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INVESTIGATION OF POROUS WALL TUBES MADE OF ACTIVATED CARBON

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Abstract

A solution has been proposed for eliminating the diffusion resistance by proper structuring of the active carbon- holder of catalysts or used as an adsorbent. A structured carbon has been obtained in the form of pipes corked from the one side. The pipes are joined together on a grid in the body of the apparatus with their openings downwards. The fluid flow from the space outside the pipes passes through the pipe walls due to their pores, enters the pipes and goes out from their openings to the free cross section area of the apparatus. If it contains components which can be adsorbed by the active carbon, after passing through the pipe wall it goes out purified from them. If the active carbon holds catalyst proper for carrying out a chemical reaction between the components of the fluid flow and if the temperature and the pressure conditions are proper, than on the surface of the catalyst the relative chemical reaction is carried out.

The investigated activated carbon pipes are prepared by pyrolysis of tubes formed from thermoreactive resin (epoxy, novolak phenol-formaldehyde and phenoplast-bakelite) and different filings as wood meal and activated carbon. The geometrical characteristics of the tubes before and after the pyrolysis are measured. The pyrolysis has been cared out for 30 minutes at temperature 750^{o}C. Flue gas containing 35 vol. % water vapor has been used as activating agent.

Pipes of active carbon with different adsorption properties have been obtained, the iodine adsorption capacity achieved by now is up to 1150mg/g and the surface area achieved is up to 1200m^2/g. Their permeability is relatively high at practically low pressure drop.

The activated carbon tubes are put between the flanges and the gaskets. First, the air from the atmosphere has been sucked through the wall of the tube by a vacuum pump. The flowrate has been measured by a rotameter and the pressure drop of the tubes - by a differential manometer. The value of mass flowrate is calculated based on the values measured by the rotameter after introducing correction for the pressure. Second, the water is

fed into the tube, passes through the wall and the volumes of the water are measured at different columns.

A mathematical model has been proposed, describing their permeability in regards to contracting and non-contracting fluids.

Keywords: diffusion resistance elimination, catalyst, activated carbon tube, catalysis, adsorption

№ 34

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Effective area of a highly efficient random packing

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Abstract

The effective area of a metal Raschig Super-Ring with a nominal diameter of 20–70mm has been investigated. The liquid superficial velocity varies between 5 and 200m3/(m2 h) but not higher than the one at the loading point. The initial gas velocity was kept constant, equal to 4000 kg/(m2 h). The absorption of CO2 in 1N NaOH solution was used as a model system. The column diameter was 470mm and the packing height—2400 mm. The liquid phase distributor ensured 923 drip points per m2. The values of the mass transfer coefficient (*KGa*) under these conditions are also represented. The results show that at high liquid superficial velocity the effective area of the investigated packings is higher than their specific area. For example, the packing with nominal diameter 70mm has an effective area more than twice higher than its specific area. That means that under these conditions the surface of the drops and jets, trickling into the free volume of the packing is more than its specific area. An equation for calculating the effective area has been obtained. Its average error amounts to 4.5%. The maximum deviation does not exceed 10%.

Keywords: Packed bed column; Raschig Super-Rings; Effective area; Absorption of CO2 in NaOH solution; Mass transfer coefficient

№ 35

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SYMPOSIUM SERIES NO. 152

COMPARISONOFTHEEFFECTIVESURFACEAREAOF SOMEHIGHLYEFFECTIVERANDOMPACKINGS THIRDANDFORTHGENERATION

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Abstract

The effective surface area ae of 14variants of three highly effective types of packings (IMTP, Raschig Super-Ring (RSR) and Ralu-Flow) made of stainless steel or plastic is investigated as a function of the liquid superficial velocity. The packing size varied from20 to 70mm, and the liquid superficial velocity from5 and 200m^3/m^2h. The comparison of the obtained data shows the following: Among all investigated packings at comparable values of the specific area and the liquid superficial velocities, themetal Raschig Super Rings have the highest effective area. They have also the lowest pressure drop at the same effective surface area and gas velocity. At comparable values of the specific area and the liquid superficial velocities the effective surface areas of plastic Ralu-Flow and plastic RSR are practically the same, but the first of them have lower pressure drop at the same gas velocity and effective surface area.

