Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
February 2015, Volume 40, Issue 2, pp 295-301

Azo Dye DB71 Degradation Using Ultrasonic-Assisted Fenton Process: Modeling and Process Optimization

- Afshin Maleki , Hiua Daraei , Elham Amir Hosseini , Shadieh Azizi , Elham Faez , Fardin Gharibi

Abstract:

In the present study, ultrasonic-assisted Fenton process called sono-Fenton (SF) with low concentration of Fenton reagents was studied via degradation of Direct Blue 71. Influences of seven operational parameters including initial pH (pH_0), initial concentration of pollutant (C_0), dose of Fenton reagents (C_{Fe} and C_{H2O2}), ultrasound irradiation frequency (Fr_S), ultrasound irradiation power (P_S), and treatment time (t_{SF}) were investigated on the dye removal efficiency (DR). A combined design of experiments consists of full factorial for t_{SF}, and Taguchi for other six parameters was designed, and experiments were conducted in accordance with the design. The experimental data were collected using a batch reactor equipped with controllable ultrasonic bath. The DR of 0–33.5 mg/l was achieved under experimental conditions. These results approved that the SF process can be a promising approach in terms of colored wastewater treatment. The data were used for model building by Taguchi and artificial neural network. Further statistical tests were applied to exhibit models goodness and to compare models. Finally, optimization process was carried out using Taguchi and genetic algorithm. The optimization procedure causes optimal point which gives an insight of optimal operating condition.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
February 2015, Volume 40, Issue 2, pp 289-293

Studies on the Oxidative Removal of Sodium Thiosulfate from Aqueous Solution

- Naveed Ahmad , Farooq Ahmad , Ihsanullah Khan , Adnan Daud Khan

Abstract:

Thiosulfate is generated from various process industries, such as petrochemical, metallurgical, photography processing, pharmaceutical, pigment and dye manufacturing units, etc. Thiosulfate-bearing wastewater is also produced during the anaerobic treatment of wastewater. In the present work, oxidative removal of thiosulfate in the presence of UV light from aqueous solution has been investigated. The effect of thiosulfate concentration, oxygen partial pressure, UV light intensity and air flow rate on the kinetics of thiosulfate removal has been explored, and suitable rate equations were developed for the oxidation processes. 67 % of thiosulfate was removed from the aqueous solution by carrying out aerial oxidation for one hour. Using photooxidation by UV light, 1,200ppm thiosulfate could be oxidized by one hour. Overall reaction by aerial oxidation followed the second-order kinetics, whereas by photooxidation, it followed third-order kinetics.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
February 2015, Volume 40, Issue 2, pp 279-288

Two-Phase Anaerobic Digestion Model of a Tannery Solid Waste: Experimental investigation and Modeling with ANFIS

- Thangamani Arumugam , Latha Parthiban , Parthiban Rangasamy

Abstract:

Anaerobic digestion of limed fleshing solid waste from leather-processing industry and effluent treatment liquid waste was studied in a two-phase digester. The hydrolysis and acidification stages resulted in the formation of volatile fatty acid (VFA), where the maximum concentration of total VFA observed in the acidogenic reactor was 18,225mg/L and the average VFA concentration was 10,574mg/L for hydraulic retention time (HRT) of 10days. The hydrolyzed predigested material was tested in a methanogenesis reactor for biogas generation at HRT of 20 days. The two-phase process of the digestion system has been modeled using adaptive neuro-fuzzy inference system (ANFIS) with HRT, pH and organic loading rate (OLR) as input parameters and cumulative gas production as output parameter. The average CH_4 production rate over the entire study period was 0.31$m^3$$CH_4$/kg VS destroyed and 0.15m^3 CH_4/kg VS fed at an overall average OLR of 1.05 ± 0.05kg VS/m^3day. Modeling with ANFIS using HRT, OLR and pH as inputs and cumulative production of gas as output produced a mean-square error of only 0.00049 which is relatively more accurate with reference to available literature.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
April 2015, Volume 40, Issue 4, pp 995-1004

A Frequency Domain PID Controller Design Method Using Direct Synthesis Approach

- Md Nishat Anwar, M. Shamsuzzoha , Somnath Pan

Abstract:

In this study, the PID controller design method based on direct synthesis approach for achieving the desired set-point or load-disturbance response is proposed. The PID controller is derived using an approximate frequency-response-matching criteria. A simple criterion has been also provided to choose the frequency points for matching of the proposed PID controller with the desired direct synthesis controller. It is a unified approach which deals with broad class of processes including integrating and inverse response, and it is directly applicable to any order of process with time delay. The ideal controller based on the direct synthesis approach has been directly approximated to the PID controller in desired frequency range. Therefore, the proposed method is free from model reduction in high-order process to low-order process and also rational approximation of the time-delay term e^{-sL}. The advantage of method is illustrated through examples taken from the literature and compared with some of the well-known methods.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
April 2015, Volume 40, Issue 4, pp 1005-1013

Experimental Exploration on Degradation of Orange G 16 an Azo Dye by Novel *Pseudoalteromonas* sp. and Its Enzyme Activity

- M. S. Giri Nandagopal , Rahul Antony , Nidhin Sreekumar , N. Selvaraju

Abstract:

Increasing textile industries in the last few decade has resulted in the discharge of very large quantities of complex chemical dye to the water system. This has affected the ecological and biological balance causing immense destruction to the nature. In this work, azo dye (Orange G 16) degradation studies by *Pseudoalteramonas* sp. were investigated. From the experiments, *Pseudoalteromonas* species degraded the Orange G 16 azo dye at a short time span within 3 h. The assay time for azoreductase activity was standardized, and maximum activity was observed at 24th. The protein concentration was estimated at three different stages of dye degradation. First stage is before addition of dye, second stage is 3 h after addition of the dye during which the dye had completely decolourized, and the third stage is 18 h after the addition of dye. From the study, it was observed that protein concentration was higher in the 24-h sample which has been induced with Orange G 16 azo dye having a concentration of 0.92 mg/ml. While comparing the total activity and specific activity of the enzyme for three samples, it was observed that the activity was higher at the 24th s and then subsided gradually. Thus, *Pseudoalteromonas* sp. is found to be efficient in degrading azo dyes because of its potential to degrade the dyes rapidly which also has a higher azoreductase activity.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
May 2015, Volume 40, Issue 5, pp 1279-1287

Numerical Study of a Nonlinear Diffusion Model for Washing of Packed Bed of Cylindrical Fiber Particles

- Bharti Gupta , V. K. Kukreja , N. Parumasur , P. Singh

Abstract:

A nonlinear model representing particle diffusion and molecular diffusion is considered in this paper. The equations are converted into dimensionless form involving Peclet and Biot numbers. The model is discretized in axial and radial domains using a cubic spline collocation method. The system of differential algebraic equations is obtained and is solved using MATLAB ODE15s. Using the actual plant data, the results are examined in terms of relative error. A uniform convergence of order two is established. Also, the model is simulated to study the effect of different parameters on exit solute concentration.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
May 2015, Volume 40, Issue 5, pp 1269-1278

Adsorption of Reactive Black-5 by Pine Needles Biochar Produced Via Catalytic and Non-catalytic Pyrolysis

- Ayesha Khan , Audil Rashid , Rafia Younas

Abstract:

Biomass derived biochar is increasingly recognized as an environmental-friendly sorbent to halt organic pollutants. This study explores the opportunity of managing pine needles waste by converting them into biochar sorbent through catalytic and non-catalytic pyrolysis, carried out at 450 °C. The difference in the biochar yield was not very obvious under catalytic and non-catalytic pyrolysis. The obtained biochars were characterized using X-ray diffraction analysis, energy-dispersive X-ray spectroscopy and scanning electron microscopy. Adsorption of Reactive Black-5 (RB-5) in aqueous solution by produced biochar was studied. The effect of adsorbent dose in batch-mode experiments was investigated. The equilibrium adsorption data of RB-5 were analyzed by Langmuir and Freundlich models. Langmuir isotherms best described the adsorption data with higher correlation coefficient R^2 values ($R^2 = 0.983$, $R^2 = 0.995$ and $R^2 = 0.941$). The maximum RB-5 adsorption capacities q_e(mg g^{-1}) of elemental copper and cuprite (Cu–Cu_2O)-based char, magnetite (Fe_3O_4)-based char and non-catalytically produced char from Langmuir model were 5.40, 2.82 and 4.37 mg g^{-1}, respectively at 0.1 g adsorbent dose. These results indicated that the biochars are suitable to be used as an adsorbent for RB-5 removal.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
May 2015, Volume 40, Issue 5, pp 1255-1268

A Feasibility Study for Synthesis Gas Production by Considering Carbon Dioxide Capturing in an Industrial-Scale Methanol Synthesis Plant

- Mohsen Abbasi , Mehdi Farniaei , Mohammad Reza Rahimpour , Alireza Shariati

Abstract:

In this paper, a feasibility study for the application of chemical-looping combustion (CLC) instead of fired furnace for synthesis gas production during methanol synthesis in an industrial-scale conventional steam reformers (CSR) has been considered. The aims are the prevention of large emission of CO_2 to atmosphere and enhancement of synthesis gas production. For this purpose, employment of Ni18–Al_2O_3, Ni40–Al_2O_3, and Fe45–Al_2O_3 oxygen carrier (OC) has been investigated. Simulation results show that complete oxidation and reduction of OC occurs in air reactor and fuel reactor (FR), respectively. Also, combustion efficiency reaches to 1 in the FR part of CLC-SR with all types of OCs. Utilizing CLC instead of fired furnace enhances CH_4 conversion and H_2 yield in SR side of CLC-SR. Results indicate that in CLC-SR, CH_4 conversion is equal to 26.4, 27.96, and 26.33 % via Ni18–Al_2O_3, Ni40–Al_2O_3, and Fe45–Al_2O_3 OC, respectively, in comparison with 26 % in CSR. Slightly higher conversion is observed with Ni40–Al_2O_3, i.e., from 26 % to almost 28 %. Synthesis gas production increases from 3633 kmol h^{-1} in CSR to 3639, 3868, and 3673 kmol h^{-1} in CLC-SR via Ni18–Al_2O_3, Ni40–Al_2O_3, and Fe45–Al_2O_3 OC, respectively. Results illustrate that by increasing FR feed temperature from 800 to 1000 K, CH_4 conversion in SR side increases 4.99, 7.93, and 4.57 % by using Ni18–Al_2O_3, Ni40–Al_2O_3, and Fe45–Al_2O_3 OC, respectively, in comparison with CSR. Also, synthesis gas production enhances 15 and 26.01 % via Ni18–Al_2O_3, Ni40–Al_2O_3, and Fe45–Al_2O_3 OC, respectively, in comparison with CSR.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
June 2015, Volume 40, Issue 6, pp 1539-1551

Generating Methods for Group Affective Preferences with Engineering Applications

- Chong Su , Hongguang Li , Jingwen Huang , Xianyu Bao

Abstract:

Traditionally, affective computing usually focuses on individual's affective dynamics instead of buildups of those of groups from a holistic perspective. Practically, the forms of group decision makers' preferences associated with multi-attribute decision-making problems are too complex to calculate programs' orders by judgment matrix, suffering difficulties in achieving the weights of sub-attributes based on the group judgment preferences. Currently, few researches are concerned with the definitions and generating methods of group affective preferences from the perspective of affective dynamics. In response to these challenges, this paper explicitly presents a stimulated and transferring affective computing model, along with the definition of group affective preferences and the interactive generating methods, which can gradually grasp group's experience in group decision making and help reduce group's subjective fatigue and make decisions more quickly. To exemplify applications of the proposed methods for a kind of multi-attribute decision-making problems, a test function and a chemical process control issue are investigated, giving rise to satisfied results and showing validity of the contribution.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
June 2015, Volume 40, Issue 6, pp 1553-1564

Removal of Colour (Direct Blue 199) from Carpet Industry Wastewater Using Different Biosorbents (Maize Cob, Citrus Peel and Rice Husk)

- Sudhakar Saroj, Satya Vir Singh , Devendra Mohan

Abstract:

Direct Blue 199 is used to colour carpets. In this study, adsorbents prepared from maize cob, citrus peel and rice husk (agricultural wastes) were used to study removal of Direct Blue 199 from its aqueous solution and a carpet industry's effluent. The adsorption equilibrium studies were carried out by varying the adsorbent dosage at a constant temperature of 28∘C . Adsorption of the dye varied with different adsorbents. Equilibrium adsorption data were correlated using Langmuir isotherms for all the three adsorbents. Kinetic study showed that it took about 2 h for 80–90% removal. Kinetic data for all the systems studied could be correlated satisfactorily by pseudo-second-order rate equation. It is confirmed by statistical *t* test (paired two samples for means) that the predicted and observed data were not significantly different statistically. The studies indicated that the adsorbents, maize cob, citrus peel and rice husk powders can be used as low-cost alternatives for the dye removal.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
August 2015, Volume 40, Issue 8, pp 2141-2151

Statistical Optimization of Phenol Degradation by *Bacillus pumilus* OS1 Using Plackett–Burman Design and Response Surface Methodology

- Sangram S. Patil, Hara Mohan Jena

Abstract:

Parameters such as initial phenol concentration, pH, temperature, inoculum size, and concentration of various medium components largely affect the phenol degradation ability of microbes; hence, these parameters must be optimized in order to achieve maximum phenol degradation. The present study is an attempt to optimize phenol degradation by *Bacillus pumilus* OS1, isolated from soil of crude oil spillage site. Experimental design methodology has been adopted for the optimization study. The Plackett–Burman design has determined five significant factors [pH, temperature, phenol concentration, inoculum size, and $(NH_4)_2SO_4$ concentration] out of the nine variables, important for phenol degradation. Response surface analysis using central composite design has been used to study mutual interactions between these variables and to find their optimum levels. The predicted result shows that maximum phenol degradation (99.99 %) could be achieved at pH 7.07, temperature 29.3 °C, phenol 227.4 mg/l, inoculum size 6.3 % (v/v), $(NH_4)_2SO_4$ 392.1 mg/l. The correlation coefficient (R^2 = 0.9679) indicates an excellent agreement between the experimental values and predicted ones. A fairly good agreement between the model predicted value and the one obtained from subsequent experimentation at the optimized conditions confirms the validity of the model.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
August 2015, Volume 40, Issue 8, pp 2153-2168

Removal of Yellow F3R, Di Maria Brilliant Blue R and Reactive Brilliant Red M-3BE from Aqueous Solutions by a Rapid and Efficient Ultrasound-Assisted Process with a Novel Biosorbent of Cottonseed Cake: Statistical Modeling, Kinetic and Thermodynamic Studies

- Musa Buyukada

Abstract:

Cottonseed cake as a domestic feed and a by-product of textile industry was utilized as a novel adsorbent for the decolorization of Yellow F3R (YF3R), Di Maria Brilliant Blue R (DBBR) and Reactive Brilliant Red M-3BE (Red F3B) aqueous solutions based on a rapid and efficient process of ultrasound-assisted adsorption. This study aimed to model the effects of the five factors on decolorization efficiency by response surface methodology: temperature, initial pH, reaction time, concentrations of initial dyestuff and adsorbent. A Box–Behnken design with five factors at three levels was used to set the experimental schedule. The maximum decolorization efficiency was obtained consistently at the lowest initial pH (2), the highest reaction time (30 min) and adsorbent concentration (1.5 g/L). Analysis of variance and the best-fit multiple nonlinear regression models were cross-validated (R^2_{pred}) accounting for 90.03–93.94 % of variation in decolorization efficiency. The decolorization of YF3R, DBBR and Red F3B on cottonseed cake fitted well pseudo-second-order kinetic mechanism and Langmuir isotherm and it was found to be of endothermic and spontaneous nature.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
August 2015, Volume 40, Issue 8, pp 2133-2139

Process Optimization of the Preparation of Vanadium Nitride from Vanadium Pentoxide

- Duan Xinhui , C. Srinivasakannan , Zhang Hong , Zhang Yuedan

Abstract:

Process optimization of vanadium nitride synthesis from vanadium pentoxide was attempted utilizing microwave carbothermal nitridation at atmospheric pressure using response surface methodology. The process variables that have significant influence on the quality of vanadium nitride such as the reaction temperature, reaction time and carbon addition ratio were investigated. The quadratic models were developed to evaluate the variables and optimize the process conditions, while the analysis of variance was utilized to identify the significant model parameters. The optimum conditions were identified to be a reaction temperature of 1400∘C , reaction time of 240 min and carbon addition ratio of 0.29; the nitride and vanadium content in the vanadium nitride products was found to be 15.83 and 80.99 %, respectively. Experiments were repeated, and the results authenticated the optimized process conditions successfully.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
August 2015, Volume 40, Issue 8, pp 2123-2132

Genetic Algorithms Applied to PCA–Residues Optimization for Defect Localization

- Tawfik Najeh, Achraf Jabeur Telmoudi , Lotfi Nabli

Abstract:

While defect localization is vital in real-world systems, some limitations inherent to the existing techniques urge us to seek more advanced methods. This paper presents a new approach which takes advantages of genetic algorithms for optimization of non-convex objective function employed in calculating structured residues. The proposed approach so far improved the current principal component analysis (PCA) based on one of the defect localization. It has excellent impact on problem solving while dealing with optimization of residues structuring. The first part illustrates both the PCA model and the traditional residues structuring approach. The principle of optimizing a problem via genetic algorithms is explained later. A proposed objective function to be optimized is defined in the next part, and its optimization via genetic algorithms allows the structured residues computation. The new approach has been applied and proved functional for monitoring the Tennessee Eastman process. We have also proved the efficient performance of the proposed method in comparing it with some state-of-the-art methods.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
August 2015, Volume 40, Issue 8, pp 2117-2122

Improved Hydrogen Production from Galactose Via Immobilized Mixed Consortia

- Gopalakrishnan Kumar, Periyasamy Sivagurunathan , Jong-Hun Park , Sang-Hyoun Kim

Abstract:

In this study, a combined encapsulation and entrapment immobilization strategy was employed to enhance hydrogen production from sewage sludge containing mixed microbial cultures. The results showed that the hydrogen production rate (HPR) and hydrogen yield (HY) of immobilized cells were significantly higher than that of the suspended cells. The peak HPR and HY of 0.76 L/L-d and 1.20 mol/mol galactose$_{added}$ attained with the immobilized cell system were comparable to that of the suspended cell system (HPR 0.62 L/L-d and HY 0.88 mol/mol galactose$_{added}$, respectively). The immobilized beads were also found to have efficient hydrogen production upon reuse for more than five cycles, with galactose removal > 85 % in all cases. Soluble metabolic product analysis revealed that fermentation followed a butyrate pathway and the major metabolites produced were acetate and butyrate. The peak total energy production rate and yield were 8.6 kJ/L-d and 308 kJ/mol $_{added}$, respectively.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
November 2015, Volume 40, Issue 11, pp 3041-3046

Electrochemical Process for Diazinon Removal from Aqueous Media: Design of Experiments, Optimization, and DLLME-GC-FID Method for Diazinon Determination

- Gilas Hosseini , Afshin Maleki , Hiua Daraei , Elham Faez , Yousef Dadban Shahamat

Abstract:

