Abstracts of Scientific Publications

Assoc. prof. Elena Razkazova-Velkova, Ph. D

INDICATOR B

P1. Oxidation of Sulfide Ions in Model Solutions of Sea Water Using of Metal Catalysts Built in Carbon Matrix

N. Dermendzhieva, **E. Razkazova-Velkova**, M. Martinov, L. Ljutzkanov, V. Beschkov

Journal of Chemical Technology and Metallurgy, 48, 5, 2013, pp. 465-468

The possibility of catalytic oxidation of sulfide ions from model solutions of seawater in a lab-scale model of fuel cell is studied. Two types of metal-containing catalysts (Mn и Co) incorporated in a matrix of activated carbon are synthesized. The metals are in the form of spinel-type oxides containing about 35 % vol. of the activated carbon. The processes of oxidation occurring in the anode space are considered. Experiments with different initial concentrations of sulfide ions (25-125 mg/dm^{-3}) are carried out. The quantity of catalyst added into the solution volume is varied. The experiments are performed at room temperature and with constant mixing rate. The sulfide ions are oxidized above 90 % in about 3 hours for all initial concentrations by the use of both types of catalysts whereas the process is much slower without a catalyst (40 % in about 3 hours).

P2. Energy Efficient SO_2 Removal from Flue Gases Using the Method of Wellman-Lord

D. Dzhonova-Atanasova, **E. Razkazova-Velkova**, L. Ljutzkanov, N. Kolev, D. Kolev

Journal of Chemical Technology and Metallurgy, 48, 5, 2013, pp. 457-464

Investigations are reviewed on development of energy efficient technology for SO_2 removal from flue gases of combustion systems by using the method of Wellman-Lord. This method is characterized by absorption of sulfur dioxide with sodium sulfite solution, which reacts to form sodium bisulfite. The absorber is typically a packed column with multiple stages. After evaporation of the solution, SO_2 and sodium sulfite are obtained. The latter is dissolved in water from condensation of the steam carrying SO_2 from the evaporator. The regenerated solution returns in the absorber. The SO_2 removed from the flue gases is obtained as a pure product for use in chemical, food or wine production. Technical and economical assessment of this regenerative method is presented in comparison to the non-regenerative gypsum method, using data from the existing research papers and own experience from investigations on improvement of the Wellman-Lord method and development of innovative gypsum technology.

P3. Visible light photocatalytic activity of TiO2 deposited on activated carbon

Alexander E. Eliyas, Ljutzkan Ljutzkanov, Irina D. Stambolova, Vladimir N. Blaskov, Sasho V. Vassilev, **Elena N. Razkazova-Velkova**, Dimitar R. Mehandjiev

Cent. Eur. J. Chem. • 11(3) • 2013 • 464-470
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Four photocatalyst samples, prepared from beech sawdust, were synthesized by an original method, combining pyrolysis and impregnation - two of them: TiO_2 + activated carbon and other two - only activated carbon. The pyrolysis process has been carried out at two different temperatures - 680°C and 830°C. The prepared samples were characterized by a series of methods - XRD, BET, SEM and DTA/TG. The most important result was achieving visible light photocatalytic activity with an azo dye pollutant for both materials. The TiO_2/AC-680°C sample demonstrated higher activity under visible light illumination than the TiO_2/AC-830°C sample. The visible light activity was attributed to the active carbon component in the composite materials, which was evidenced by the photocatalytic tests with bare carbon (without any TiO_2) manifesting visible light activity. The AC-680°C carbon was superior to the AC-830°C under visible illumination probably due to its higher specific surface area and porous texture. UV-light testing of the photocatalytic activity revealed that the TiO_2/AC-680°C sample was higher than that of the TiO_2/AC-830°C under polychromatic UV-A illumination (320-400 nm with a maximum at l = 365 nm). The TiO_2/AC-680°C sample was also more efficient with the monochromatic UV-C illumination (l = 254 nm).

P4. Kinetics of oxidation of sulfide ions in model solutions of sea water

N. Dr. Dermendzhieva, **E. N. Razkazova-Velkova**, V. N. Beschkov

Bulgarian Chemical Communications, Volume 47, Number 3 (pp. 766 – 770) 2015

The possibility of catalytic oxidation of sulfide ions from model solutions of seawater is studied. ZrO2 catalyst incorporated into a matrix of activated carbon is synthesized. The surface of the catalyst is characterized by iodine adsorption. The effect of the deposited catalyst is studied. Experiments at different initial concentrations of sulfide ions and temperatures are conducted in two regimes - continuous aeration or stirring at the same speed without aeration. The reaction products in the case of continuous aeration are 90% of sulfate ions relative to the initial quantity of sulfides. The reaction products at stirring without aeration at the same temperatures are stable

reducers that should not be dumped into the sea water. The oxidation in the regime of continuous aeration follows the kinetics of a first order reaction with relatively low activation energy.