KEYWORDS: packedbedcolumn, effective surface area, pressure drop, comparison, different packings, RSR, IMTP, Ralu-Flow

№ 36

Proceedings of conference "Combined and hybrid adsorbents". Editors J. M. Loureiro and M.T Kartel, Springer, 2006, 231-236

AN OPPORTUNITY FOR REDUCTION OF THE INFLUENCE OF DIFFUSION RESISTANCE WHEN CARRYING OUT CATALYTIC AND ADSORPTION PROCESSES BY USING POROUS WALL TUBES MADE OF ACTIVATED CARBON

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Abstract

A solution has been proposed for eliminating the diffusion resistance by proper structuring of the activated carbon-support of catalysts or used as an adsorbent. A structured carbon has been obtained in the form of tubes corked from the one side. The fluid flow from the space outside the tubes passes through the pipe walls due to their pores, enters the tubes and goes out from their openings to the free cross section area of the apparatus. If it contains components which can be adsorbed by the active carbon, after passing through the tube wall it goes out purified from them. If the activated carbon holds catalyst proper for carrying out a chemical reaction between the components of the fluid flow and if the temperature and the pressure conditions are proper, than on the surface of the catalyst the relative chemical reaction is carried out. Tubes of activated carbon with different adsorption properties have been obtained, the iodine adsorption capacity achieved by now is up to 1150mg/g and the surface area achieved is up to 1200m^2/g.

Keywords: diffusion resistance, catalyst, activated carbon tube, catalysis, adsorption

№ 37

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Comparison of the effective area of some highly effective packings

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Abstract

The effective area ae of three types of highly effective packings such as Raschig Super-Ring, IMTP and Ralu-Flow made from stainless steel and from plastic with nominal size from 20 to 70 mm, are investigated using the Danckwerts method with absorption of CO_2 in NaOH by pseudo-first-order fast chemical reaction. The liquid superficial velocity L varied between5and 200 $m^3/(m^2h)$. The comparison of the obtained data shows the following:

Among all investigated packings at comparable values of the specific area and the liquid superficial velocities, themetal Raschig Super-Rings (RSR) have the highest effective area. They have also the lowest pressure drop versus effective area, at the same gas velocity.

At comparable values of the specific area and the liquid superficial velocities the effective areas of the plastic Ralu-Flow and plastic RSR are practically the same, but the first of them have lower pressure drop versus effective area, at the same gas velocity.

As it is to be expected, all metal packings have greater effective area than all plastic ones with the same specific area. That means among all investigated 14 packings, themetal RSR have the greatest effective area.

Keywords: Packed bed column; Effective area; Pressure drop; Comparison; Different packings; RSR; IMTP; Ralu-Flow

№ 38

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Electrochemical Properties Investigation of Nanasized Fe_3O_4

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Abstract

Nanosized crystalline Fe3O4 (with average particle size of 16nm) was successfully synthesized on the carbon matrix surface. The thus prepared sample was heat-treated in the temperature range 300◦C – 750◦C to remove residual impurity and to obtain a final product with 77:23 ratio between magnetite to carbon support. The sample was subjected to physicochemical and electrochemical tests. The purity of the phase and the particles size was determined by XRD analysis and confirmed by FESEM micrographs. The SSA of the sample measured by the B.E.T method was 120 m^2g^{-1}. A series of electrochemical tests including EIS, CV and long-term constant current cycling tests have been performed. The obtained reversible capacitywithin15 cycles was in the range of 400–550mAh.g−1. The electrochemical behavior of the test sample and the possible practical use as anode material in lithium secondary batteries are discussed.

Keywords: lithium batteries, anode materials, nanosizedmaterials, iron oxides

№ 39

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SYNTHESIS OF NANOSIZED TiO_2 PARTICLES ON ACTIVATED CARBON

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Abstract

Nanosized TiO_2 particles loaded on activated carbon were obtained successfully by original method of pyrolysis in a stream of exhaust gas and water vapour at two different temperatures.

XRD analysis show that the powders obtained at lower temperature (680 ^oC) consist of three phases- mainly anatase, some Ti_2O_3 and Ti_4O_7, while the calcinations at 830^oC leads to a change in the phase composition- prevailing rutile, anatase and Ti_2O_3.The size of the crystallites was evaluated by Scherrer formula and is in the range 10-40 nm.

