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**Li Peng, Xianyi Chen, Yanqing Zhang, Yongli Du, Manhong Huang, Jue Wang. Remediation of metal contamination by electrokinetics coupled with electrospun polyacrylonitrile nanofiber membrane. Pages 1-10.**

Polyacrylonitrile nanofiber (PANN) membrane fabricated by electrospinning was adopted for the first time as the reactive medium to remove metal ions from the contaminated soils. Characteristics of metal ion remediation by electrokinetics/PANN permeable reactive barrier (EK/PANNPRB) were investigated. Applied voltages, initial metal ion concentrations and soil pH were changed to explore the adsorb and complex behavior of PANN with metal ions. The results showed EK/PANNPRB had higher removal efficiency than EK without PRB. The metal ion removal efficiencies by PANNPRB decreased when the applied voltage was increased. The lower the initial metal ion concentrations and soil pH, the better were the removal rates. At the applied voltage of 25 V, metal ion concentrations of 5, 10, and 100 mg L<sup>-1</sup> and pH of 1.2, the removal rates of Zn<sup>2+</sup>, Fe<sup>3+</sup>, and Ca<sup>2+</sup> were 99.15%, 98.03%, and 99.73%, respectively. The results indicated that EK/PANNPRB system was suitable for the remediation of soil contaminated by metal ions with removal rates much higher than those exhibited by the EK system without modified PRB.

- **Keywords:** Electrokinetics; Polyacrylonitrile nanofiber; Metal ions; Applied voltage; Electrostatic spinning

**Yusuke Koshiba, Takuya Nishida, Nobu Morita, Hideo Ohtani. Explosion behavior of n-alkane/nitrous oxide mixtures. Pages 11-15.**

The explosion properties of alkane/nitrous oxide mixtures were investigated and were compared with those of the corresponding alkane/oxygen and alkane/air mixtures. The explosion properties were characterized by three parameters: the explosion limit, explosion pressure, and deflagration index. For the same alkane, the order of the lower explosion limits (LELs) of the mixtures was found to be alkane/oxygen  $\approx$  alkane/air  $>$  alkane/nitrous oxide. In addition, the mixtures containing nitrous oxide tended to exhibit higher explosion pressures than the corresponding mixtures containing oxygen under fuel-lean conditions. The Burgess–Wheeler law was also observed to hold for the mixtures containing nitrous oxide.

- **Keywords:** Nitrous oxide; Explosion limit; Explosion pressure; Burgess–Wheeler law; Gas explosion; Deflagration index

**Ezerie Henry Ezechi, Shamsul Rahman bin Mohamed Kutty, Amirhossein Malakahmad, Mohamed Hasnain Isa. *Characterization and optimization of effluent dye removal using a new low cost adsorbent : equilibrium, kinetics and thermodynamic study. Pages 16-32.***

The adsorption capacity of a neglected adsorbent, *Ageratum conyzoides* leaf powder (ACLP), was investigated in this study for effluent dye removal. The adsorbent was characterized using FESEM, FTIR, BET, XRF, XRD and EDX. The combined effects of three independent variables (pH, dye concentration and adsorbent concentration) were evaluated in a batch study through Box Behnken model of the response surface methodology (RSM) for experimental design, analysis and process optimization. Dye removal efficiency was monitored at a predetermined contact time of 20 min. Adsorption kinetics was examined by first and second order rate models, Elovich and intraparticle diffusion models, while equilibrium study was examined by Langmuir and Freundlich isotherm models. At optimum conditions of pH 4 and adsorbent concentration of 0.06 g, dye removal efficiency exceeded 90% and was successfully optimized by RSM. Adsorption kinetics was described by pseudo second order kinetic model while equilibrium study was represented by Langmuir isotherm with maximum adsorption capacity of 192.4 mg/g. Preconcentration of MB onto ACLP was investigated and a factor of 108.3 was obtained. ACLP was regenerated and could be reused for a minimum of 20 cycles. Thermodynamic studies show that adsorption was spontaneous and exothermic. The results illustrate that *Ageratum conyzoides* leaf powder could be effectively utilized for effluent dye removal.