P5. **Pressure drop of highly efficient Raschig Super-Ring packing for column apparatuses**

D. B. Dzhonova-Atanasova, Sv. Ts. Nakov, **E. N. Razkazova-Velkova**, N. N. Kolev

Bulgarian Chemical Communications, Volume 47, Number 3 (pp. 793 – 799) 2015

The present work presents and generalizes own experimental data for the pressure drop of highly efficient metal Raschig Super-Ring (RSR) packing for packed columns. The contemporary demands from the chemical industry for environment protection and waste free production lead to focusing on application of these apparatuses in purification of flue gases and waste water. RSR is modern high-performance random packing of latest generation, which combines effective mass transfer, large interfacial area and uniform distribution of the phases over the column cross section. There is no universal methodology for calculating the performance characteristics of this packing. The constants of the existing equations for practical calculations are obtained for each individual packing size. The aim of the present work is to propose more precise equations for prediction of the pressure drop of RSR packing, which are common for all investigated sizes and reflect the influence of the packing geometry and the column redumping.

P6. **Electrochemical reduction of sulfur dioxide by oxidation of hydrogen sulfide in aqueous media**

D. Uzun, **E. Razkazova–Velkova**, V. Beschkov, G. Pchelarov, K. Petrov

Bulgarian Chemical Communications, Volume 47, Number 3 (pp. 867 – 871) 2015

The reduction of sulfur dioxide at high temperature is reported. This article reveals that electrochemical reduction of SO_2 is possible at room temperature. Electrochemical processes for treatment of H_2S in Black Sea waters and flue gases are presented in order to minimize their environmental impact. We found suitable conditions and electro catalysts for the realization of the process to reduce the flue gases from thermal power plants along the coast of the Black Sea and to solve the problem of hydrogen sulfide in the deep Black Sea waters.

P7. **Electrochemical method for energy production from hydrogen sulfide in the Black sea waters in sulfide-driven fuel cell**

D. Uzun1, E. **Razkazova–Velkova,** K. Petrov, V. Beschkov

Bulgarian Chemical Communications, Volume 47, Number 3 (pp. 929 – 938) 2015

The aim of the present research is the development of an economically feasible electrochemical method for extraction of H_2S contained in Black Sea waters, using it as a fuel in a

sulfide/oxygen(air) fuel cell. Low HS^- concentrations and presence of NaCl, similar to the conditions in the depth of Black Sea, have been investigated. Electrochemical condition for oxidation of sulfide HS^- directly to sulfite and sulfate on electrode (anode) catalysts have been found. Different anode catalysts for HS- oxidation have been tested: graphite, cobalt phtalocyanine (CoPc) and perovskite ($La_{1,3}Sr_{0.7}NiO_4$). No catalytic poisoning has been observed by the oxidation products (sulfite and/or sulfate). Perovskite and CoPc have been found as the more suitable catalyst for this fuel cell system. The characteristics of the sulfide driven fuel cell have been tested with optimized HS- anodes and previously developed oxygen (air) cathodes. Electric power of P = 7.5 mW has been obtained.

P8. Electrocatalysts for sulphur ions oxidation based on DWCNTs, MWCNTs, higher fullerenes and manganese

G. Pchelarov, D. Uzun, **E. Razkazova-Velkova**, O. Dimitrov, S. Vassilev, K. Petrov

Bulgarian Chemical Communications, Volume 49 Special Issue C (pp. 218– 226) 2017

The possibility of utilizing electrocatalysts such as manganese deposited on fullerenes and carbon nanotubes is considered. These have been studied for oxidation of SO_3 to SO_4 and reduction of NO_3 to NO_2 and N_2, thus creating a SOx/NOx fuel cell suitable for cleaning the environment while generating electrical energy. Mn has been deposited on Double Wall Carbon Nanotubes (DWCNTs) and Higher Fullerenes (HFs) from manganese acetate by thermal treatment and/or freeze drying. The electrocatalysts were characterized by scanning electron microscopy (SEM) and X-ray diffraction (XRD). Electrochemical testing has been done by cyclic voltammetry and E/V polarization curve plotting. The freeze dried electrodes comprised of Mn/HFs are found to yield the lowest overpotentials at sufite oxidation, while the electrodes comprised of Mn/HFs/DWCNTs yield the highest activity at nitrite reduction. The results presented clearly show, that electrodes containing HFs, DWCNTs and manganese oxides are effective catalysts in SOx/NOx fuel cells.

