STUDY OF CONVERSION OF CELLULOSE INTO MICRO-AND NANOCRYSTALLINE PARTICLES DURING ACIDIC HYDROLYSIS

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ABSTRACT

Acid hydrolysis is a common process used for the production of microcrystalline (MCC) and nanocrystalline cellulose (NCC). When the starting cellulose feedstock is treated with boiling dilute acids (1-3 M), a sharp decrease in degree of polymerization (DP) is observed until achieving a minimum constant value called level-off degree of polymerization (LODP), which is close to DP value of elementary nanocrystallites. Despite achieving of LODP, after such chemical treatment the micron-size particles of MCC are formed instead of nanoparticles - a paradox that requires an explanation. It was found that dilute acid causes a selective hydrolysis of non-crystalline domains (NCD) to LODP without breaking the strong lateral contacts between crystallites in cellulose microfibrils. Therefore, the subsequent sonication of hydrolyzed cellulose in an aqueous medium leads to transverse splitting of relatively long fibers with obtaining of shorter low-molecular fragments of the fibers, namely micron-scale particles of MCC. On the other hand, treatment with concentrated acids (7-9 M) at moderate temperatures (45-60^{o}C) cause not only the hydrolysis of NCD, but also the destruction of strong inter-crystalline contacts between nanocrystallites in cellulose microfibrils, thus facilitate the release of free nano-scale particles of NCC after subsequent ultrasound disintegration of weak particulate aggregates in an aqueous medium**.**

SCALE EFFECT OF SPRAY-DRIED MICROCRYSTALLINE CELLULOSE

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ABSTRACT

In this research, a fractal structure of beads of different sizes obtained by spray-drying of aqueous dispersions of microcrystalline cellulose (MCC) was studied. These beads are formed as a result of aggregation of rod-shaped cellulose nanocrystalline particles (CNP). It was found that increasing the average radius (R) of the formed MCC beads results in increased specific porosity (P) and reduced apparent density (ρ). The dependences of P and ρ on scale factor (R/r) can be expressed by power-law equations: $P = P_0(R/r)_p^{E-D}$ and , $\rho = d(R/r)_d^{E-D}$ where the fractal dimensions D_p = 2.887 and D_d =2.986 are close to Euclidean dimension E=3 for three-dimensional space; r=3 nm is radius of cellulose nanocrystalline particles, P_o = 0.03 cm^3/g is specific porosity and d=1.585 g/cm^3 is true density (specific gravity) of CNP, respectively. Thus, with the increase in the size of formed MCC beads, the order in the packing of the beads is distorted conforming to theory of diffusion-limited aggregation process**.**

SILICA SOLS - SYNTHESIS METHODS, PROPERTIES AND APPLICATIONS

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ABSTRACT

The article considers examples of obtaining silica sols by ion-exchange methods. An analysis was made of the factors of this method that affect the properties of the resulting sols. The principal technological scheme of an industrial plant for the production of silica-sol by an ion-exchange method were considered. The results of studies of the sol-gel transition in silica-sol obtained by the ion exchange method were presented. The growth kinetics of colloidal silica-sol particles, which were obtained from solutions of polysilicic acid, was investigated. The dependence of the growth kinetics of colloidal particles from solutions of polysilicic acid on the temperature and on the initial pH of the sol was shown. The dependence of the gel time on the dimensions of the colloidal particles in the ash, on temperature, concentration and pH, was shown. The effect of the composition of the liquid phase on the stability of silica sols was established. Influence of the charcoal characteristics on the properties of the xerogels obtained. The effect of silica powder on the properties of the xerogels obtained was analyzed. An analysis of the possibilities of the practical application of silica powder as a binder in the preparation of heat-resistant heat-shielding composite materials was carried out

SIMULATION OF THE PROPERTIES AND BEHAVIOR OF INDIVIDUAL PARTICLES OF SILICA SOLS

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ABSTRACT

This article is devoted to the description of the interaction of particles of the dispersed phase in a colloidal solution and of silica-sol particles in an electrolyte solution. The proposed theoretical consideration of this interaction is the development of the theory of DLVO. When creating a model, it was assumed that silica-salt particles that are in an electrolyte solution are a collection of charged particles, but at the same time, they are electro-neutral particles. In describing the interaction of these systems, an approximation is taken about the smallness of the size of charged particles compared to the distance between them. In the present work, an attempt was made to describe the interaction of colloidal particles within the framework of the model of interaction of point charges. For this propose a simple model describing the interaction of the two systems of electric charges located at arbitrary distances from each other. The analysis of the obtained potential dependences on the "elasticity" of colloidal particles showed the presence of three special points. These points are associated with a qualitative change in the type of interaction of the particles with each other, which allows us to distinguish 4 types of colloidal particles in electrolyte solutions. The calculations indicate the possible existence of ultra-soft colloidal systems with long-range forces of interaction between the particles. In such systems, the formation of long-range hyper structures is possible, that is, the formation of aggregates without short-range interaction between particles. Based on the analysis of the results obtained, a classification system for colloidal particles is proposed. For rigid colloidal systems, an expression for the viscosity of a colloidal solution is obtained depending on the volume fraction **of the** dispersed phase and on the parameter characterizing the law of attraction in the interaction of colloidal particles.

