ABSTRACT AND REFERENCES

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DEVELOPMENT OF ENGOBE COMPOSITION WITH THE USE OF PHARMACEUTICAL GLASS WASTE FOR GLAZED CERAMIC GRANITE (p. 6-12)

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This paper reports results of research into the application of pharmaceutical glass waste, which is a mixture of medical ampoules, in the production of ceramic tiles. Disposal of such waste reduces the negative impact on the environment and contributes to saving mineral raw materials. At the same time, environmentally safe handling of ampoule forms of pharmaceutical glass waste at the disposal stage implies the removal of drugs' residues from them.

The appropriateness of using glass ampoules cleaned from drug residues as a fluxing component of engobe coatings for glazed ceramic granite is experimentally and theoretically substantiated.

Comparative analysis of the charge composition of engobes of various manufacturers and of different chemical compositions of fluxing materials, which are components of these engobes, was carried out. The chemical composition of pharmaceutical glass waste was found to suggest the similarity of the basic properties of melts of these wastes and engobe glass frit.

The paper considers the dependence of viscosity of the melts of engobe glass frits on the temperature. It was found that by the estimated values of viscosity of melts and experimentally determined characteristics of fusibility, glass waste can serve as substitutes for expensive engobe frits, when used with other traditional components of engobes.

The chemical composition of the waste and of the basic engobe frit was determined by the method of X-ray spectrometry. Fusibility characteristics were explored using the thermoscope MISURA. Temperature coefficient of linear expansion of glass materials was determined with the use of the dilatometer LIL402PC.

The research into the development of engobe coatings using pharmaceutical glass waste for the technology of glazed ceramic granite at firing temperature of 1185 °C was carried out. The rational charge composition of glazed engobe with a whiteness of 76 % was determined, which contains 30 % by weight of glass waste. The engobe tiles with water absorption of 0.3–0.4 % and the limit of flexural strength of 52–54 MPa were obtained.

Keywords: pharmaceutical glass waste, glazed ceramic granite, engobe, charge composition.

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ENVIRONMENTAL POTENTIAL ANALYSIS OF CO-PROCESSING WASTE IN CEMENT KILNS (p. 13-21)

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The technology of waste co-processing in cement kilns has proven to be a reliable, efficient and convenient method of waste disposal (domestic and industrial). However, countries around the world face the following key barriers to the implementation of the technology of waste co-processing in cement kilns: fuzzy legislation, lack of financial support, public acceptance, etc. These barriers can be partially eliminated by the measures proposed in this study.

In addition, waste sorting and processing are often not carried out systematically. National and international cement companies operate modern cement kilns which could substitute a part of their fossil fuel and raw material with suitable waste streams to be co-processed. Co-processing non-recyclable waste is often a valid option to close loops towards circular economy. This technology is widely used in different European countries, but with different environmental impacts. Therefore, it is important to investigate the environmental potential of this technology, which is variable for different waste morphology conditions.

The potential benefits of the technology of solid waste co-processing in cement kilns are investigated. The methodology of estimation of greenhouse gas emissions for biogenic emissions in determining the benefits and environmental potential of the technology is applied. The example of the Ukrainian cement industry identified the possibility of: reducing the anthracite coal consumption in clinker production up to 262 kt/a; preventing up to 284 kt_{CO2eq}/a emissions from coal substitution. For the waste management sector, the potential of co-processing is identified: MSW disposal up to 1,213 kt_{MSW}/a; prevention of greenhouse gas emissions up to 111 kt_{CO2eq}/a in landfills. These findings are important in a number of countries, as the key barriers to co-processing in cement kilns are related. Environmental analysis results and proposed measures to avoid the identified key barriers to technology implementation can be applied to many countries.

Keywords: co-processing, resource saving, cement industry, greenhouse gas emissions, key barriers.

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CONSTRUCTION OF THE METHOD FOR SEMI-ADAPTIVE THRESHOLD SCALING TRANSFORMATION WHEN COMPUTING RECURRENT PLOTS (p. 22-29)

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A method has been constructed for the threshold semi-adaptive scaling transformation. The method provides calculation of recurrent plots, which adequately map the dynamics of real complex dynamic systems in natural and technical spheres. A new scientific result implies the development of theoretical basis for the method of semi-adaptive scaling transformation of the threshold during calculation of recurrent plots by improvement of linear normalized spaces due to introduction of a scalar product of vectors. The proposed method of threshold transformation provides computation of recurrent plots with increased information content, invariance to parameters of measured state vectors, and irregularity of measurements. We performed tests of operability of the proposed method of semi-adaptive scaling transformation of the threshold based on experimental measurements of concentrations of formaldehyde, ammonia, and carbon monoxide in atmospheric air in a typical industrial city with conventional stationary and mobile sources of pollution.