INDICATOR Г

P1. Study of the Influence of Different Catalysts on the Rate of Oxidation of Sulfide Ions in Model Solutions of Seawater

Nadezhda Dermendzhieva, **Elena Razkazova-Velkova**, Martin Martinov, Ljutzkan Ljutzkanov, Venko Beschkov,

Journal of Chemical Technology and Metallurgy, 49, 5, 2014

The possibility for catalytic oxidation of sulfide ions in model solutions of seawater is studied. The catalysts - synthesized metal oxides incorporated in a matrix of activated carbon, are characterized by iodine adsorption. The possibility for using activated carbon as a catalyst is also considered. The influence of the amount of the catalyst is investigated. The experiments are performed at room temperature, with a constant mixing rate and initial concentrations. The oxidation of sulfide ions in the anode compartment of a laboratory scale fuel cell is described. A comparison is made of the oxidation rate into a fuel cell with the catalytical oxidation without electrodes and electrical connections at the same conditions.

P2 A Method for the Simultaneous Cleansing of H_2S and SO_2

Dzhamal R. Uzun, **Elena Razkazova-Velkova**, Venko Beschkov, and Konstantin Petrov

International Journal of Electrochemistry, Volume 2016, Article ID 7628761, 5 pages, International Journal of Electrochemistry
http://dx.doi.org/10.1155/2016/7628761

A method for the simultaneous electrochemical purification of hydrogen sulfide and sulfur dioxide from sea water or industrial wastes is proposed. Fundamentally the method is based on the electrochemical affinity of the pair H_2S and SO_2. The reactions (oxidation of H_2S and reduction of SO_2) proceed on a proper catalyst in a flowreactor, without an external power by electrochemical means. The partial curves of oxidation of H_2S and reduction of SO_2 have been studied electrochemically on different catalysts. Following the additive principle the rate of the process has been found by intersection of the curves. The overall process rate has been studied in a flow type reactor. Similar values of the process rate have been found and these prove the electrochemical mechanism of the reactions. As a result, the electrochemical method at adequate conditions is developed. The process is able to completely convert the initial reagents (concentrations CH2S, SO2= 0), which is difficult given the chemical kinetics.

P3, Electricity Production from Marine Water by Sulfide-Driven Fuel Cell

Venko Beschkov, **Elena Razkazova-Velkova**, Martin Martinov and Stefan Stefanov

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While there is a universal trend to replace fossil fuels at least partially, renewable fuels seem to impose new solutions. Hydrogen sulfide, typical for closed water ponds such as the Black Sea, seems to offer one namely, a new sulfide-driven fuel cell providing for exchange of OH^- anions across the membrane by use of hydrogen sulfide in natural marine water. When tested in batch and continuous operation modes, this solution showed that the initial sulfide concentration needed to achieve results of practical value was within 200 to 300 mg dm^3. The predominating final products of the energy production process were sulfite and sulfate ions. Very low overpotentials and mass transfer resistances were observed. The mass balance and the electrochemical parameters showed about 30% efficiency in sulfate ions as the final product. Efforts should be made to enhance sulfide to sulfate conversion. The observed current and power density were comparable and even better than some of the results so far reported for similar systems. Three types of ion exchange membranes were tested. Comparison of their ion conductivity to literature data shows good performance. At higher initial sulfide concentrations polysulfides and thio-compounds were formed with considerably low current yield.

P4 Sulfide and nitrate driven fuel cell. Chemical and biochemical denitrification

S.Stefanov, **E. Razkazova-Velkova**,M.Martinov, Ts. Parvanova-Mancheva, V. Beschkov

Bulgarian Chemical Communications, Volume 50, Special Issue B, (pp. 123 – 129) 2018

A fuel cell is constructed for simultaneous sulfide oxidation and nitrate reduction. The results for biological and chemical denitrification in the cathode compartment are compared. The influence of different concentrations of sulfides and nitrates on the electrical power output of the fuel cell is examined, as well as their simultaneous neutralization. The electrodes used in the anode compartment are graphite rods and pyrolyzed paddling. The biological reduction of the nitrates is carried out by *Pseudomonas denitrificans* which increases the rate of nitrate depletion compared to the chemical fuel cell.