In the present study, electrochemical process was studied via removal of diazinon (O,O-diethyl O-2-isopropyl-6-methylpyrimidin-4-yl phosphorothioate) as an insecticide/ acaricide organic case study. Influences of three operational parameters including initial ferrous ion concentration, initial hydrogen peroxide concentration, and initial diazinon concentration were measured and optimized in diazinon removal process. Response surface methodology (RSM) was used to design the experiments. The experimental data collected in a laboratory-scaled batch reactor equipped with four graphite bar electrodes as cathode and an aluminum sheet electrode as an anode. Quantitative analysis of diazinon was done with gas chromatography equipped with flame photometric detector. Disperse liquid–liquid microextraction was used prior to gas chromatography in order to extraction and preconcentration of diazinon from aqueous media to extraction phase. Acetone and chlorobenzene were used as disperser and extraction solvent, respectively. Maximum diazinon removal efficiency of 87% (0.85mg mass removal) in C_0 of 2mg/L and 80% (120mg mass removal) in C_0 of 300mg/L was achieved under different experimental conditions. The obtained experimental data were used for model building by RSM approach. Finally, optimization process was carried out using RSM algorithm.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
November 2015, Volume 40, Issue 11, pp 3019-3027

Bio-Oil Production from Fast Pyrolysis of Cotton Stalk in Fluidized Bed Reactor

- Najaf Ali , Mahmood Saleem , Khurram Shahzad , Arshad Chughtai

Abstract:

Fast pyrolysis was used to convert waste biomass into bio-oil, which has a benefit of storage and transportation with the potential as a fossil oil substitute. Pakistani cotton stalk was pyrolyzed in a bench-scale bubbling fluidized bed reactor. The effect of reaction conditions such as temperature and feed size on the bio-oil, char and gas yields was investigated. The optimal pyrolysis temperature for the production of bio-oil was 490 °*C* which gave the maximum yield (36 wt%) of product at feed size of 1.0 mm. Bio-oil yield increased with the increase in temperature, while the yield of char decreased. The various properties of bio-oil attained under these pyrolysis conditions were defined. Chemical composition of bio-oil was determined using FTIR and GC–MS analysis, and major chemical compounds were phenols, carboxylic acids, ketones, aldehydes, furans and sugars.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
November 2015, Volume 40, Issue 11, pp 3029-3039

Unsteady Radiative MHD Free Convective Flow and Mass Transfer of a Viscoelastic Fluid Past an Inclined Porous Plate

- M. K. Nayak , G. C. Dash , L. P. Singh

Abstract:

The present paper is related to the study of an unsteady radiative magnetohydrodynamic free convection flow of a viscoelastic fluid past an inclined plate embedded in a porous medium. The fluid is incompressible and optically transparent. The effects of chemical reaction, heat source and viscous dissipation are considered during the present study. The case of viscous flow has been discussed as a special case, and the reported results of previous authors have been highlighted also. The novelty of our study is not only to analyze the effect of elasticity but also to account for the viscous dissipation which is important in case of radiative and optically transparent flows. An approximate analytical solution has been obtained by applying perturbation method. Results of the present study are in good agreement with Reddy et al. (Asian J Curr Eng Maths 1(3):115–119, 2012) and Chen (Int J Heat Mass Transf 53:4263–4276, 2010). It is interesting to note that higher Prandtl number fluid under the influence of magnetic field reduces the velocity, whereas elasticity property increases it. Moreover, higher viscous dissipation leads to an increase in the fluid temperature and hence reduces the heat transfer rate from the inclined plate.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
November 2015, Volume 40, Issue 11, pp 3007-3017

Adsorption-Based Removal of Gas-Phase Benzene Using Granular Activated Carbon (GAC) Produced from Date Palm Pits

- Muhammad Shariq Vohra

Abstract:

The Kingdom of Saudi Arabia is one of the leading countries in date fruit farming, and by-products from date palm trees can be used for several important applications, including pollution control. This study successfully employed date palm pit-based granular activated carbon (GAC) to adsorb gas-phase benzene under dynamic flow conditions. The percent carbon content (w/w) for *raw date palm pits* and *produced GAC samples* was found to be 47 and 82 %, respectively. Furthermore, the specific surface area (SSA_{BET}) of the produced GAC was 822 m^2/g, and the t-Plot micropore area and t-Plot external surface area were 734.99 and 87.26 m^2/g, respectively. The BJH graph for the pore size distribution also indicated a mesoporous structure. The use of date palm pit-based GAC for gas-phase benzene adsorption under dynamic continuous-flow conditions showed high efficiency with breakthrough points for different systems ranging from several hours to several days. The role of surface functional groups and their interactions with the benzene rings during the adsorption process were also explored, and surface oxygen-based groups may initiate an electron donor–acceptor mechanism with the benzene's aromatic ring π electrons. The findings confirmed that GAC produced from date palm pits can be successfully used for gas-phase benzene adsorption under various conditions. It is hoped that countries with large-scale date fruit farming, such as the Kingdom of Saudi Arabia, will be able to utilize this rich resource for environmental applications.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
December 2015, Volume 40, Issue 12, pp 3409-3415

Comparison of Electrocalorimetric and Cooling Methods to Determine Specific Heat of Aqueous Solutions of the Sodium Salt Carboxymethylcellulose

- Karol Prałat

Abstract:

This article includes the results of experimental research, determining specific heat of water, glycerin, rapeseed oil and aqueous solutions of carboxymethylcellulose sodium salt. Two research methods were used during measurements. The first one uses Newton's law of cooling. The second one uses electrocalorimetric measurements. The average calculated values of determined parameter for model liquids did not exceed 1 % error in cooling method and did not exceed 2 % error in calorimetric method. Good conformity of both methods enabled to use them in measurements of liquids with unknown values of specific heat *C*. In case of carboxymethylcellulose sodium salt, together with increasing concentration, specific heat increases. Significant impact on obtained results has also molar mass *M*. The highest values *C*, were obtained for carboxymethylcellulose sodium salt with a molar mass 700,000 kg/kmol and concentration 0.005 kg p/kg within the range of temperatures (303–325) K. Obtained result was over 19 % higher than water.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
December 2015, Volume 40, Issue 12, pp 3373-3377

Mechanism of Intercalation Extent in Polymer/Clay Nanocomposites

- Ahmad Nawaz Khan , Aneela Hayder , Wei-Tsung Chuang

Abstract:

The mechanism of the intercalation and the expansion of the interlayer distance of nanoclays due to the penetration of polymeric chains is studied using X-ray diffraction as a function of temperature. Poly(trimethylene terephthalate) (PTT) and poly(trimethylene naphthalate) (PTN) belonging to the polyester family were chosen for the formation of nanocomposites with the layered structure nanoclays. The PTN contains the polymorphism (α-form and β-form) with respect to the temperature. In case of PTT/nanoclay composites, the relative increase in the intercalation extent is found with increasing the temperature. For PTN/nanoclay composite, the intercalation extent is relatively decreased by increasing the temperature due to the fact that thermodynamically and kinetically the transformation of α- to β-form is favored instead of the expansion of nanoclay's interlayer distance.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
December 2015, Volume 40, Issue 12, pp 3393-3407

Simulation-Based Artificial Neural Network Predictive Control of BTX Dividing Wall Column

- Rajeev Kumar Dohare , Kailash Singh , Rajesh Kumar , Sushant Upadhyaya

Abstract:

For the separation of ternary liquid mixture, use of dividing wall column is one of the nonconventional techniques in the field of liquid separation by thermal process. Benzene, toluene, and *o*-xylene have been selected as a ternary system for this study. As it is difficult to control the product purity directly due to delay time in the composition analyzer, temperatures of the appropriate trays were selected as the controlled variables. Reflux rate, sidestream flow rate, and reboiler heat duty were selected as manipulated variables to control sixth tray temperature of rectifying section, 11th tray temperature of the main column, and 12th tray of stripping section. Back-propagation algorithm was used as a training algorithm to tune the connection weights for the function of each neuron. The control performance of ANNPC was investigated for ±10 % load changes in feed flow rate, feed composition, and liquid split factor. The control performance was analyzed by using performance criteria indexes and performance parameters such as IAE, ITAE, ISE, ITSE, rise time, and settling time. It is observed that these performance parameters are less for ANNPC as compared to PID control. The settling time in case of PID varies from 2.77 to 4.55 h, significantly higher than that in ANNPC (0.37–0.66 h). The rise time is 0.66–1.20 h for PID and 0.03–0.27 h for ANNPC. These results indicate that ANNPC performs better than PID controller.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
December 2015, Volume 40, Issue 12, pp 3379-3391

Novel Design and Simulation of a Solar Air-Conditioning System with Desiccant Dehumidification and Adsorption Refrigeration

- Kamel Rabhi , Chaouki Ali , Rached Nciri , Habib Ben Bacha

Abstract:

The work deals with the design and the functioning simulation of a novel solar air-conditioning system. The new design of the system is developed with two key stages: multi-bed dehumidifier system that ensures a regular dehumidification, and an adsorption chiller that increases the energetic performance of the system. Three operation modes (summer with dehumidification, summer without dehumidification and winter modes) are detailed for the proposed solar air-conditioning system. The simulation of the functioning of the designed system was carried out, under variable meteorological conditions, in order to foresee the energetic performance and predict the temperature range ensuring the sense of well-being.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
December 2015, Volume 40, Issue 12, pp 3363-3372

Application of Response Surface Method for Optimization of Adsorptive Removal of Eriochrome Black T Using Magnetic Multi-Wall Carbon Nanotube Nanocomposite

- F. Bandari , F. Safa , Sh. Shariati

Abstract:

