ANALYSIS OF THE WORLD MARKET OF LITHIUM. RESOURCES, MINING AND DEVELOPMENT PROSPECTS

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ABSTRACT

To date, lithium is a mineral resource, which is characterized by some of the fastest growth rates in terms of price, consumption and production volumes. In this paper, we attempted to estimate the rates of consumption, the growth of production volumes and the growth of the explored volumes of lithium mineral resources. The growth of lithium consumption stimulated the growth of geological exploration of its mineral resources, which resulted in a sharp increase in explored reserves. We made an attempt to evaluate other, poor in lithium mineral resources. Due to possible depletion of existing resources, poor resources can become the most promising source of resources. An attempt is made to forecast the development of the lithium market, its extraction and price. Possible directions and prospects of lithium extraction from poor sources of raw materials, which are underground waters, associated oil waters. It is also shown the possibility of increasing the degree of its extraction from existing sources of raw materials. The directions for solving these problems are continued.

METHODS FOR EXTRACTION OF LITHIUM FROM NATURAL RAW MATERIALS

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ABSTRACT

The present work is devoted to comparison of different methods of lithium extraction from natural raw materials. The main methods of processing spodumene and other lithium minerals used in industry are considered. Nowadays, hydro-mineral raw materials gradually become the main source of lithium. The analysis of methods for processing lithium-containing hydro-mineral raw materials is considered. A method of extraction of lithium from natural brines by precipitation of sparingly soluble salts is the most commonly used in practice. However, from an ecological point of view, more promising are sorption methods of extraction of lithium from natural and technological solutions that are poor in lithium content. In view of complexity of the salt composition of hydro-mineral raw materials, the use of highly selective inorganic ion-exchange materials is the most promising method for recovery of lithium. To complete the general picture of lithium production, an analysis was made of modern methods for obtaining metallic lithium and various lithium-containing compounds. Described are methods of reprocessing lithium carbonate into other compounds, as well as methods for obtaining lithium hydroxide and lithium chloride. To obtain metallic lithium, electrochemical and vacuum-thermal methods are considered. Briefly considered are also methods of lithium refining. In conclusion, a need for processing secondary lithium resources is considered.

CORRELATION METHOD FOR ESTIMATING THE DISTORTION DEGREE OF CRYSTALLINE STRUCTURE OF CELLULOSE

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ABSTRACT

In this paper a simple method for estimating the parameter of volume distortion of crystalline lattice, $\delta v = (V/V_o)-1$ for cellulose samples was proposed, where V and V_o are specific volume of distorted and undistorted crystalline unit cell, respectively. As is known, the crystalline lattice of cellulose nanocrystallites is imperfect due to presence of structural defects such as paracrystalline distortions, dislocations, vacancies, etc. It was found that specific volume of crystalline unit cell (V) and interplanar spacings (d) are linear functions of inverse lateral size of crystallites (D^{-1}). Combining these functions after excluding D^{-1}, the dependence $V=f(d)$ can be obtained that provides the estimation of δv parameter for various cellulose samples. The procedure includes determination of interplanar spacing, d, using the sharp diffraction peak of cellulose at the 2Θ between 22 and 23°, and then calculation of δv parameter with a standard deviation of ± 0.001 by the equations $\delta v = 3.084 \, d \, (nm) - 1.184$ for CIβ samples and $\delta v = 4.163 \, d \, (nm) - 1.598$ for CIα samples. It was found that the large crystallites of tunicate cellulose have a low distorted crystalline structure, whereas crystalline lattice of small crystallites of cellulose isolated from herbaceous plants, wood, flax and cotton fibers is more distorted. Study of CIβ and CIα cellulose samples having the close crystallinity and lateral size of crystallites showed that CIα lattice is more distorted compared to CIβ lattice.

IMPROVED X-RAY METHOD FOR DETERMINATION SIZES OF CELLULOSE CRYSTALLITES

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ABSTRACT

Method of wide angle X-ray shattering (WAXS) is a non-destructive method that is widely used to estimate the sizes of crystallites by means of the Scherrer equation. However, this method has a limitation, since a width of X-ray diffraction peaks depends not only on the size of crystallites but also on other factors, such as instrumental effect and second-order distortions of crystalline lattice, i.e. Δ–factor. The method of measuring the correction for the instrumental factor (b) is well known, but Δ–factor is ignored that leads to understated sizes of cellulose crystallites. In this paper the simple procedure for determination of Δ–factor and actual sizes of crystallites was proposed. As it was revealed, Δ–factor is linear function of interplanar spacings (d) of crystalline lattice. After finding the numerical coefficients (k and C) of the function: $\Delta = kd + C$, the correction for broadening of diffraction peaks was calculated, which allows to determine the actual transverse size (D_a) and actual length (L_a) of crystallites. Study of various samples of CIβ showed that tunicate cellulose has the largest crystallites: D_a=13

nm; L_a = 400 nm. Actual sizes of crystallites in isolated CIβ celluloses of other origin (herbaceous plants, wood, bast fibers, cotton fibers, etc.) were smaller: D_a was in the range of 4.2 to 10 nm, whereas L_a in the range of 48 to 116 nm.