P5. Sulfite driven fuel cell for environmental purposes: optimization of the oxidation conditions

S.Stefanov, M. Martinov, **E. Razkazova-Velkova**

Bulgarian Chemical Communications, Volume 50 Special Issue A (pp. 77 - 81) 2018

The growing world population puts ever-increasing environmental requirements on all industries, be it construction, pharmacology or energy generation. One of the more potent and hard-to-neutralize industrial waste products are sulfites (typically sodium or calcium) generated by flue-gas desulfurization processes. Our project aims at neutralizing these dangerous compounds by oxidizing them in a fuel cell (FC) of our own design while simultaneously gaining electrical power. The present study's goal is to find suitable catalysts for the oxidation process. The experiments show that a nickel coated graphite fiber is an appropriate candidate to be used as electrode for the anode compartment of the fuel cell. A comparison of the electrochemical characteristics of the chosen fuel cell with different oxidizing agents (aerated seawater, hydrogen peroxide and ammonium chloride) is presented as well.

P6 Comparative study of the catalytic and non-catalytic oxidation of sulfide from model solutions of sea water

N.Dr. Dermendzhieva, **E. N. Razkazova-Velkova**, V. N. Beschkov

Bulgarian Chemical Communications, Volume 52, Issue A (pp. 35-38) 2020

DOI: 10.34049/bcc.52.A.317

Oxidation of sulfide ions from model sea water solutions with and without a catalyst was investigated. The catalyst used is zirconium dioxide (ZrO_2) incorporated in activated carbon matrix the surface of which was characterized by adsorption to iodine. The experiments were conducted at different initial sulfide ion concentrations and temperatures and two modes of operation - continuous aeration and stirring at constant speed. The influence of the presence of light was also studied. The rate of oxidation in continuous aeration processes is twice as high as that of constant-rate stirring processes without aeration. In the presence of a catalyst and a continuous aeration process, the sulfide ions are oxidized for 1 hour at 60 °C and 2 hours at 20 °C with the reaction products being 90% sulfate ions relative to the initial sulfide. At the same temperatures and concentrations, but in the non-aeration-stirring processes, a significant amount of intermediate compounds - resistant reducers - were obtained, and therefore this option is ecologically unacceptable. The oxidation rate of the processes carried out without a catalyst was by 50-80% lower in both modes of operation.
In order to increase the active surface and to use instead of powdered catalyst a structured one appropriate for real use or as electrode in a fuel cell, the ZrO_2 was incorporated into pyrolyzed and

activated carbon padding. Comparative experiments were carried out with padding with and without a catalyst, as well as with non-pyrolized padding. The number of cycles, at which the padding can be used, was also studied.

P7. Dynamic hold-up of modern high-performance packings

Sv. Ts. Nakov, D. B. Dzhonova-Atanasova, **E. N. Razkazova-Velkova**

Bulgarian Chemical Communications, Volume 52, Special Issue F (pp. 32-35) 2020

DOI: 10.34049/bcc.52.F.0005

Metal Raschig Super-Ring (RSR) and Intalox Metal Tower Packing (IMTP) are modern high-performance packings that combine efficient mass transfer, large interfacial surface area and regular phase distribution over the cross section of the column apparatus. This work presents and summarizes original experimental data of the dynamic hold-up of 4 IMTP sizes and 7 RSR sizes. Dimensionless criterion equations are proposed for both types of packings to calculate their dynamic hold-up for regimes below the loading point. The average arithmetic error of the IMTP equation is 7.5% and of the RRS equation is 4.6%. The proposed equations not only take into account the geometry of the packings, but also the effect of the dumping of the packing in the column.