- **Keywords:** *Ageratum conyzoides*; Adsorption kinetics; Adsorption isotherm; Box Behnken; Effluent dye; Thermodynamics

**Peter Okoh. *Maintenance grouping optimization for the management of risk in offshore riser system. Pages 33-39.***

Riser system failure in relation to major accidents is one of the potential undesirable events in the offshore petroleum industry. It has the potential for high consequence such as several fatalities/injuries, severe environmental impact or gross economic loss. Besides, it may be related to maintenance being insufficient, incorrect, a new hazard source or a triggering event for an accident scenario. Furthermore, there has been a paradigm shift in the design of unmanned platforms following the Piper Alpha disaster in 1988. Firefighting systems are usually not installed anymore based on the reason that the risk reduction benefit they offer to maintenance personnel is not commensurate with their frequency of visits unlike in manned facilities, i.e. a negative risk balance. In manned facilities, where such safety systems are installed, maintenance personnel are subject to major hazard exposure due to the visits required of them. Hence, there is the need to reduce the risk to personnel as much as reasonable. Maintenance grouping optimization can serve as an alternative contributor to the reduction of maintenance frequencies which should reduce the risk, but on the other hand, as the human error opportunities increase, the likelihood of making errors increases which increases risk. The main objective of this paper is to investigate how maintenance grouping optimization and the potential human error can be balanced in relation to reducing the major accident risk. The paper builds on a review of literature on maintenance optimization, human reliability and risk.

- **Keywords:** Maintenance grouping; Optimization; Human error; Major accident; Risk; Offshore

**Chen-Wei Chiu, Yu-Hsiu Li. *Full-scale experimental and numerical analysis of water mist system for sheltered fire sources in wind generator compartment. Pages 40-49.***

Through a series of full-scale fire experiments and numerical simulations, the effectiveness of water mist system on wind generator could be estimated, and compared with fire parameters, such as exposed or unexposed fire sources, number of nozzles, unsheltered or sheltered fire sources, and fire source location. The experimental study found that the position of the water mist nozzles and whether the flames inside the oil pan are covered have a significant influence on overall extinguishing efficacy. The water mist system proved to have sound effectiveness on fire suppression in wind generators with sheltered fire source. According to FDS simulations of water mist systems, the simulated temperature curve declined more significantly than that for the actual measurements, indicating that the cooling effect of the simulated water mist was better. However, simulations were used for a situation where water mist was unable to directly extinguish the fire. Analysis of the simulated airflow showed that an opening caused the water to discharge outwards and the airflow was disturbed by the outside; thus, the extinguishing effect was poorer. There was less water with a sheltering object, and thus the extinguishing effect was poorer.

- **Keywords:** Full-scale fire experiments; Numerical simulations; Water mist system; Wind generators; Sheltered fire sources; FDS

**Khaled Chetehouna, Eddy El Tabach, Loubna Bouazaoui, Nicolas Gascoin. *Predicting the flame characteristics and rate of spread in fires propagating in a bed of Pinus pinaster using Artificial Neural Networks.* Pages 50-56.**

Physical and geometrical characteristics of flame propagation are very important to better understand the forest fire spread behaviour and to improve risk management tools. Having a tool to predict these characteristics is of practical and theoretical interest for a better understanding of the complex chemical and physical mechanisms which occur during forest fire phenomena. A metamodel is presented based on Artificial Neural Networks (ANNs) for estimating physical and geometrical parameters of the forest fire front, namely the rate of spread (ROS), flame height (Hf) and flame tilt angle ( $\alpha_f$ ). The ANN was developed using literature data obtained from experiments of fire propagation in beds of Pinus pinaster needles. The optimal feedforward ANN architecture with error backpropagation (BPNN) was determined by the cross validation method. The ANN architecture having 5 hidden neurons proved to be the best choice. Comparing the modelled values by the ANN with the experimental data indicates that neural network model provide accurate results. The performance of the ANN model was compared with a metamodeling method using a multilinear regression approximation.

- **Keywords:** Forest fires; Rate of spread; Flame geometrical characteristics; Simulation metamodeling; Artificial neural networks; Backpropagation

**Zhi Yuan, Nima Khakzad, Faisal Khan, Paul Amyotte. *Dust explosions : a threat to the process industries.* Pages 57-71.**

This paper considers more than 2000 dust explosion accidents that occurred worldwide between 1785 and 2012. The statistical features of these cases are first examined spatially and temporally. Accident frequencies at different levels of economic development are further discussed. China and the United States are chosen as examples to represent the differences in distribution features of dust explosions in countries with different economic development levels. Data for combustible dusts leading to dust explosions in both China and the United States are also collected and categorized. The features of ignition sources for dust explosions, the types of enterprises with high risk, and the critical equipment in such enterprises are also analyzed. The results could help identify hazards of dust explosions in various industries, monitor the critical equipment, and further suggest safety improvement procedures to reduce the probability and damage of dust explosions.