The samples were characterized by XRD and DTA/TGA. Adsorption desorption isotherms were carried out. Specific surface area and pore size distribution were evaluated. The TiO_2 on activated carbon composites prepared at 680^oC possess relatively high specific surface area (480 m^2/g) and total pore volume 0,4 cm^3/g. Both samples contain micropores and mesopores.

Keywords: B: nanocomposites, porosity, D: carbon, TiO_2

№ 40

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A Study of Nanosize Fe_3O_4 Deposited on Carbon Matrix

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Abstract

Nanosized crystalline Fe3O4 (with an average particle size of 16 nm) was successfully synthesized on a carbon matrix surface. The prepared sample was heat-treated in the temperature range 300 ^{o}C–750 ^{o}C to remove residual impurities and to obtain a final product witha77:23 ratio between magnetite and the carbon support. The sample was subjected to physicochemical and electrochemical tests. The purity of the phase and the particles size was determined by X-ray diffraction analysis and confirmed by field emission scanning electron micrographs. The specific surface area of the sample measured by the B.E.T method was 120 m2 g−1. A series of electrochemical tests including EIS, CV and long-term constant current cycling have been performed. The obtained reversible capacity within 15 cycles was in the range 400–550mAh·g−1. The electrochemical behavior of the test sample and its possible practical use as an anode material in lithium secondary batteries are discussed.

Keywords: Lithium Batteries, Anode Materials, Nanosize Materials, Iron Oxides.

№ 41

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Silica Obtained Via Pyrolysis of Waste "Green" Tyres –A Perspective Filler for Rubber Industry

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Abstract

Waste tyres · Recycling · Pyrolysis Silica

A solid product (named SiO2D) is obtained as a result of subjecting tread of "green" tyres to pyrolysis in the presence of water vapour. It has been found by FT-IR and EDX-RF spectroscopy that the product contains 30 % of carbon, 65 % of SiO2, 3 % of ZnO and 2 % of other components. The physicochemical and dynamic properties of the vulcanizates based on SBR filled with 75 phr SiO2D have been studied and compared to those of vulcanizates filled with conventional SiO2 as well as with such filled with a mixture of SiO2 and carbon black N 330 at a 2:1 ratio. Compositions with and without bis(3- triethoxysilylpropyl)disulfide have been also investigated. It has been established that there are not differences in the mechanical properties (modulus 300, tensile strength, abrasion, etc.) as well as the dynamic properties (heat build-up, tan E, etc.) of the vulcanizates filled with SiO2D and of those filled with conventional SiO2 and carbon black at a 2:1 ratio.

№ 42

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NEW TECHNOLOGY FOR PURIFICATION OF THE FLUE GAS FROM SULFUR DIOXIDE

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Abstract

A new type of installation for SO2 removal from flue gas, producing high quality gypsum, is described. It ensures conditions at which the absorption process is practically gas side controlled with elimination of the resistance in the liquid phase boundary layer between gas and liquid and between the liquid and solid CaCO3 used as absorbent. This gives the possibility to calculate the absorption using data from literature, which eliminates the necessity of performing experiments for the given system and absorber construction. The new installation ensures high absorption degree, more than 99%, and provides optimal conditions for oxidation of the CaSO3 to gypsum, small height of the packing of the absorbers and low pressure drop. The installation is intended for removal of SO2 from the flue gases from small and middle capacity boilers, but with small changes can be used for big boilers too.

Key words: SO2 removal, flue gas, new type of installation, slurry, gypsum, absorption degree, gas side controlled absorption, packed bed column, Holpack packing, small and middle capacity boilers.

№ 43

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CURRENT PROBLEMS AND DEVELOPMENT IN FLUE GAS DESULFURIZATION

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Abstract

One of the most widely used processes of SO2 removal from flue gases is absorption by slurry containing CaCO3. The existing installations are designed for big capacity boilers and provide low degree of absorption. The stringent environmental protection regulations for SO2 emissions in EU call for better solutions. The aim of the present discussion on the current problems and achievements in gas desulfurization is to help the finding of the proper direction of the efforts for developing of a new technology and the choice of apparatuses and equipment.