P8. Wastewater treatment of sulfur and nitrate contaminated fluxes into fuel cells

E.Razkazova-Velkova, S. Stefanov, T. Parvanova-Mancheva, M. Martinov

Bulgarian Chemical Communications, Volume 52, Issue A (pp. 87-92) 2020

DOI: 10.34049/bcc.52.A.236

Fuel cells (FC) with microbial oxidation of sulfides and chemical denitrification and a microbial assisted process for both reactions were studied. A comparison between microbial and chemical fuel cells at the same conditions is also presented. A novel type of electrodes with pyrolyzed and activated carbon paddling is used for immobilization of the bacterial strain for sulfide oxidation. *Pseudomonas putida* 1046 is studied as a model strain for the anodic compartment and *Pseudomonas denitrificans* for the cathodic one

P9. Integrated absorption-adsorption process for waste-free decontamination of gases from sulfur dioxide. Part 1. Choice of ion-exchange resin and adsorption and desorption parameters

S. Stefanov, **E. Razkazova-Velkova**

Bulgarian Chemical Communications, Volume 52, Special Issue F (pp. 57-63) 2020
***DOI: 10.34049/bcc.52.F.0010* 57**

One of the most hazardous atmospheric air pollutants is sulfur dioxide. Its main anthropogenic source is the burning of fossil fuels with high sulfur content. A waste-free new technology is proposed for decontamination of sulfur dioxide-containing gases that uses its absorption by water, followed by adsorption by ion-exchange resin, subsequent desorption and further processing of the contaminant. As a first step for detailed investigation of the technology a screening for the appropriate resin is conducted. Seven different ion exchange resins and a zeolite are presented in this study. After the initial evaluation Dowex® 66 is selected as the most promising one and further experiments regarding adsorption and desorption times, as well as variation of the concentration of desorbing agent, are performed. Lastly, consecutive adsorption/desorption is conducted to determine the number of cycles the resin can operate at peak performance.

P10. Performance of Sulfide-Driven Fuel Cell Aerated by Venturi Tube Ejector

Venko N. Beschkov**, Elena N. Razkazova-Velkova**, Martin S. Martinov and Stefan M**.** Stefanov

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https://doi.org/10.3390/catal11060694

Hydrogen sulfide is frequently met in natural waters, like mineral springs, but mostly it is found in marine water with low renewal rate. The Black Sea has extremely high hydrogen sulfide content. It can be utilized in different ways, but the most promising one is direct conversion into electricity. This result can be attained by a sulfide-driven fuel cell (SDFC), converting sulfide to sulfate thus releasing electric energy up to 24 GJ/t. One of the most important problems is the mass transfer limitation on oxygen transfer in the cathode space of the fuel cell. This problem can be solved using a gas diffusion electrode or highly efficient saturation by oxygen in an ejector of the Venturi tube type. This work presents experimental data in laboratory-scale SDFC for sulfide conversion into sulfate, sulfite and polysulfide releasing different amounts of electric energy. Two types of aeration are tested: direct air blow and Venturi-tube ejector. Besides pure graphite, two catalysts, i.e., cobalt spinel and zirconia-doped graphite were tested as anodes. Experiments were carried out at initial sulfide concentrations from 50 to 300 mg/L. Sulfate, sulfite and thiosulfate ions were detected in the outlet solutions from the fuel cell. The electrochemical results show good agreement with the chemical analyses. Most of the results show attained high efficiencies of the fuel cell, i.e., up to 80%. The practical applications of this method can be extended for other purposes, like treatment of polluted water together with utilization as energy.

P11. Membraneless fuel cells for remediation of sulfide- and nitrate-contaminated fluxes

S. Stefanov, Ts. Parvanova-Mancheva, L. Ljutzkanov, **E. Razkazova-Velkova**

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***DOI: 10.34049/bcc.54.B2.0475* 125**

Sulfides and nitrates are dangerous environmental pollutants with sources both natural and anthropogenic. The search for cheaper wastewater treatment techniques and alternative energy sources has led to a new branch of scientific interest – fuel cells for wastewater treatment. The present research is dedicated to remediation of sulfide- and nitrate-polluted fluxes in the anodic and cathodic compartments, respectively, of a membraneless fuel cell of our own design. The core of the fuel cell is a cylindrical tube of activated carbon, playing the role of both an electrode and a non-selective membrane. Both abiotic and microbial fuel cells (FCs and MFCs, respectively) are being investigated for their efficiency at neutralization of contaminated fluxes with different initial concentrations of sulfide and nitrate ions, as well as their electrical power output. *Pseudomonas putida* 1046 is used in the MFC for sulfide oxidation.