- **Keywords:** Dust explosion; Data analysis; Accidents analysis; Dust explosion hazards; Safety management; Statistical features

**Emmanuel Kwasi Addai, Dieter Gabel, Ulrich Krause. *Explosion characteristics of three component hybrid mixtures. Pages 72-81.***

Hybrid mixtures of a combustible dust and flammable gas are usually found in many industrial processes that handle combustible dust, vapor or gas. The work of this paper investigates the explosion behavior of mixtures consisting of three flammable components and air. The materials used in this case are corn starch, methane and acetone in vapor state. The experiments took place in the standardized 20 L explosion sphere where modifications were done to allow input of solvent and gas. The test protocol was according to EN 14034 with electrical igniters as ignition source but in the case of pure dust tests both chemical and electrical igniters were used. The experimental results demonstrate the significant enhancements in explosion likelihood and explosion severity when small amounts of solvents or gases below their respective lower explosion limits were mixed with dust. They also confirm that a hybrid mixture explosion is possible even when dust, gas and vapor concentrations are respectively lower than their minimum explosion concentration (MEC) of dust and lower explosion limit (LEL) of gas and vapor. Considering dust as main component the results presented show that the addition of less than 4 vol. % of gaseous fuel significantly lowers the MEC of starch from 250 g/m<sup>3</sup> to 5 g/m<sup>3</sup> and also increase the explosion severity of the dust. In the case of gas/vapor, the addition of starch below the MEC decreases the LELs from 4.9 to 1.0 vol. % and 2.5 to 0.5 vol. % for both methane and acetone respectively.

- **Keywords:** Dust explosion; Hybrid mixture explosion; Gas/vapor explosion; Explosion limits; Explosion pressure rise

**Masayuki Tanabe. *Forced ventilation effect by Air-Fin-Cooler on flammable gas cloud dispersion. Pages 82-92.***

This paper is the second installment of a paper published on Process Safety and Environment Protection in 2013, which evaluates the Air-Fin-Cooler (AFC) forced ventilation effect over natural ventilation inside congested LNG process train, i.e., modularized LNG, considering the Air Change per Hour (ACH) using Computational Fluid Dynamics (CFD) analysis. This second paper evaluates the effect of forced ventilation on gas cloud dispersion using CFD in order to evaluate possible design measures, such as safety distance in trains and whether to shut down the AFC in case of releases. The results of this evaluation show that gas cloud accumulation is reduced by AFC induced air flow in the case of shorter separation distances between modules. Based on the results, two design measures are proposed, i.e., keep AFC running during emergency and train orientation against prevailing wind direction.

- **Keywords:** Air-Fin-Cooler; Forced ventilation; Separation distance; LNG; CFD

**Anees A. Khadom, Ahmed F. Hassan, Baker M. Abod. *Evaluation of environmentally friendly inhibitor for galvanic corrosion of steel-copper couple in petroleum waste water. Pages 93-101.***

The inhibition of steel-copper couple galvanic corrosion in petroleum waste water solution by Curcuma longa was studied at different temperature and different cathode to anode ratios using weight loss technique. Inhibition efficiency was increased with increase in inhibitor concentration but decrease with rise in temperature. Adsorption followed the Temkin isotherm with negative values of  $\Delta G_{ads}$ , suggesting a stable, and spontaneous inhibition process. Mathematical equations were suggested to represent the corrosion rate data with high correlation coefficients. Quantum chemical parameters

were calculated for inhibitors using the AM1-SCF method to simulate the adsorption of the C. longa molecules on couple surface.

- **Keywords:** Galvanic corrosion; Green inhibitor; Adsorption; Quantum chemical; Kinetic parameters; Regression

**Ming Yang, Faisal Khan, Leonard Lye, Paul Amyotte. *Risk assessment of rare events. Pages 102-108.***

Rare events often result in large impacts and are hard to predict. Risk analysis of such events is a challenging task because there are few directly relevant data to form a basis for probabilistic risk assessment. Due to the scarcity of data, the probability estimation of a rare event often uses precursor data. Precursor-based methods have been widely used in probability estimation of rare events. However, few attempts have been made to estimate consequences of rare events using their precursors. This paper proposes a holistic precursor-based risk assessment framework for rare events. The Hierarchical Bayesian Approach (HBA) using hyper-priors to represent prior parameters is applied to probability estimation in the proposed framework. Accident precursor data are utilized from an information theory perspective to seek the most informative precursor upon which the consequence of a rare event is estimated. Combining the estimated probability and consequence gives a reasonable assessment of risk. The assessed risk is updated as new information becomes available to produce a dynamic risk profile. The applicability of the methodology is tested through a case study of an offshore blowout accident. The proposed framework provides a rational way to develop the dynamic risk profile of a rare event for its prevention and control.