Key words: wet flue gas desulfurization, SO2 removal efficiency, bisulfite oxidation, lime, limestone, slurry, gypsum, scrubber.

№ 44

Journal of International Scientific Publications:
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EQUILIBRIUM PARTIAL PRESSURE OF SO2 OVER THE ABSORPTION SLURRY IN CASE OF PURIFICATION OF THE FLUE GAS FROM SULFUR DIOXIDE USING GYPSUM TECHNOLOGY

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Abstract

The most widely used process for purification of flue gases from SO2 is its absorption with slurry containing CaCO3. Up to now there are installations for carrying out of the SO2

absorption according to this process only for big capacity boilers because of the great height of the existing absorbers for this technology, about 20-30 m. To create new absorbers for small and middle capacity boilers, equilibrium data for the absorption of SO2 are necessary. Up to now such data are available in the literature only for a temperature of 25oC. That is why experiments for obtaining of equilibrium data for the partial pressure of SO2 over slurry containing CaCO3, CaSO3 and CaSO4 at different temperatures are carried out. The results show that the increasing of the temperature from 25 to 45°C leads to about 3 times increasing of the partial pressure of SO2 in the area of the lowest partial pressures. The respective increasing for the range of 25o to 60oC is about 10 times.

Key words: SO2, purification of flue gas, equilibrium partial pressure, absorption slurry, gypsum, absorption degree, experiment.

№ 45

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OXIDATION OF CaSO3 BY AIR IN THE TECHNOLOGY FOR PURIFICATION OF FLUE GASES FROM SO_2

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Abstract

The presented investigations are connected with creation of a new suitable for small and middle capacity boilers technology for removal of SO2 from flue gases by absorption with CaCO3 slurry, producing gypsum for building material. To reduce the capital investments it was decided to eliminate the hydrocyclone block and the centrifuge of the existing technologies and to dry the slurry of CaSO4.2H2O directly in a spray dryer by flue gases, utilizing the heat of evaporation in a contact economizer system. This decision required practically full oxidation of the CaSO3 to CaSO4 in the oxidizer. A construction of a new oxidizer, divided by vertical partitions into 4 chambers with regular distribution of the air in the slurry by means of perforated horizontal tubes, is described. Some possibilities for leaning of the orifices of the tubes are specially investigated and a solution is found. It is shown that at presence of catalysts, Fe and Mn ions, more than 99% of the slurry can be oxidized in 9 hours. The obtained after the drying of the slurry gypsum is white. The test of its compressive strength shows a value of 3.5 MPa, i.e. 40% higher than the requirements of the Bulgarian national standard for building gypsum. The obtained data are used for designing the oxidizer of an industrial installation for purification of flue gases from SO2.

Key wards: purification of flue gases, SO2.removal, absorption degree, new technology, catalyst, CaSO3 oxidation, slurry, gypsum compressive strength.

№ 46

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Title: NANOSIZED TiO2 PARTICLES LOADED ON ACTIVATED CARBON AND THEIR APPLICATION FOR OZONE DECOMPOSITION AT ROOM TEMPERATURE

Article Type: Normal Paper
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Abstract:

Nano-sized TiO2 particles loaded on activated carbon were obtained successfully by original pyrolysis method in a stream of exhausted gas and water vapor, using two different temperatures. The samples were characterized by XRD,DTA/TGA, BET and SEM. The X-ray method reveals that the powders obtained at 680^{o}C consist of three phases - mainly anatase, some Ti2O3 and traces of Ti4O7. The specimen, calcinated at 830^{o}C, comprises mainly rutile phase. The calculated mean size of the crystallites was in the range of 10-40 nm. The composites TiO2 on activated carbon (TiO2/AC), prepared at 680^{o}C, possessed relatively high BET surface area and total pore volume of 0.4 cm^{3}/g. The obtained TiO2/AC composites showed good catalytic activity for the degradation of ozone. Ca. 35 % ozone conversion was registered at the beginning of the reaction. A stable conversion (ca. 13 %) and high selectivity was observed after the first 5min.

Keywords: nanostructured materials, oxide materials, transition metal alloys and compounds, catalysis, scanning electron microscopy, X-ray diffraction