Response surface method was employed to optimize adsorptive removal of Eriochrome Black T (EBT) from aqueous solutions using the magnetic multi-wall carbon nanotube (MMWCNT) nanocomposite. The nanocomposite was synthesized by mixing commercial multi-wall carbon nanotube and a solution containing ferric and ferrous salts in highly basic media at elevated temperature. Properties of the nanocomposite were characterized by scanning electron microscope (SEM), Fourier transform infrared (FTIR) spectrometer, and X-ray diffractometer. Adsorption experiments were carried out based on a central composite design (CCD) with four input variables including adsorbent dosage (w: 2–10 g/L), contact time (t: 35–95 min), pH (2–9), and ionic strength (i: 0.02–0.1). Regression analysis showed good fit of the experimental data to a quadratic polynomial model with coefficient of determination (R^2) value of 0.9897 and Fisher ratio of 103.34. Adequacy of the model was verified by analysis of variance (ANOVA), lack-of-fit test, and residual analysis. Optimum values of the variables for maximum adsorptive removal of EBT were predicted by the model (w = 5.39 g/L; pH = 2.11; t = 78 min and i = 0.08). The observed dye removal of 99.80% in the predicted optimal condition confirmed high efficiency of the response surface method in modeling EBT removal from aqueous solutions using MMWCNT nanocomposite.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
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Adsorption of Reactive Blue Dye from Aqueous Solutions Using Sawdust as Adsorbent: Optimization, Kinetic, and Equilibrium Studies

- G. M. Ratnamala, U. B. Deshannavar, Sunil Munyal, Kushal Tashildar, Suraj Patil, Amar Shinde

Abstract

Adsorption using sawdust from Malaysian teak wood as adsorbent has been studied in order to remove reactive blue dye from aqueous solutions (AS). The dye removal study comprised of investigation of parameters such as concentration of dye, pH, agitation time, and temperature. Optimization was performed using response surface methodology. Kinetics of adsorption of reactive blue dye with activated sawdust was analyzed using Lagergren's kinetic models, and it was found that the dye reduction efficiency by activated sawdust followed pseudo-second-order kinetic model. Langmuir and Freundlich's isotherm models were used for the fitment of batch adsorption experimental data, and it was observed that Langmuir model was found to agree with the values obtained by experimentation based on regression analysis and RMSD values. The study showed that activated sawdust as a promising adsorbent for the reduction of reactive blue dye from AS.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
February 2016, Volume 41, Issue 2, pp 345–355

Remediation of Cu(II) from Well Water of Iraq by Using Cortex of Fruits and Agricultural Waste

- Thamer J. Mohammed, Raheek I. Ibrahim

Abstract

Copper ion Cu(II) is among the main pollutants present in excessive amounts in underground water in many locations in Iraq. The present work studies adsorptive removal of Cu(II) from well water using waste materials such as watermelon shell, lemon, and banana peels. Influences of many parameters like initial concentration, dosing, contact time, pH, and particle sizing were examined. The elimination efficiency of the watermelon shell was 90 % compared with that of lemon Peel was 78 %, while for banana Peel was observed to be 65 %. Meanwhile, the highest possible adsorption capacity was 9.54 mg/g for watermelon shell, 8.24 mg/g for lemon peel, and 7.65 mg/g for banana peel. The column test was applied to the real well water, confirmed that reloading of the column could enhance its own removing efficiencies by 15–30 %. However, characterization of adsorption of the watermelon shell, measured from FTIR and SEM micrograph, verified that watermelon shell is a powerful adsorbent due to its own functional groups as well as cavities on its surface texture. In the same context, comparison between adsorption capability of watermelon shell and both Langmuir and even Freundlich models points out that Langmuir is much better fit the experimental data. Overall results confirm that watermelon shell is an excellent and also alternative adsorbent material for eliminating copper ions. Moreover, it is natural, environmentally friendly, and cost-effective for treating contaminated well water in Iraq.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
February 2016, Volume 41, Issue 2, pp 357–369

Comparative Study of the Performance of Fischer–Tropsch Synthesis in Conventional Packed Bed and in Membrane Reactor Over Iron- and Cobalt-Based Catalysts

- Dounia Alihellal, Lemnouer Chibane

Abstract

A comparative study of Fischer–Tropsch synthesis for synthesizing liquid hydrocarbons from syngas was carried out in a conventional packed bed reactor and in a water perm-selective membrane reactor over iron and cobalt catalysts. The process was performed under different operating conditions, such as inlet syngas feed molar ratio, total pressure, gas velocity, temperature, reactor dimensions and sweep fluid ratio. The main simulation results show that the use of the concept of membrane reactor can improve the process performance compared to that obtained in the case of the conventional packed bed reactor. Furthermore, under certain operating conditions, the process could be intensified by a reduction of carbon monoxide conversion magnitude via the water–gas shift reaction. This is possible by using a hydrophilic membrane. Our findings indicate that the membrane reactor provides a quasi-complete conversion of carbon monoxide over iron- or cobalt-based catalysts.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
February 2016, Volume 41, Issue 2, pp 371–379

Laboratory Studies of Post-combustion CO_2 Capture by Absorption with MEA and AMP Solvents

- Aleksander Krótki, Lucyna Więcław-Solny, Adam Tatarczuk, Marcin Stec

Abstract

With regard to the climate policy that has been adopted, the implementation of the carbon capture and storage and carbon capture and utilization technologies seems to be the unavoidable solution to reduce emissions from the energy sector. As most Polish energy is derived from coal, the government has taken steps to reduce CO_2 emissions by initiating a strategic research program—"Advanced technologies for energy generation: Development of a technology for highly efficient zero-emission coal-fired power units integrated with CO_2 capture." This paper presents the results of an investigation of a process for continuous removal of CO_2 from the gas stream on a laboratory unit. This study was conducted at the Institute for Chemical Processing of Coal in Zabrze, Poland. The purpose of the tests that were conducted was to establish the effect of the sorption column load on CO_2 recovery and on the process regeneration heat duty. In the second part of the paper, a simple comparison of three amine solvents is presented as a part of the solvent selection process for further pilot plant tests.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2385–2392

Preparation and Characterization of Activated Carbon from Vegetable Waste by Microwave-Assisted and Conventional Heating Methods

- Özgül Gerçel, H. Ferdi Gerçel

Abstract

In this research, the use of vegetable waste has been investigated as a cheap and available precursor of activated carbon. Activated carbons were prepared through chemical activation by conventional and microwave heating systems. The most effective activated carbon was obtained by KOH activation–conventional heating using eggplant as a precursor. The chemical and textural characteristics of AC_1 were investigated using N_2 adsorption–desorption measurements, SEM, FTIR spectroscopy, TGA, EDX and CHN elemental analysis. The success of the prepared adsorbent in the removal of a textile dye (Burderm Orange II) and the effect of temperature and pH on the removal efficiency were studied. The best fit was obtained with a Langmuir isotherm model, and a maximum monolayer adsorption capacity of BOII was 833.33 mg g^{-1} at 40°C for pH 2. Kinetic parameters, such as rate constants, equilibrium adsorption capacities and related correlation coefficients, were calculated.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2393–2398

Synthesis and Use of Low-Band-Gap ZnO Nanoparticles for Water Treatment

- Sunil Kumar, Alpana Thakur

Abstract

Zinc oxide has been prepared with crystallite size in nanodimension by the use of wet chemical technique. The crystalline nature of nano-ZnO with average crystallite size of 36–63 nm was confirmed by X-ray diffraction. The synthesized nano-ZnO was further characterized by ultraviolet–visible spectroscopy, Fourier transform infrared spectroscopy and energy-dispersive X-ray spectroscopy. The prominent spherical surface morphology of synthesized nano-ZnO was confirmed by scanning electron microscopy. The optical band gap of 3.12 eV was obtained for nano-ZnO. The prepared nano-ZnO were utilized for the treatment of dye as well as bacterial cultures found in aqueous phase. Excellent remediation by nano-ZnO was observed against the fast green dye and bacteria *Bacillus subtilis* and *E. coli*.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2399–2408

Modeling of the Flue Gas Condensation for the $PM_{2.5}$ Removal Efficiency of a Integrated Technology

- Jing Liu, Dong-lin Cheng

Abstract

A combined pseudo-homogeneous and fractal geometry model was developed to simulate the process of a integrated technology. The technology was proposed to replace heat pipes and WFGD, which is based on the theory that liquid membrane and droplets grow in size by vapor heterogeneous condensation with they acting as nucleation centers and then the grown droplets are removed efficiently by using integrated diverse combinations of condenser pipes and a highly efficient scrubber. The model has been approached useful for both analyzing results and aiding in design of the technology by conducting a two-dimensional steady-state model by means of infinitesimal analysis, incorporating with the models of whole fine particles absorption efficiency of a regularly arranged liquid membrane and droplets column group, and the models of geometric classifications for liquid and solid based on the fractal dimension identified by different structural of radius of gyration of liquid–solid interface transition zone. The predicted values were also compared with the experimental results, and they are in excellent agreement. The results showed that: When the fractal dimension d_f is 0.3, the calculation result is the most closer to actual experiment parameter. The $PM_{2.5}$ diffusion volume flux value V_w ranges from 22 and 45 mm/s.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2409–2415

Separation of Methylene Blue as Pollutant of Water by SBA-15 in a Fixed-Bed Column

- Talib M. Albayati, Anaam A. Sabri

Abstract

A methylene blue (MB) dye pollutant was separated by SBA-15 for the first time in fixed-bed continuous systems. The continuous adsorption experiments were included: the effect of bed height, flow rate and initial concentration on breakthrough curve investigation. Breakthrough performance showed SBA-15 has the most promise for application in continuous adsorption systems. The results illustrate that MB capture is obtained at the maximum uptake (83.6 mg/g) when the bed height was (6 cm), initial concentration (40mg/L) and flow rate (0.6mL/min). The mesoporous SBA-15 was recovered effectively by calcinations and employed again for five times in continuous system successfully.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2417–2427

