEN ON ACTIVITY OF PROTEASE INHIBITORS

page 27–30

***Bochkarev Sergiy,*** *Senior Lecturer, Department of Physical Education, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: bochkarev.s.v@gmail.com, ORCID: http://orcid.org/0000-0003-4399-7907*

***Krichkovska Lidiya,*** *Doctor of Biological Sciences, Professor, Head of the Department of Organic Synthesis and Nanotechnology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, ORCID: http://orcid.org/0000-0001-8197-9801*

***Petrova Iryna,*** *PhD, Doctor of Juridical Science, Professor, Department of Information Security, Kharkiv National University of Internal Affairs, Ukraine, e-mail: ekobezpeka.ira@gmail.com, ORCID: http://orcid.org/0000-0002-1652-6715*

***Petrov Sergey,*** *PhD, Associate Professor, Department of Organic Synthesis and Nanotechnology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: petrowsa@gmail.com, ORCID: http://orcid.org/0000-0001-6500-5310*

***Varankina Oleksandra,*** *PhD, Associate Professor, Department of Biotechnology, Biophysics and Analytical Chemistry, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: avarankina@gmail.com, ORCID: http://orcid.org/0000-0002-6117-7091*

***Belinska Anna,*** *PhD, Associate Professor, Department of Organic Synthesis and Nanotechnology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: belinskaja.a.p@gmail.com, ORCID: http://orcid.org/0000-0001-5795-2799*

The object of research is the biological value of the protein-fat base for athletes, workers of heavy physical labor, military personnel, depending on the conditions of its preliminary processing. A technological audit, the purpose of which was to determine the change in the content of amino acids after enzymatic hydrolysis in samples of the protein-fat base, that had undergone pretreatment by microwave radiation, was conducted. The effectiveness of the protein-fat base pretreatment by microwave radiation was evaluated on the amount of α-amino nitrogen after enzymatic hydrolysis.

Based on the analysis of the obtained data, the optimal conditions of the protein-fat base pretreatment were established: 250–350 seconds of microwave treatment time and its hydration to the 12–14 % of moisture content. Such processing will increase the biological value of the protein-fat base, namely, increase the degree of digestion and digestibility of proteins in the gastrointestinal tract.

Keywords: oil seeds, protease inhibitors, ultrahigh-frequency radiation, enzymatic hydrolysis of protein.

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## INVESTIGATION OF ANTHOICIANS AVAILABILITY IN SUNFLOWER SEED HUSKS

page 31–34

***Papchenko Victoriia,*** *PhD, Deputy Director for Science, Ukrainian Scientific Research Institute of Oils and Fats of the National Academy of Agricultural Sciences of Ukraine, Kharkiv, Ukraine, e-mail: vikucya@gmail.com, ORCID: http://orcid.org/0000-0002-3692-0699*

***Matveeva Tatiana,*** *PhD, Associate Professor, Scientific Secretary, Ukrainian Scientific Research Institute of Oils and Fats of the National Academy of Agricultural Sciences of Ukraine, Kharkiv, Ukraine, ORCID: http://orcid.org/0000-0002-3867-8146*

***Belinska Anna,*** *PhD, Associate Professor, Department of Organic Synthesis and Nanotechnology, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: belinskaja.a.p@gmail.com, ORCID: http://orcid.org/0000-0001-5795-2799*

***Rudniev Vasyl,*** *PhD, Head of the Physical, Chemical and Biological Laboratory, Emeritus Professor Mykola Bokarius Kharkiv Research Institute of Forensic Sciences, Ukraine, e-mail: vasiliy.rudniev@gmail.com, ORCID: http://orcid.org/0000-0002-2550-3515*

***Zviahintseva Oksana,*** *PhD, Senior Lecturer, Department of Biotechnology, Biophysics and Analytical Chemistry, National Technical University «Kharkiv Polytechnic Institute», Ukraine, e-mail: oksana.kaf.226@gmail.com, ORCID: http://orcid.org/0000-0003-1921-4204*

***Cherevichna Nataliya,*** *PhD, Associate Professor, Department of Commodity and Examination of Foods, Kharkiv State University of Food Technology and Trade, Ukraine, e-mail: cherevichna@gmail.com, ORCID: http://orcid.org/0000-0002-6660-5366*

The comprehensive approach that provides a theoretical and experimental justification of a new feedstock for the production of anthocyanins is proposed. Such approach is needed in order to solve the problem of obtaining natural dyes. As sunflower is the main oilseed crop in Ukraine, hundreds of thousands tons of husks are obtained every year as secondary products (wastes) in fat and oil industry while processing its seeds. The must promising raw material for extraction of natural dyes is the sunflower husk as a cheap and affordable base.

The presence of polyphenolic compounds in sunflower seed husks samples was determined by qualitative reactions. Quantitative determination of anthocyanins in sunflower seed husks samples was performed by spectrophotometric method. For this purpose anthocyanins were extracted from the previously defatted and crushed husks with an aqueous solution of HCl (1 % m/m). The average content of anthocyanins in terms of cyanidin-3.5-diglucoside reached up to 0.42 %.