FIXATION OF SINGULAR POINTS IN THE SOL-GEL TRANSITION BY RHEOLOGICAL METHODS

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ABSTRACT

The rheology of the gelation processes was investigated. A measurement complex was developed which allowed obtaining the rheological kinetic curves from the start of the sol-gel transition until the complete conversion of sol into a gel. A wide range of critical shear stresses was measured. It was found that the starting sol is Newtonian liquid and after undergoing the gelation process, it was converted into Bingham body with a phase transition of the 2nd kind. The developed device made it possible to establish the appearance of the initial part of the rheological curve and to develop the correct method for determining the time for the onset of the gelling process. A new phenomenon was discovered: the kinetic curves in the coordinates of Avrami-Erofeev-Bogolubov's equation (AEBE) have inflection points, which bisect of the curves by initial and final parts. Numerical treatment of the rheological curves showed that the AEBE's constant k is independent of temperature and that is the same for the initial and final parts of the curves. It depends only on the chemical nature of a reacting system. It was shown that AEBE's parameter $n = 23.4 \pm 2.8$ for the initial part of the rheological curves is not dependent on the temperature in contrast to the final part of the rheological curves. The observed phenomenon is attributable to the reduction of the feasible directions number of fractal aggregates growth. The data obtained indicate that the sol-gel transition can refer to phase transitions of the 2nd kind.

INSTALLATIONS FOR THE EMULSIONS AND SUSPENSIONS PREPARATION

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ABSTRACT

Installation for the preparation of emulsions and suspensions refers to devices intended for the preparation of disperse systems. It can be used in the synthesis of polyhydric alcohols and other organic and organometallic compounds, where the immiscible liquids interact. The installation comprises a hydraulic jet mixer pump connected to the outlet of a hydromechanical dispersion pump. The installation comprises one or more components of the dispensing systems, each of which consists of a supply container and the dispenser. Technical result of the installation is created by intensifying the process of mixing and improving the quality of the final products.

AEROBIC FERMENTATIONS: PROVIDING MICROORGANISMS WITH OXYGEN

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ABSTRACT

A mathematical analysis of the distortion of the microkinetic dependence of the respiration rate on the dissolved oxygen concentration for microcolonies and for microbial agglomerates with nonideal stirring of the fermentation liquid was carried out. The microkinetic dependence is described by the Michaelis-Menton equation. It is shown that the oxygen concentration varies with the depth of the microbial agglomerate. It is proposed to determine the dependence of the average on the whole agglomerate rate of oxygen consumption on the oxygen concentration on the surface of the agglomerate as macrokinetic one. It is shown that this macrokinetic dependence can also be represented by the Michaelis-Menton equation, but the substrate constant in it differs from the microkinetic one and is linearly related to the Damköller criterion for the agglomerate. The size of the agglomerate is assumed to be equal to the smallest scale of turbulent pulsations. It has been shown that the oxygen concentration optimal for microorganisms, in this case is significantly increasing compared with microkinetic one, and, as a rule, changes during the process of batch fermentation. As a result, maintaining it at a certain constant level does not ensure optimal oxygen supply to microorganisms throughout the whole process. The control algorithm is described on the basis of measuring the respiration rate. It allows to provide the whole process with the greatest possible supply of oxygen.

APPLICATION OF NANOSYSTEMS FOR IMPROVING RESIDUAL OIL RECOVERY IN AGING FIELDS

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ABSTRACT

Injection of surfactant with added Al (50-70 nm) nanoparticles into the formation, bottom hole and flowlines was applied to reduce water cut and increase amount of oil produced from wells in Saadan field in nothern part of Azerbaijan. As a result oil production rose, the amount of formation water and scaling decreased, as well as uninterrupted run days of wells increased.

MANAGEMENT OF REOTECHNOLOGICAL PROPERTIES OF HIGHLY VISCOUS OILS BASED ON NANOTECHNOLOGIES

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ABSTRACT

New nanocomposites have been developed and studied based on nanotechnologies from a range of innovative technologies for the purpose of asphalt resin paraffin control. The effects of new

ingredients on high-viscosity oils have been studied and satisfactory results have been achieved. The nanocomposition was tested at the production well.