Effects of Potassium, Magnesium, Zinc, and Manganese Addition on the Anaerobic Digestion of De-oiled Grease Trap Waste

- Li-Jie Wu, Takuro Kobayashi, Hidetoshi Kuramochi

Abstract

Dosage of nutrients for anaerobic digestion is essential to maintain their treatment performance. Kitchen waste generally contains low concentrations of nutrients, especially metals. However, for de-oiled grease trap waste (GTW), such a kitchen waste, little data are available in terms of nutrient supplementation to enhance anaerobic digestion. In order to determine the effects of different concentrations of metals on anaerobic digestion of de-oiled GTW and the optimal metal dosages, a step-wise batch experiment for four metals, potassium (K), magnesium (Mg), zinc (Zn), and manganese (Mn), with a blank test as control, was conducted to gradually lower the concentrations of metals. The supplementation of individual K, Mg, Zn, and Mn did have effects on enhancing the process to different extents. The appropriate concentrations of investigated metals for accelerating anaerobic digestion of de-oiled GTW were as follows: K 720.2mg/g COD, Mg 47.3mg/g COD, Zn 1.1mg/g COD, and Mn 11.6mg/g COD, respectively. The requirements of four metals obtained in the experiment agreed with the results of theoretical calculations.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2429–2438

Post-optimality Analysis of Production Levels in a Petrochemical Complex

- Abdallah Al-Shammari

Abstract

This study investigates the effect of uncertainty or variation associated with some model parameters on the production rates in a petrochemical complex. A modified approach to post-optimality analysis is used to assess and evaluate such effects. Frequent and small variations in parameters, like product prices, or constraints, like demand and supply, can seriously affect the optimum solution. To overcome this problem, various fuzzy and stochastic programming techniques have been proposed in the literature to determine robust solutions. However, application of post-optimality analysis in the petrochemical industry has received less attention. In this paper, a modified method for post-optimality (stability) analysis is applied to a petrochemical complex model formulated as a linear programming problem. The proposed approach differs from stochastic programming in that it can provide the decision-maker with simple and useful information that enables identification of sensitive parameters and constraints that need better estimation and monitoring. The results present the stability limits within which the assigned production rates remain optimum and sensitivity information like the Lagrange multiplier is still valid. By applying these results, the profit of the petrochemical complex can be increased by between 3.4 and 6.3 % by adjusting some model constraints.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2563–2571

Continuous anaerobic hydrogen and methane production using water hyacinth feedstock

- Chyi-How Lay, Biswarup Sen

Abstract

The water hyacinth, *Eichhornia crassipes*, impacts the environment in a number of ways. This study develops a continuous cultivation strategy and investigates the effect of these strategies for hydrogen production in anaerobic sequencing batch reactor (ASBR) and intermittent-continuous stirred tank reactor (I-CSTR) systems using the water hyacinth as feedstock. Glucose (10 g/L) was used as the feedstock to start-up the fermentor using pig slurry seed in a batch model. ASBR with increasing water hyacinth concentration was used as the start-up strategy for hydrogen production. However, the hydrogen performance decreased with increasing water hyacinth concentration. Finally, the metabolic pathway shifted to methane production with no hydrogen. A strategy for controlling the substrate and reaction pH and shortening the hydraulic retention time (HRT) in I-CSTR was used to enhance the hydrogen production. Low hydrogen production performance was achieved with a hydrogen production rate of 1.1 with 82.4mL/L-d methane production rate resulting from the I-CSTR operated using pH 4.0 feedstock and HRT 2days.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2573–2582

Combined Effect of CNTs with ZIF-302 into Polysulfone to Fabricate MMMs for Enhanced CO_2 Separation from Flue Gases

- Muhammad Sarfraz, M. Ba-Shammakh

Abstract

Multiwalled CNTs and zeolitic imidazole frameworks (ZIF-302) were collegially incorporated into glassy polysulfone (PSF) to prepare mixed-matrix membranes (MMMs) to separate CO_2 from post- combustion flue gas stream. Varying loadings of both nanofillers were incorporated into PSF using solution-casting technique to optimize CO_2 separation performance of MMMs under dry and wet conditions. The flexible MMMs rendered homogeneous dispersion of fillers, improved polymer–filler adhesion, and thermally stable structure. Gas sorption analyses along with dry and wet gas permeation experiments demonstrated improved CO_2 permeability and CO_2/N_2 ideal selectivity of MMMs owing to collegial effect of nanofillers. The composite membrane containing 8 wt% CNTs and 12 wt% ZIF-302 nanofillers showed an optimum separation performance by providing a CO_2 permeability of 18 Barrers with CO_2/N_2 selectivity of 35. The permeation features of MMMs were slightly improved under humid conditions as compared to dry ones.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2583–2587

Fabrication and Composition Investigation of $WSi_2/MoSi_2$ Composite Powders Obtained by a Self-Propagating High-Temperature Synthesis Method

- Ying Zhou, Zongtao Zhang

Abstract

In this paper, $MoSi_2/WSi_2$ composite powders with different phase compositions were fabricated via a self-propagating high-temperature synthesis (SHS) method. The influence of initial raw material compositions on the formation and the phase evolution of the $MoSi_2/WSi_2$ composite powders were investigated. Thermodynamic analysis indicated that the incorporation of W in the starting materials decreased the adiabatic temperature during the SHS reaction, and self-sustainable reaction can be hindered when the W content reached up to 40%. For samples with raw material composition of (1−*x*)Mo·xW·2Si 1−x)Mo·xW·2Si (*X* = 0.10, 0.20, 0.30, 0.40), composite $MoSi_2/WSi_2$ powders can be prepared, which were confirmed by the existence of two fitted peaks that can be assigned to tetragonal $MoSi_2$ (103) and WSi_2 (103) crystallographic planes in the XRD fine scan patterns. SEM images also confirmed the existence of two maxima in particle size distributions for samples with high W addition contents. The formation of $MoSi_2/WSi_2$ composite powders and the evolution of composite phases reported in this paper may provide an effective strategy for the synthesis of silicide based composite materials.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2589–2600

Analysis of the Pressure Drop Through the Bed and Across the Supporting Grid in Type II-TBC: Experimentation and Modelling

- Bensaber Bensebia, Ouahida Bensebia

Abstract

Experimental data on pressure drop and bed expansion were collected over a wide range of operating conditions (U g =0−8ms −1 Ug=0−8ms−1 , L=0−27.90kgm −2 s −1 L=0−27.90 kgm−2s−1 , H st /d C =0.5−1,φ=0.32−0.82,ρ p =736 Hst/dC=0.5−1,φ=0.32−0.82,ρp=736 and 868kgm −3 868kgm−3 , and d p =10 dp=10 and 15 mm) in a type II-TBC. The variations in the pressure drop through the fluidized bed and through the supporting grid were analysed, and the effect of the gas velocity, the liquid spray, the height of the static bed and the free area of the support grid was studied. A model based on an approach including all components of the pressure drop through the fluidized bed and through the support grid has been proposed for the prediction of the pressure drop through the entire column. The predictions for all experimental data were in very good agreement with the experimental data ($AARD$ (−ΔPC) =10.70 AARD(−ΔPC)=10.70 %). The choice of the appropriate correlation to estimate the liquid holdup was conducted on the basis of a systematic study for a large number of correlations among the most usual. This study was also aimed to determine the deviations induced by the use of different liquid holdup correlations, when calculating the pressure drops. An interpretation was proposed to explain the disparity in results in the calculation of pressure drop using different correlations to estimate the rate of the liquid holdup.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2601–2609

Kinetic Analysis of Pyrolysis of Waste Polyolefin Mixture

- Karmina Miteva, Aleksovski Slavcho

Abstract

The waste plastics can be converted into valuable fuels by the process of pyrolysis. To optimize the process of pyrolysis of polymers, the knowledge of thermal degradation kinetics is needed and it is usually studied by thermogravimetry. Thermogravimetric analysis is an excellent tool for studying the kinetics of thermal degradation, since it enables determination of the basic kinetic parameters such as activation energy, reaction order and pre-exponential factor. In this work, kinetic analysis of thermal and catalytic degradation of polyolefin mixture of polypropylene and high-density polyethylene was investigated under non-isothermal conditions at different heating rates: 3–20 K/min. The activation energy was determined applying the model-free methods, proposed by Flynn–Wall–Ozawa and Kissinger–Akahira–Sunose. Results have shown that the average activation energy values determined by both methods are similar. The activation energy for degradation of the polyolefin mixture decreases considerably by adding the catalyst.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2611–2621

Comparative Study Between Response Surface Methodology and Artificial Neural Network for Adsorption of Crystal Violet on Magnetic Activated Carbon

- Iman Salehi, Mahboube Shirani

Abstract

The easily separable and regenerable magnetic activated carbon was synthesized for adsorption of toxic cationic dye, crystal violet, from aqueous solution. The synthesized magnetic activated carbon was characterized by SEM–EDX. The magnetic property of sorbent was evaluated by VSM method. The obtained saturation magnetization of 41.56emu g^{-1} showed facile separation of sorbent after adsorption process. The effect of five parameters of pH, temperature, time, initial dye concentration and sorbent amount on adsorption (%) were investigated. The percentage of adsorption was mathematically described as a function of experimental parameters and was estimated by central composite design (CCD). The maximum adsorption percent of 99.5±0.2 was obtained experimentally which was close to the percent of CCD prediction of 99.90 %. The same design was used for a three-layer artificial neural network model (ANN). The predicted data of CCD versus ANN showed the linear agreement with regression value (R 2) (R2) of 0.9994 which confirmed the ideality of CCD and ANN. The results of two models were compared in terms of coefficient of determination (R 2) (R2) and mean absolute percentage error (MAPE) to indicate the prediction potential of CCD and ANN. The MAPE (%) of 0.59 and 0.38 was found for CCD and ANN respectively. The obtained results indicated higher capability and accuracy of ANN in prediction. The experimental data were found to be properly fitted to the Langmuir and Freundlich models which indicates that the sorption takes place on a heterogeneous material and the sorption capacity of 12.59 mgg^{-1} was achieved.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2623–2629