P12. Electrocatalysts Based on Novel Carbon Forms for the Oxidation of Sulphite

George Pchelarov , Dzhamal Uzun, Sasho Vassilev , **Elena Razkazova-Velkova**, Ognian Dimitrov ,Aleksandar Tsanev, Adriana Gigova, Nadezhda Shukova and Konstantin Petrov

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https://doi.org/10.3390/catal12010093

Described herewith is an electrochemical method to decontaminate sulphur compounds. Studies were carried out of sulphites (SO_3^{2-}) oxidation on a range of anode catalysts. The electrocatalysts were characterized by scanning electron microscopy, XRD, XPS and BET. Polarization curves were recorded of electrodes incorporating lyophilized higher fullerenes and manganese oxides. The experiments showed that lyophilized higher fullerenes and C60/C70 fullerene catalysts in conjunction with manganese oxides electrochemically convert sulphites (SO_3^{2-}) to sulphates (SO_4^{2-}). The oxidation products do not poison the electrodes. The XPS analysis shows that the catalysts incorporating DWCNTs, MWCNTs and higher fullerenes have a higher concentration of sp3C carbon bonding leading to higher catalytic activity. It is ascertained that higher fullerenes play a major role in the synthesis of more effective catalysts. The electrodes built by incorporating lyophilized catalysts containing higher fullerenes and manganese oxides are shown as most promising in the effective electrochemical decontamination of industrial and natural wastewaters.

P13 Integrated Absorption–Adsorption Process for Waste-Free Decontamination of Gases from Sulfur Dioxide, Part 2: CFD Modeling and Experimental Investigation of a Bubble-Cap Tray

Apostol Apostolov , Stela Panyovska , Stefan Stefanov , Daniela Dzhonova-Atanasova , **Elena Razkazova-Velkova** and Stefan Michev

Sustainability **2024**, 16, 2472.

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There are many technologies for removal of sulfur dioxide (SO_2) from flue gases. They are intrinsic part of the efforts for sustainability of energy production as they reduce the harmful impact of fossil fuel combustion on the environment by minimizing one of the main air pollutants. A wide range of methods use alkaline absorbents. In most cases, the products obtained from the absorption process have to undergo further oxidation, which increases the cost of carrying out the process. As a final result, the sulfates obtained (Na_2SO_4 and $CaSO_4$) have limited practical application and there is a problem with their disposal. Scientific and engineering efforts have been directed towards the development of a practically waste-free technology for gas purification from SO_2.An absorption–adsorption method is proposed, which comprises absorption of SO_2 in water with simultaneous adsorption of the resultant sulfurous acid (H_2SO_3) from the aqueous solution with a synthetic anion-exchange resin. Regeneration of the adsorbent is accomplished with a dilute solution of ammonia (NH_3), followed by decomposition of the resulting ammonium sulfite ($(NH_4)_2SO_3$) with nitric acid (HNO_3). The products of the processes are pure gaseous (liquefied) SO_2 and an aqueous solution of ammonium nitrate (NH_4NO_3). Sulfur dioxide has a wide range of applications in the chemical industry; ammonium nitrate is a product with a variety of commercial uses as well, the most common of which is as a soil fertilizer. The new absorption–adsorption method offers a practically waste-free technology. The basic unit of this technology is a bubble-cap tray column where the absorption–adsorption process is carried out in an aqueous suspension of a synthetic anion-exchange resin. This work presents a CFD simulation of the flow on the bubble-cap tray. A physical model of the column is constructed, which contains a bubble-cap tray fabricated by 3D printing. As a result of this experimental study, new data on the tray pressure drop, gas holdup, and the kinetics of the absorption–adsorption process were obtained.

P14. Mathematical Modeling of Absorption-adsorption Processes for Waste Free Decontamination of Gases from SO2 in a Bubble Tray Column

Petya Popova-Krumova, **Elena Razkazova-Velkova**, Boyan Boyadjiev and Christo Boyadjiev

E3S Web of Conferences 521, 02002 (2024) *FCEE2024*

https://doi.org/10.1051/e3sconf/202452102002;

Integrated absorption-adsorption for waste free desulfurization of gases from SO_2 in a bubble tray column is presented. The method includes physical absorption of SO2 with water and chemical adsorption of HSO_3^- from the water solution by particles anionite. The two steps method is integrated in one apparatus-a bubble tray column. This method is regenerative and the regeneration is made with solution of ammonium hydroxide. The further step for utilization of the obtained $(NH_4)_2SO_3$ and (NH_4HSO_3) is by using HNO_3) for production of concentrated SO_2 (gas) and NH_4NO_3 (solution). Convection-diffusion and average concentration models are presented, which are used to describe absorption and adsorption processes. A comparison of the calculated trough the mathematical model and the experimental data is shown