**Keywords:** anthocyanin pigments, extraction, secondary products, sunflower seed husks.

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## THE INFLUENCE OF ANTIOXIDANT HEAT TREATMENT ON UTILIZATION OF ACTIVE OXYGEN FORMS DURING STORAGE OF CUCUMBERS

page 35–41

***Priss Olesia,*** *Doctor of Technical Sciences, Associate Professor, Department of Technology of Processing and Storage of Agricultural Products, Tavria State Agrotechnological University, Melitopol, Ukraine, e-mail: olesyapriss@gmail.com, ORCID: http://orcid.org/0000-0002-6395-4202*

***Danchenko Olena,*** *Doctor of Agricultural Sciences, Professor, Department of Technology of Processing and Storage of Agricultural Products, Melitopol State Pedagogical University named after Bogdan Khmelnitsky, Ukraine, e-mail: nndea@ukr.net, ORCID: http://orcid.org/0000-0001-7041-3706*

***Yevlash Viktoria,*** *Doctor of Technical Sciences, Professor, Department of Chemistry, Microbiology and Nutritional Hygiene, Kharkiv State University of Food Technology and Trade, Ukraine, e-mail: evlashvv@gmail.com, ORCID: http://orcid.org/0000-0001-7479-1288*

***Zhukova Valentina,*** *PhD, Senior Lecturer, Department of Technology of Processing and Storage of Agricultural Products, Tavria State Agrotechnological University, Melitopol, Ukraine, e-mail: zhuzhuvf@gmail.com, ORCID: http://orcid.org/0000-0002-1963-659X*

***Verkholantseva Valentyna,*** *PhD, Senior Lecturer, Department of Processing and Food Production Equipment named after professor F. Yalpachik, Tavria State Agrotechnological University, Melitopol, Ukraine, e-mail: wer.valentina@gmail.com, ORCID: http://orcid.org/0000-0003-1961-2149*

***Stepanenko Dmytro,*** *PhD, Associate Professor, Department of Ecology and Zoology, Melitopol State Pedagogical University named after Bohdan Khmelnytsky, Ukraine, ORCID: http://orcid.org/0000-0002-6757-9382*

The effect of heat treatment with antioxidants on the degree of chilling injury, the dynamics of malonic dialdehyde and enzymatic antioxidants in the storage of cucumbers is analyzed. It is shown that the combination of heat treatment and the antioxidant composition Chl+I+A makes it possible to avoid chilling injury until the end of storage.

Cucumbers with heat treatment with antioxidants for the entire storage time demonstrate deviations from the background value of malonic dialdehyde by no more than 13.5 %, which reflects the stable functioning of the antioxidant system. Heat treatment with biologically active substances can slow the rate of decrease in activity of superoxide dismutase, which contributes to its activity at 60 % of the initial value after 28 days of storage.

The use of this treatment induces catalase activity in cucumbers, which grows according to the degree of their cold tolerance. Heat treatment with antioxidants regulates the activity of peroxidase in cucumbers, which is evidence of the slowing down of aging processes.

**Keywords:** cucumber storage, heat treatment with antioxidants, malonic dialdehyde, superoxide dismutase, catalase, peroxidase.

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## EFFECT OF SEED SOWING PERIOD ON POLYPHENOLIC COMPOUNDS CONTENT IN BASIL (OCIMUM BASILICUM L.) UNDER GREENHOUSE CONDITIONS

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***Priss Olesia,*** *Doctor of Technical Sciences, Associate Professor, Department of Technology of Processing and Storage of Agricultural Products, Tavria State Agrotechnological University, Melitopol, Ukraine, e-mail: olesyapriss@gmail.com, ORCID: http://orcid.org/0000-0002-6395-4202*

***Burdina Irina,*** *Postgraduate Student, Department of Plant Growing, Tavria State Agrotechnological University, Melitopol, Ukraine, e-mail: irina.plehun@gmail.com, ORCID: http://orcid.org/0000-0002-5991-0186*

***Kiurchev Sergey,*** *PhD, Professor, Head of the Department of Technology of Construction Materials, Tavria State Agrotechnological University, Melitopol, Ukraine, e-mail. dec.tgatu@ukr.net, ORCID: http://orcid.org/0000-0001-6512-8118*

***Verkholantseva Valentyna,*** *PhD, Senior Lecturer, Department of Processing and Food Production Equipment named after professor F. Yalpachik, Tavria State Agrotechnological University, Melitopol, Ukraine, e-mail: wer.valentina@gmail.com, ORCID: http://orcid.org/0000-0003-1961-2149*

***Stepanenko Dmytro,*** *PhD, Associate Professor, Department of Ecology and Zoology, Melitopol State Pedagogical University named after Bohdan Khmelnytsky, Ukraine, ORCID: http://orcid.org/0000-0002-6757-9382*

The object of the research is the process of formation of the polyphenolic complex by basil plants. The complexity in evaluating the process of polyphenols accumulation lies in the fact that the formation of these compounds occurs under the influence of a number of biotic and abiotic factors, leading to variation in the level of polyphenols in a very wide range even for plants of the same cultivar.

The influence of different seed sowing periods of five cultivars of basil on the accumulation of polyphenolic compounds in each cutting of green mass was investigated. The obtained data were mathematically computed using AgrostatNew and MicrosoftExcel software. It was found that cultivars with purple coloration of leaves accumulate by 51.2–66.6 % more polyphenols than green cultivars. It was observed that in the green cultivars Bad'oryi, Rutan and Siaivo, the level of polyphenols increases with each subsequent cutting of green mass during the February and April seed sowing periods. The cultivars with purple coloration of leaves have shown the highest level of accumulated polyphenols in the first cutting for the February seed sowing period and in the fourth and fifth cutting in April. The level of polyphenols in all the cultivars, which were sown in March, did not significantly change during cutting, indicating the optimal cultivation conditions.

**Keywords:** basil, polyphenolic compounds, seed sowing periods, number of cuttings.

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