The Effect of Surfactant on Selectivity in the Extraction of Aromatic Hydrocarbons from the Lube Oil

- Hidaya Izza, Mourad Korichi

Abstract

An investigation was conducted in order to examine the effect of the addition of surfactant to the fraction of the light lubricating oil (spindle) during the solvent extraction process. The solvent power and selectivity can be further increased by using surfactant as an additive. This could facilitate the separation phase and increase the yield of the raffinate. In this study, we suggested the use of ethoxylated anionic surfactant (sodium lauryl ether sulfate). The aromatics in the lube oil were extracted at different temperatures (ranging from 333.15 to 343.15 K) with different concentrations of surfactant (ranging from 0.01 to 0.1 wt%). The extraction temperature and the amount of surfactant in furfural were systematically investigated to determine their optimum values. Compositions in monoaromatics, diaromatics, polyaromatics, and saturates were determined by using UV–Vis spectrophotometry. When surfactant was added, the solvent acquired the ability to preferentially extract polyaromatics instead of the monoaromatics. This directly affects the required oil quality. It was found that using 0.01 wt% of surfactant at 343.15 K yields the optimum extraction conditions.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2631–2646

Prediction of Photocatalytic Degradation and Mineralization Efficiencies of Basic Blue 3 Using TiO 2 TiO2 by Nonlinear Modeling Based on Box–Behnken Design

- Musa Buyukada

Abstract

In the present study, nonlinear modeling of color and chemical oxygen demand (COD) removal of Basic Blue 3 as a fairly toxic textile dye by photocatalytic degradation using TiO 2 TiO2 was investigated. A three replicates and one duplicate of Box–Behnken design with 45 runs, with three factors and three levels of catalyst concentration of 0.5–1.5 g/L, initial dye concentration of 20–100 mg/L, and initial pH of 3–11 were set to quantify the explanatory variables. ANOVA results showed that the best-fit multi-nonlinear regression models were cross-validated (R 2 pred) (Rpred2) accounting for 99.98–99.79 % and were expressed (R 2 adj) (Radj2) accounting for 99.88–99.85 % of variation in decolorization (color removal) and mineralization (COD removal), respectively. In total, 0.51 g/L of TiO 2 TiO2 , 100 mg/L of initial dye concentration, and initial pH of 7 were established as optimum operating parameters by leave-one-out optimization that resulted in 88.61 and 79.03 % for color and COD removal, respectively. 88.78 % of color removal and 76.95 % of COD removal were determined by cross-validation experiments at optimum conditions. Results showed that optimum point determination was successful.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2647–2658

Optimum Operating Parameters for Hollow Fiber Membranes in Direct Contact Membrane Distillation

- Khalid T. Rashid, Sunarti Binti Abdul Rahman

Abstract

The aim of this study is the optimization of the operating conditions of PVDF-co-HFP hollow fiber membrane for direct contact membrane distillation applications. The influence of the operation parameters, such as the feed temperature (40–80 ∘ *C* ∘C), the feed flow rate (0.3–0.6L/min), and the PVP content (0–9%), as well as the feed concentration increased from 3.5 to 5.0 wt%, and their interactions on the PVDF-co-HFP hollow fiber membrane permeate flux have been investigated. The optimum operating parameters have been specified using second-order FULL FACTORIAL and Taguchi optimization techniques to find optimum values for operation parameters in the DCMD process in order to obtain a good value of permeate flux. The results showed that PVDF-co-HFP membrane has the best performance at 21 (*kg*/*m* 2 *h* kg/m2h) when a hot feed temperature of 80 ∘ *C* ∘C with 0.6 L/min flow rate, 3.5wt% NaCl feed concentration and 9 wt% PVP content in the casting solution were used. The PVP % content and inlet temperature had a significant impact on the permeate flux, while feed flow rate and feed concentration have less influence.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2659–2670

Study on Catalytic Wet Air Oxidation Process for Phenol Degradation in Synthetic Wastewater Using Trickle Bed Reactor

- Mohammad F. Abid, Ghanim M. Alwan

Abstract

The present work aims to study the feasibility of utilizing a trickle bed reactor, packed with activated carbon catalyst, for phenol degradation in synthetic wastewater. Effect of operating variables (e.g., pH, pressure, temperature, gas flow rate, liquid flow rate, and flow mode) on the performance of the trickle bed reactor was investigated and optimized. Results showed that phenol degradation would be enhanced by increasing temperature, pressure, and gas flow rate, while initial concentration of phenol and liquid flow rate give a different trend. It was found that down-flow mode exhibits better performance than up-flow mode. High degradation rate of phenol of about 97 % was obtained at optimum conditions (liquid space time = 0.143 h, temperature = 160 °C, oxygen partial pressure = 0.9 MPa, and phenol concentration = 5 mg/l). Reaction kinetics including effects of catalyst deactivation on the oxidation process was investigated. Results showed that the oxidation process behaves as pseudo-first-order reaction with respect to phenol concentration, and 0.6 with respect to oxygen solubility. Activation energy is 77.7 kJ/mol. and reaction rate constant is equal to 1.826×10 9 *l*/*kg* cat 1.826×109l/kgcat h. However, when catalyst deactivation was taken into account, the reaction rate constant and activation energy were 2.9×10 11 *l*/*kg* cat 2.9×1011l/kgcat h and 114.43 kJ/mol, respectively, and the oxygen order was equal to 1.4. The calculated kinetic parameters were compared with the data reported in the literature.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2671–2680

Optimization of Growth Parameters for Diamond Films Grown by MPCVD Using Response Surface Methodology

- Caiyi Jiang, Shenghui Guo, Jiyun Gao

Abstract

Diamond films were synthesized by microwave plasma chemical vapor deposition under different deposition parameters. Response surface methodology was adopted to guide the optimization of synthesis parameters including the substrate temperature (716–884 ∘ C) ∘C) , gas pressure (4.32–7.68 kPa), and volume concentration of methane to hydrogen (1.3–4.7 %) for deposition of the films. A 5-level-3-factor central composite design was employed to evaluate effects of the deposition parameters on the response (growth rate and pure index). The significant level of both the main effects and the interaction is investigated by analysis of variance. With its assistance, the growth quality of the obtained samples was improved dramatically. The structure, surface morphology and growth rate of films were characterized by X-ray diffractometer and scanning electron microscopy. The diamond phase content of films was investigated using Raman spectroscopy and X-ray photoelectron spectroscopy. The optimum substrate temperature, gas pressure, and volume concentration of methane to hydrogen were found to be 837 ∘ ∘ C, 6.95 kPa and 2 %, respectively. Under this experimental condition, the growth rate and pure index of diamond films were 0.378 μ μ m/h and 4.092, which are quite good correlation with value (0.383 μ μ m/h and 4.182) predicted by the model. The diamond phase content of the films is 89.5 %.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2751–2770

Modeling of Two-Phase Relative Permeability in Cambrian and Early Miocene Sandstone Reservoirs: A Case Study, Egypt

- Mohamed S. El Sharawy

Abstract

The relative permeability is the ratio of the effective permeability to the absolute permeability. Due to the importance of relative permeability in reservoir simulation, there is a dominant need to upscale it. So, several models were introduced to modeling the relative permeability. Some correlation models were dependent on capillary pressure measurements, while other models did not require such measurements. In this study, four relative permeability correlation models were chosen to apply them on two sandstone reservoir (labeled A and B) data sets. The two reservoirs belong to different ages and depositional environments. Both reservoirs are located in the Southern Gulf of Suez, Egypt. Reservoir A is the Nubian sandstone of Cambrian age. Reservoir B is the Nukhul clastic of Early Miocene age. The data sets include laboratory measurements of unsteady-state gas–oil relative permeability and steady-state water–oil relative permeability tests. The results indicate that the practical and modified Corey models were the most applicable model for the studied reservoirs. Additionally, prediction of relative permeability at saturation end points was carried out based on using routine core porosity and permeability by introducing new empirical equations. The relative permeability was used to identify rock wettability, water cut, water cutoffs and the areal and vertical sweep efficiencies.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2553–2561

Enzymatic Synthesis of Mono- and Diglyceride Using Lipase From *Candida rugosa* Immobilized Onto Cellulose Acetate-Coated Fe_2O_3 Nanoparticles

- Abhishek Kumar Singh, Mausumi Mukhopadhyay

Abstract

A lipase from *Candida rugosa* was covalently immobilized on the cellulose acetate (CA)-coated Fe_2O_3 nanoparticles for the biocatalysis applications. The characterization of the Fe_2O_3-CA particles before and after immobilization of lipase was studied. The biocatalyst was assayed for the glycerolysis of olive oil in solvent system. The effect of reaction time, temperature, molar ratio of glycerol to oil and amount of lipase on the glycerolysis reaction was investigated. Results showed that the high yield of monoglycerides (49.7 wt%) and diglycerides (17.4 wt%) was achieved at 40 °C temperature and 0.02 g of lipase with relatively low glycerol to oil molar ratio (2:1) within 4 h of reaction time. Kinetics of immobilized lipase followed Lineweaver–Burk model with lower K_m and V_{max} values when compared to the free lipase. The immobilized lipase showed higher activity, thermal stability and reusability compared to the free lipase.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Chemical Engineering
July 2016, Volume 41, Issue 7, pp 2545–2552

Preparation and Characterization of PES-Blend-Sulfonated PVC Nanofiltration Membranes: Investigation of Polymers Blend Ratio

- E. Bagheripour, A. R. Moghadassi

Abstract

Polyethersulfone (PES)/sulfonated polyvinyl chloride (SPVC)-blend membranes were prepared by commonly phase inversion method and casting solution technique, and polyvinylpyrrolidone was used as a pore former in the casting solution. PES/SPVC nanofiltration membranes with different polymer ratios were prepared and characterized by scanning electron microscopy (SEM), porosity measurement, water content, tensile strength and dead-end filtration experiments (permeability flux and salt rejection). SEM images showed an asymmetric structure with a dense top layer and porous sub-layer for all of the prepared membranes. Membrane porosity was increased with increasing of SPVC content of the casting solution. Adding SPVC into the casting solution led to increasing of membrane water content, pure water flux, permeation flux and pore size compared to bare PES membrane. By increasing of SPVC content (5 wt%), an initial improvement was observed in the rejection, and then, it diminished. Tensile strength was also enhanced initially by the addition of SPVC into the casting solution and again decreased.