Taking into account the proposed method of semi-adaptive scaling transformation, the obtained results of the calculation of recurrent plots confirmed its operability in general. It was found that the calculation of RP during the semi-adaptive transformation of the threshold for various α angular dimensions of a recurrence cone, equal to 1°, 5°, 10°, and 20°, indicates that accuracy of recurrent plots in detection of dangerous states in dynamic systems increases with a decrease in angular dimensions of a cone. It was established experimentally that the values of angular dimensions of the recurrence cone should be 1–5° for adequate mapping of recurrent states of real dynamic systems with the use of calculated recurrent plots.

Keywords: recurrent plot, complex dynamic systems, semi-adaptive threshold transformation, atmospheric pollution.

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IMPROVEMENT OF THE INSTALLATION WITH AN EXTENDED BARREL OF CRANKED TYPE USED FOR FIRE EXTINGUISHING BY GEL-FORMING COMPOSITIONS (p. 30-36)

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Extinguishing fires with gel-forming compositions was found to be a promising direction of increasing the extinguishing efficiency, especially at multi-storey buildings and facilities for different functional purposes, because it makes it possible to prevent unintended damage from flooding the lower floors.

To extinguish fires at residential and industrial buildings rapidly, the new installation for fire extinguishing by gel-forming compositions was proposed. The rational use of the fire-extinguishing capacity of gel-forming compositions in it is achieved through the application of a cranked extended barrel with a special mixer and a sprayer. This new installation enables extinguishing by gel-forming compositions from the distance of 3–5 m to the fire site, ensuring safety of a firefighter-rescuer.

The full-scale sample of the original two-cranked barrel-sprayer of the portable installation was constructed, manufactured, and tested. By performing experimental research, it was proven that its use, due to its compactness in the folded state and the ease of unfolding into operating position, provides convenience of transportation and operation efficiency under rapidly changing conditions of a fire, especially in high-rise buildings.

Feeding gel-forming compositions in the finely sprayed form decreases their consumption for extinguishing fires by 1.5 times, compared with the previously proposed technical solutions.

To determine the effective value of dispersion and intensity of spraying gel-forming compositions in mathematical models of consumption for extinguishing the simulated fire and the time to extinguish it, we used second degree polynomials. Unknown coefficients were determined by the standard least square method. As a result, the rational values of the diameter of droplets (1 mm) and intensity of feeding (0.6 l/s) of gel-forming compositions were determined, which ensured the technical optimum of their use. Thus, it was found that the parameters of extinguishing the simulated fire 1A by the finely dispersed gel-forming compositions correspond to the total consumption of 2.5 kg, which is 3.5 times less compared with water.

Keywords: gel-forming compositions, extended barrel, extinguishing installation, finely sprayed jet, simulated fire.

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DETERMINATION OF THERMAL AND PHYSICAL CHARACTERISTICS OF DEAD PINE WOOD THERMAL INSULATION PRODUCTS (p. 37-43)

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The studies allowed manufacturing dead pine wood thermal insulation materials for the arrangement of premises. Raw materials for their production are wood fibers formed as flat boards. The mechanisms of the thermal insulation process during energy transfer through the material, which makes it possible to influence this process are determined. It is proved that the processes of thermal insulation consist in reducing the porosity of material. So, with a decrease in material density, thermal conductivity decreases, and vice versa. Modeling of the heat transfer process in the swelling of the fireproof coating is carried out, temperature dependences of thermophysical coefficients are determined. Based on the obtained dependences, thermal conductivity for dead pine wood products, reaching 0.132 W/(m·K) is estimated. In case of adhesive bonding of wood products, it decreases to 0.121 W/(m·K) and when creating wood wool thermal insulation boards it decreases to 0.079 W/(m·K), respectively. Features of inhibition of the process of heat transfer to the adhesive bonded wood wool material are associated with the formation of pores. This is because in small pores there is no air movement, accompanied by heat transfer. Thermal conductivity of

homogeneous material depends on density. So, with a decrease in the material density to 183 kg/m^3, thermal conductivity decreases 1.67 times, and vice versa, when using the board, thermal conductivity decreases only 1.1 times. This allows confirming the compliance of the discovered real mechanism of thermal insulation with the revealed conditions for the formation of properties of the inorganic and organic-mineral bonded wood wool material, as well as practical attractiveness of low-quality wood. The latter, in particular, relate to determining the amount of the binder component. Thus, there is reason to argue about the possibility of directed regulation of the processes of formation of wood thermal insulation materials using wood wool and inorganic and organic-mineral binder, which can form a fire-retardant film on the material surface.