EPOXY MATRIX COMPOSITES FOR FIRE-SAFE CONSTRUCTION

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ABSTRACT

For the purpose of fire safe construction it is necessary to reduce fire hazards of of building materials, including polymer matrix composites. In the present work we have studied the thermal stability, flammability, fume evolution of epoxy matrix composites with different types and amounts of hardeners, fillers, plasticizers and fire retardants. It is shown that chemical composition of fillers has little effect on the flammability of epoxy composites when the content of mineral fillers is less than 45% by mass. Smoke formation decreases linearly with increasing the degree of filling. A correlation was found between the oxygen index and the combustibility index when tested by the ceramic pipe method in accordance with RU GOST 12.1.044. It is shown that to obtain low-combustible materials the oxygen index should exceed 31%. It has been established that the chemical structure of additive aromatic brominated fire retardants has practically no effect on flammability. It was found that the optimal concentration of industrial brominated fire retardants is 8-10% by mass. To reduce the flammability of epoxy composites, additive brominated fire retardants in the form of a solution in N,N-dimethyl-2,4,6-tribromoaniline have been proposed. The high efficiency of acetyl- and α-hydroxyethyl ferrocene as a smoke suppressor of epoxy composites is shown.

PROPERTIES AND REACTIVITY OF CYCLOCARBONATES

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ABSTRACT

Commercially, polyurethanes are produced by the reaction of diisocyanates, polyols (polyester or polyether) and low molecular weight chain extender. Toxicity, moisture sensitivity and phosgene-based synthesis of diisocyanates resulted in investigations focused on obtaining the non-isocyanate polyurethanes (NIPUs). This work presents the review of synthesis and structure–properties relationship of non-isocyanate polyurethanes obtained by reacting cyclic carbonated intermediates with diamines or polyamines.. Described five-membered ring cyclic carbonate intermediates were obtained by carbonation of glycidyl ethers chemically modified bio-based substances, e.g. carbonated vegetable oils. The mechanical and thermal properties of NIPUs are affected by functionality, structure and molecular weight of cyclic carbonate intermediates and diamines or polyamines.

APPLICATIONS OF PARALLEL REACTION-SEPARATION PROCESSES (RSP) AS CLEANER PRODUCTION (CP) TECHNOLOGIES IN CHEMICAL ENGINEERING

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ABSTRACT

Reactive separation processes (RSP) have demonstrated their decisive advantages over more conventional processes. Running a chemical reaction in the same place and at the same time with some physical process of separation in the resultant reaction zone is an effective way to increase chemical processing rates. Reaction and the diffusion step here affect each other rather strongly. Through utilization of these and other effects associated with heterogenization in the system, dramatic improvements can be attained in the rates of many chemical processes together with much higher yields and enhanced selectivity. This means improved purity of products, reduced pollution and conserved energy and materials. Improved performance can be achieved via parallel reaction-separation even with conventional processes. It's necessary to pay attention on other advanced but not enough learnt RSP variant, when reaction and separation occur simultaneously in integrated reactor/desorbers (RDP). The article is devoted to: RSPs classification, algorithm of production purity increasing on the base of system approach with RSPs using, RSPs makrokinetics, increasing of production purity when using RSPs (on the example of classification production).

TECHNOLOGIES OF CONSTRUCTION CANNONS: THEORY AND PRACTICE

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ABSTRACT

The article describes the history of creation of the mathematical theory and operation of artillery pieces intended for driving piles or other construction elements by shooting them into the ground. The historical background section covers the period since the 30th to the middle 90th of the 20th century. The article gives a brief description of FSA-2 – the facility for driving (shooting) anchors into the ground – which was successfully used in Tyumen, Russia when laying pipelines for preventing them from floating-up in swamps, and the multipurpose facility for shooting anchors and piles FSAP-2; the article also presents photos of the FSAP-2 driving piles vertically and horizontally puncturing embankments or hummocks. The article describes the method of impulse indentation of piles into the ground offered in the mid-nineties and gives numerical characteristics of efficiency and productivity of the FSAP-2 obtained as a result of commercial use of the facility at oil and gas fields in Western Siberia and industrial construction in Ural. The article describes features of the design of single-barrel guns which can be applied for construction works at water objects and also substantiates application of impulse indentation of long construction (structural) elements into the ground by artillery pieces located on a water surface. Also the article provides general results of modern investigations starting from 2000. In particular, the schematic design diagram and mathematical models of multibarrel construction cannons are given. Numerical experiments performed on the basis of mathematical models of multibarrel construction guns allow us to assume that multibarrel

artillery pieces are as effective as single-barrel cannons applied for solving problems of construction. For instance, the numerical experiments have demonstrated a possibility of shooting piles into the moderately firm ground from multibarrel guns over 30 m deep. The article presents mathematical models and results of numerical experiments concerning the use of gas-dynamic artillery pieces for driving piles by shooting them into the ground.