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Turbid-Metric Approach on the Study of Adsorptive Component of Paint Effluent Coagulation Using Snail Shell Extract

- M. C. Menkiti, M. I. Ejimofor

Abstract

This work focuses on the adsorptive study of paint effluent coagulation using snail shell coagulant (SSC), in which samples were subjected to physiochemical and instrumental analyses [Fourier transform infrared (FTIR), differential scanning calorimetry/thermo gravimetric analysis (DSC/TGA), scanning electron micrograph (SEM), X-ray diffraction (XRD)]. Nephelometric jar test was also employed and the data generated were subjected to adsorptive kinetic, equilibrium and thermodynamics analyses. 42 % protein was recorded for the snail shell. SEM images and FTIR spectra indicated significant porosity and ammine presence in the SSC. DSC/TGA and XRD indicated samples of high thermal stability and organized crystalline structure, respectively. The data correlated best with Langmuir isotherm with linear regression coefficient (R^2) values >0.9 over the temperatures investigated. Pseudo-second-order kinetic model best described the process at K 2 <0.05 K2<0.05 (g/mg/min) and R^2 values >0.99. The thermodynamics parameter (ΔG ΔG , ΔH ΔH and ΔS ΔS) shows that the process was feasible and spontaneous. The intra-particle diffusion was found to be the rate-limiting step. It could be concluded that while SSC achieved 92 % turbidity removal, the adsorptive component of the process was significant.

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Optimisation and Kinetic Studies of Acid Esterification of High Free Fatty Acid Rubber Seed Oil

- Lai Fatt Chuah, Awais Bokhari, Suzana Yusup

Abstract

Pretreatment of the high free fatty acid (FFA) rubber seed oil from Malaysia (RSOM) and Vietnam (RSOV) via esterification reaction has been investigated. Response surface methodology analysis using central composite design was used to optimise important parameters, including reaction temperature, catalyst loading, methanol-to-oil molar ratio and reaction time on FFA reduction. Optimal esterification conversion was achieved at 50 ∘ ∘ C, 1.38 wt%, 15.98:1 molar ratio and 2 h for RSOM with 99.3% FFA reduction, whereas 65 ∘ ∘ C, 10.74 wt%, 10:1 molar ratio and 1 h for RSOV with 98.6% FFA reduction. Catalyst loading had been found to have the most effect on the FFA reduction followed by methanol-to-oil molar ratio while increasing temperature and reaction time had nominal effect. The frequency factor and activation energy of RSOV were about 1.8- and 1.2-fold higher than RSOM.

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Modification of Natural Zeolite by Carboxylate Compounds and Minerals for Removal of Zinc Ions from Wastewater: Equilibrium and Kinetic Studies

- Bahareh Sadeghalvad, Zahra Ahali, Amirreza Azadmehr

Abstract

In this study, zeolite composite with different compounds (minerals containing: gypsum, gypsum–bentonite, bentonite, calcite and pumice, and carboxylates containing: tartrate, citrate and oxalate) was investigated as an adsorbent of zinc ions. The oxalate-loaded zeolite composite was recognized as the best composite to remove zinc. This composite was characterized by X-ray diffraction and FTIR spectroscopy. The effect of initial Zn(I) concentration and mass of adsorbent have been investigated on adsorption process. The equilibrium study was performed and followed by six different isotherm models which include two-parameter (Langmuir, Freundlich, Temkin and D–R) and three-parameter (Redlich–Peterson and Khan) models. The successful fitted results were obtained by using Langmuir model which indicated to homogeneity adsorption and the maximum adsorption capacity of oxalate-loaded zeolite composite for zinc ions (57 mg/g). Based on free energy of adsorption value (12 KJ/mol), interaction between zinc ions and oxalate-loaded zeolite composite is chemical adsorption, that is to say, ion exchange. The kinetic of adsorption has been investigated by considering four kinetic equations as pseudo-first-order, pseudo-second-order, intra-particle diffusion and Elovich models that kinetic mechanism is well described by pseudo-second-order model with correlation coefficient (r 2) r2) more than 0.994. This means that amount of oxalate-loaded zeolite composite and concentration of Zn(II) are main rate of adsorption controller.

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Bio-oxidation of Escape Methane from Landfill Using Leachate-Modified Aged Refuse

- Juan Mei, Guangyin Zhen, Youcai Zhao

Abstract

A landfill bio-cover material for methane bio-oxidation was explored using aged refuse coupled with leachate. It was found that the aged refuse taken from an 8-year landfill could be used for the bio-oxidation of methane generated from landfill; moreover, the bio-oxidation ability was further enhanced in the presence of leachate. The highest methane oxidation capacity of 390 g CH 4 /(m 2 CH4/(m2 day) was obtained for the aged refuse modified with the leachate from aged-refuse bio-filter, close to the performance of compost. Leachate with extremely high organic matter content, however, was unfavorable for the growth of methane bio-oxidation *Methanotrophs* in aged refuse presumably because of oxygen consumption during organic matter degradation process. Thus, the recommended properties of leachate should be as follows: NH + 4 NH4+ -N < 2500 mg/L, NO − 3 NO3− -N 700–1800 mg/L, and COD > 500 mg/L. In addition, the organic matter and water contents in aged refuse after modified by leachate need to be controlled at 15.0–18.0 and 31.4–32.1 %, respectively, for the purpose of efficient *Methanotrophs* metabolisms. Practical use of this novel bio-cover in real landfills cannot only control greenhouse gas emission, but promote the recycle and reuse of aged refuse, and simultaneous high-strength leachate treatment.

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Electrospun Polystyrene Nanofiber as an Adsorbent for Solid-Phase Extraction of Disulfine Blue from Aqueous Samples

- Negar Hashemifard, Shahab Shariati

Abstract

In this research, polystyrene nanofibers were synthesized by electrospinning method and used as adsorbent in solid-phase extraction of Disulfine blue from aqueous solutions. Some important parameters affecting extraction efficiency including sample flow rate through the adsorbent, ionic strength, pH of the sample solution, weight of adsorbent, volume, and type of eluent were evaluated and optimized. Under the optimized conditions, the calibration graph was linear in the range of 6.4–1000 μgL −1 μgL−1 with correlation coefficient (r 2) (r2) of 0.9962. The limit of detection and enhancement factor of proposed method, for extraction from 50 mL sample solution, were obtained as 2 μgL −1 μgL−1 and 9.5, respectively. Finally, the proposed method was successfully applied for extraction and measurement of Disulfine blue from real samples, and satisfactory results were obtained.

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Adsorptive Cation Exchanger Mixed Matrix Membrane Chromatography for the Isolation of Lysozyme from Chicken Egg White

- N. Shamsinar, Syed M. Saufi

Abstract

Membrane chromatography, which uses an adsorptive membrane, is an alternative technology that overcomes the limitations of packed-bed column chromatography. Mixed matrix membrane (MMM) preparation is a simple method by which adsorptive membranes can be prepared. In the current study, several potential low-cost cation exchange (CEX) resins were screened for their ability to bind lysozyme (LYS) at various pH values prior to the preparation of CEX MMMs. The best binding was shown by Lewatit CNP105 at pH 7. A subsequently prepared Lewatit CNP105—CEX MMM followed the Langmuir adsorption isotherm, with a maximum binding capacity of 223 mg LYS/g membrane. In batch binding from a chicken egg white (CEW) solution at pH 7, both positively charged (LYS, pI 10.7) and negatively charged (conalbumin (CNL), pI 6.1; and ovalbumin (OVL), pI 4.5) proteins were bound onto the MMM. However, CNL and OVL were only loosely bound and were washed out during the washing step. Almost pure LYS was recovered during the elution step, as shown by SDS–PAGE gel analysis.

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Energy Efficiencies of Three Configurations of Two-Stage Vapor Compression Refrigeration Systems

- Wafa Halfaoui Mbarek, Khir Tahar

Abstract

A thermodynamic analysis is performed on three different configurations of R134a two-stage vapor compression refrigeration systems designed to equip cold store rooms. For economic and commercial reasons relating to agricultural activities in southern Tunisia, two seasonal food products, dates and poultry, are selected for storage at different temperatures. Performance optimization of the refrigeration systems is investigated under various operating conditions in order to choose the most efficient for a given situation. The three-stage vapor compression refrigeration systems have the same main components, but they differ in the arrangement of the flash separator. For the first considered system, the flash separator is installed before the first evaporator. In the second system, the flash separator is introduced before the second evaporator. For the third refrigeration system, the flash separator is placed before the two evaporators. An analytic study is performed in order to analyze the influence of the condensing temperature, the inter-stage pressure, the subcooling, and the superheat on the system performances. For the same operating conditions, each cycle is optimized with regard to energy performance, refrigeration efficiency, total compressor power consumption, and specific cooling capacity. A comparison between the obtained results for the three considered cycles is established. Optimum values of evaporators' superheat and inter-stage pressure are determined.