Keywords: thermal insulation materials, wood wool, thermal conductivity, heat capacity, inorganic and organic-mineral binder.

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IMPROVEMENT OF THE MODEL OF FORECASTING HEAVY METALS OF EXHAUST GASES OF MOTOR VEHICLES IN THE SOIL (p. 44-51)

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Consideration of the problem of modeling the penetration of heavy metals of exhaust gases of automobile engines is carried out for the soil with permeability coefficient c_p and diffusion coefficient D. As a result of mathematical modeling, an exponential equation is obtained, the input variables for which are the surface concentration of harmful components c, permeability coefficient c_p, diffusion coefficient D and soil depth l. The output variables for the obtained

exponential equation is the concentration of harmful components C_1 at a depth l.

According to the obtained equation, the depth of penetration of heavy metals into the soil – l is theoretically investigated, depending on the surface concentration $c_1<c_2$ and at constant ratio c_p/D. As a result, the penetration depth of heavy metals increases, which is due to an increase in the driving force of the diffusion process. Having studied the effect of an increase in the c_p/D ratio on the penetration depth of heavy metals into the soil at constant surface concentrations c_1 and c_2, a decrease in their penetration depth is found, which is due to a decrease in the diffusion process.

The obtained theoretical results are confirmed by experimental studies of the depth of penetration of heavy metals – exhaust gases of the ZMZ-511.10 petrol engine into the soil. It is found that the content of heavy metals in the soil at an arbitrary depth corresponds to theoretical calculations, and the discrepancy is within the measurement error. When measuring the lead concentration, the discrepancy is within 12.5–15 %, zinc 5.5–7.5 %, manganese 8.5–11 %. So, the concentrations of heavy metals, measured at arbitrary depths, are 0.1 and 0.2 m for lead; 0.1, 0.2 and 0.3 m for zinc; 0.1; 0.2 and 0.25 m for manganese. This indicates the validity of the results obtained by the exponential equation. Therefore, the proposed model provides high accuracy in determining the concentration of heavy metals in the soil and can be used for forecasting their penetration depth if the surface concentration is known.

Keywords: road transport, fuel, petrol, exhaust gases, heavy metals, soil, pollution forecasting.

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THE EFFECT OF USING AN ENERGY ACCUMULATOR ON THE LEVEL OF EMISSIONS OF POLLUTANT SUBSTANCES BY A SHUNTING LOCOMOTIVE (p. 52-58)

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Shunting locomotives at railroad stations account for most emissions of pollutants into the atmosphere. A significant share of these emissions depends on the position of the driver's controller that is used to operate a diesel locomotive, as each position of the controller corresponds to a specific rotation frequency and power of the diesel engine. We have investigated the influence of application of the energy accumulator within a power circuit of a shunting locomotive on the level of emissions of pollutants into the atmosphere when it performs different shunting operations. The relation has been established between the levels of pollutant emission into the atmosphere and the types of shunting operations performed. We have obtained statistical data regarding the time of a diesel locomotive shunting operation at each position of the driver's controller when performing different types of shunting work. That makes it possible to optimally select the parameters of an energy accumulator for a shunting locomotive, which can meet both the technical and environmental requirements. It was established, based on the results from the current study, that using the energy accumulator within a power circuit of a shunting diesel locomotive reduces the amount of emissions of carbon oxide CO, nitric oxide NO_x, sulfur dioxide SO_2, soot and hydrocarbons, into the atmosphere by 20...30 % depending on the type of performed shunting operations and the capacity of the energy accumulator applied. Bringing down the level of specified emissions would make it possible to improve environmental conditions at a station.

Keywords: emissions of pollutants, shunting operations, modernization of shunting locomotives, energy collector, hybrid drive.

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