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Batch Adsorption Studies on the Removal of Acid Blue 25 from Aqueous Solution Using *Azolla pinnata* and Soya Bean Waste

- Muhammad Raziq Rahimi Kooh, Muhammad Khairud Dahri

Abstract

Azolla pinnata (AP) and soya bean waste (SBW) were studied for their potentials to remove hazardous dye, acid blue 25 (AB25), from aqueous solution in a batch adsorption process. Various parameters such as pH, contact time, concentration and temperature were studied. The optimum pH was found to be at pH 2.0, and short duration of contact time at 180 min was sufficient to attain equilibrium. The experimental data were fitted to three different isotherm models, and the adsorption was best described by the Langmuir isotherm model. The maximum monolayer capacities were estimated to be 38.3 and 50.5mgg −1 50.5mgg−1 for SBW and AP, respectively. Kinetics studies showed that the adsorption system for both adsorbents follow pseudo-second-order model. Weber–Morris model showed that intraparticle diffusion is not the rate-limiting step, while Boyd model suggested that film diffusion may be the controlling mechanism for both adsorbent. The adsorption processes were found to be thermodynamically feasible. AP-AB25 system is endothermic in nature, while SBW-AB25 is exothermic. Regeneration experiment showed that NaOH is effective at regenerating the spent adsorbent, where at fifth cycle, the adsorption capacities of AP and SBW were comparable to the unspent adsorbents. All of these discoveries highlighted the potential of both AP and SBW as effective adsorbents for removal of AB25.

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Oil Refinery Wastewater Treatment by Using Membrane Bioreactor (MBR)

- Qusay F. Alsalhy, Riyadh S. Almukhtar

Abstract

In this work, a new hollow fiber membrane was fabricated for the treatment of industrial wastewater in Al-Daura refinery in Baghdad using the submerged membrane bioreactor (MBR) technique with a new membrane-type module. The hollow fiber characterization seems to be within the range of ultrafiltration membranes, and the fabricated hollow fibers have a skinless porous outer surface. The effects of mixed liquor suspended solids (MLSS) concentration (i.e., 500 and 1000 mg/l) and preheating temperatures of the effluent wastewater (i.e., 25, 45, and 55 °*C*) at different preheating periods (i.e., 15, 30, and 45 min) on the performance of MBR and removal efficiency of COD, BOD, oil content, phenol, and turbidity were investigated. It was found that the removal efficiency of COD, BOD, oil content, phenol, and turbidity were enhanced by increasing of MLSS concentration. This efficiency was significantly enlarged by applying different preheating temperatures and times. For example, at 45 min preheating time, the removal efficiency of COD, BOD, oil content, and phenol at 1000 mg/l, and 55 °*C* were measured to be 71, 60 and 100 %, respectively. In fact, the obtained results confirmed that the initial wastewater preheating followed by the submerged MBR can be offered a possibility of alternative process for oily wastewater treatment, especially when reuse of oily wastewater is taken into account.

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Research Article - Chemical Engineering
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The Effect of Presence of SiO_2, Al_2O_3 and P_2O_5 on the Reduction Behaviour of Fe_2O_3 Nuggets with Coke Fines

- Prithviraj Gupta, Arnab De

Abstract

A detailed investigation is made to study the effect of the presence of gangue materials like SiO_2, Al_2O_3 and P_2O_5 on the reducibility of iron ores in the blast furnace and sponge iron/DRI plants. The shatter index and abrasion index are found to improve marginally with increased content of the gangue materials, though the improvement is not significant. The rate of reduction decreases with time, and interfacial chemical reaction is identified as the rate-controlling resistance. The apparent activation energy is determined from the slope of the plot $1-(1-f)$ 0.5 $1-(1-f)0.5$ versus time, where f denotes the extent of reduction. At a high temperature (1373 K), a little deviation from linearity is observed, indicating greater contribution of diffusion. The apparent activation energy is found to vary between 125.82 and 149.49 kJ/mol for different composition of the nuggets. The presence of SiO_2 and Al_2O_3 is found to reduce the apparent activation energy, E, while the presence of P_2O_5 increases the value of E. The average decrease in the apparent activation energy is found to be 1.63 and 1.33 kJ/mol per unit mass% increase in SiO_2 and Al_2O_3, respectively, and the average increase in the apparent activation energy is 2.69 kJ/mol per unit mass% increase in P_2O_5.

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Fire Retardancy of Cloisite ® Cloisitex00AE; **20 Organoclay Modified Dehydrated Castor Oil-Based Alkyd Resin**

- E. M. Madiebo, C. F. Uzoh

Abstract

The effect of Cloisite ® Cloisite x00AE; 20 organoclay content on fire retardancy, mechanical and chemical properties of dried films of halogen-free alkyd resins synthesized from Cloisite ® Cloisite x00AE; 20 organoclay and dehydrated castor oil (DCO) were investigated. Structural elucidation of the raw and the fire-retardant resins was confirmed through Fourier transform infrared spectroscopy instrumental techniques. The DCO modified alkyd resin macromolecule was synthesized through alcoholysis–esterification interface using glycerol, phthalic and maleic anhydride. Eight samples of fire-retardant resin were produced. Samples I, II, III, IV, V and VI contain 0, 2, 4, 6, 8 and 10 % by mass of Cloisite ® Cloisite x00AE; 20 organoclay, respectively. Samples VII and VIII contain 4 % of weight of Cloisite 20 with 100 % PA and 3:1 ratio of phthalic anhydride and maleic anhydride, respectively. The fire retardancy was evaluated using Westgate vertical match test. It was found that fire retardancy increases with increases in Cloisite ® Cloisite x00AE; 20 contents without any noticeable effect on chemical resistance, but certain drawbacks with adhesive and gloss properties were observed. The best result was observed with sample IV which contains 6 % by weight of Cloisite ® Cloisite x00AE; 20 and showed excellent fire-retardant properties with adhesion, gloss and hardness properties of 5B, 80 and 1.8 Kg, respectively. The infrared (IR) spectra band at 1035, 921, 792, 683 and 556 cm^{-1} of Si–O–Si and O–Si–O stretching confirms the successful grafting of the organomodifier.

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Nano-Structured Porous Yttria-Stabilized Zirconia Membrane for High-Temperature CO 2 CO2 Capture from H 2 /CO 2 H2/CO2 Mixture

- Sajid Hussain Shah, Yoshimitsu Uemura, Suzana Yusup

Abstract

A yttria-stabilized zirconia (YSZ, 8 mol % *Y* 2 *O* 3 Y2O3) membrane was prepared employing zirconium n-propoxide as a precursor via sol–gel method. Unlike conventional methods, hydrolyzing water was slowly released in this method through esterification of 1-propanol and glacial acetic acid. X-ray diffraction verified that YSZ membrane was partially transformed to the tetragonal phase. Ten times dip-coated membrane thickness was about 742 nm, determined by field emission scanning electron microscopy (FE-SEM) micrograph. Brunauer–Emmet–Teller measured average pore size of unsupported YSZ from gas adsorption and desorption indicating two modes centered at 2.66 and 2.38 nm. Crystallite size (D) as calculated from Scherrer's equation was 6.8, 12.23, and 13.61 nm for unsupported YSZ powder before and after calcination, respectively, at 25, 500, and 600 ∘ *C* 600∘C. Thermogravimetric analysis showed that the mass loss of the samples calcined at temperatures higher than 600 ∘ *C* 600∘C had no significant differences indicating the completion of loss of organics. Supported YSZ membrane was tested by a gas permeation apparatus. The single gas permeance of YSZ membrane including *α*−*Al* 2 *O* 3 α−Al2O3 was measured as 14.89×10 −6 14.89×10−6 and 1.75×10 −6 *molm* −2 *s* −1 *Pa* −1 1.75×10−6molm−2s−1Pa−1 for H 2 H2 and CO 2 CO2 at 300 ∘ *C* 300∘C , respectively. Permeance of H 2 H2 and CO 2 CO2 through YSZ in 75:25 H 2 H2 /CO 2 CO2 binary feed mixture was 9.696×10 −6 9.696×10−6 and 0.97×10 −6 *molm* −2 *s* −1 *Pa* −1 0.97×10−6molm−2s−1Pa−1 , respectively, at 300 ∘ *C* 300∘C . The selectivity of hydrogen in YSZ was 10. It was concluded that the membrane was highly promising for the separation of H 2 /CO 2 H2/CO2 mixture from various H 2 H2 -containing process streams under steam environment for high-temperature separation.

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Synthesis of Bentonite–Carbon Nanotube Nanocomposite and Its Adsorption of Rhodamine Dye From Water

- Mohammed Ibrahim Mohammed, Sitki Baytak

Abstract

In this work, cheap and effective nanocomposite material has been synthesized by mixing natural bentonite (B) with 5 % multiwall carbon nanotubes followed by heat treatment to 650 ∘ ∘ C in the inert atmosphere. It makes a potentially attractive adsorbent of rhodamine dye (RhB) from wastewater. The nanocomposite adsorbent (BCA) was characterized by X-ray diffraction, scanning electron microscopy and Fourier transform infrared spectroscopy. The effects of contact time, adsorbent dosage, initial dye concentration and pH on dye removal were investigated. The isotherm of dye adsorption was studied. The adsorption isotherm of dye onto B and BCA showed good fitting to Langmuir and Freundlich isotherm models. The maximum adsorption capacity (q m) (qm) of B and BCA samples is 8.6 and 142.8 mg/g, respectively. Both bentonite and modified bentonite are capable of removing the RhB dye from water. In general, the nanocomposite sample BCA significantly enhances the removal of RhB dye from aqueous solution. In addition, the BCA could be used as an eco-friendly adsorbent to remove the dye from colored wastewater.