- **Keywords:** Rare event; Precursor; Hierarchical Bayesian Approach; Mutual information; probabilistic risk assessment; Bayesian network

**Ali Reza Zarei, Hadi Rezaeivahidian, Ali Reza Soleymani. *Investigation on removal of p-nitrophenol using a hybridized photo-thermal activated persulfate proces : central composite design modeling. Pages 109-115.***

The aim of this work is the study of p-nitrophenol (PNP) removal, as a nitroaromatic compound, using a hybridized photo-thermally activated potassium persulfate (KPS) in a fully recycled batch reactor. Response surface method was used for modeling the process. Reaction temperature, KPS initial dosage and initial pH of the solution were selected as variables, besides PNP degradation efficiency was selected as the response. ANOVA analysis reveals that a second order polynomial model with F-value of 41.7, p-value of 0.0001 and regression coefficient of 0.95 is able to predict the response. Based on the model, the process optimum conditions were introduced as initial pH of 4.5, [KPS]<sub>0</sub> = 1452 mg/L and T = 66 °C. Also experiments showed that using thermolysis and photolysis of the persulfate simultaneously, the role of thermolysis is not considerable. A pseudo first order kinetic model was established to describe the degradation reaction. Operational cost, as a vital industrial criterion, was estimated so that the condition of initial pH of 4.5, [KPS]<sub>0</sub> = 1452 mg/L and T = 25 °C showed the highest cost effective case. Under the preferred mild condition, the process will reach to 84% and 89% of degradation and mineralization efficiencies, after 60 and 120 min, respectively.

- **Keywords:** Nitroaromatic compounds; Hybridized persulfate activation; p-Nitrophenol removal; Design of experiment; Cost estimation; Kinetic

**Faisal Khan, Samith Rathnayaka, Salim Ahmed. *Methods and models in process safety and risk management : past, present and future. Pages 116-147.***

The paper reviews past progress in the development of methods and models for process safety and risk management and highlights the present research trends; also it outlines the opinions of the authors regarding the future research direction in the field. Based on the open literature published in the leading journals in the field of safety, risk and reliability, the review covers the evolution of the methods and models developed for process safety and risk management. The methods and models are categorized as qualitative, semi-quantitative, quantitative and hybrid. The progress in the last few decades is discussed in the context of the past. Developments in the current decade formulate the basis of the present trends; future directions for research in these fields are also outlined. The aim of the article is to provide a historical development in this field with respect to the driving forces behind the development. It is expected that it will help researchers and industrial practitioners to gain a better understanding of the existing concepts. At the same time the aim is to provide direction to bridge the existing gaps through research and developments.

- **Keywords:** Process safety; Risk assessment; Inherent safety; Dynamic risk; Accident model; Safety management

**P.J. Thomas, G.J. Vaughan. *Pitfalls in the application of utility functions to the valuation of human life.* Pages 148-169.**

Safety strategies in the process and other industries depend ultimately on how much the owners and operators decide should be spent on protection systems to protect workers and the public from potential plant hazards. An important input to decisions of this sort is the value of life, which needs to be assessed in a valid manner so that safety decisions can be made properly. A key reference point for decisions on safety investment decisions in the UK is a 1999 study on the "value of a prevented fatality" (VPF), which employs a two-injury chained model that has been shown previously by the present authors to possess internal inconsistencies. The 1999 study made extensive use of utility functions to interpret survey data, and it is this feature that is explored in this paper. It will be explained here how different forms of utility function of the Exponential family can produce the same figure for an intermediate parameter in the calculation of the VPF from the two-injury chained model. Exponential utility functions are, however, unlikely to provide a realistic representation if their calculated risk-aversions need to be negative or zero in order to match survey data, which would imply an incautious attitude amongst those taking decisions on safety. The use of an incompletely specified wealth threshold in the utility modelling is explored in the light of a proposal by the authors of the 1999 study that a second utility function can be used to determine the individual's utility when his wealth lies below the threshold, which constitutes the lower limit of validity of the first utility function. The proposition is shown to be untenable. The results presented in this paper raise further concerns about the lack of validity of the 1999 study on which the UK VPF is based and hence on the safety decisions that have been made in consequence.

- **Keywords:** Safety; Utility functions; Value of a Prevented Fatality; VPF; Health and Safety Executive; Human life

**Izabela Bartkowska. *Drop in dry mass and organic substance content in the process of autothermal thermophilic aerobic digestion.* Pages 170-175.**

This paper presents the results of a study of a sludge subjected to the (ATAD) process – Autothermal Thermophilic Aerobic Digestion occurring in a two-stage installation operated in a municipal wastewater treatment plant in Olecko, Poland. The study of the sludge and the analysis of obtained results were conducted over 2011 and 2014. The subject of the study was a thickened sludge in an intermediate tank from which it was next transferred to facility reactors. The stabilization of processed sludge was evaluated analyzing the change in the dry mass (DS) content in the sludge. Measurements were

carried out in thickened sludge samples and after the ATAD process. Collected results were then subjected to a statistical analysis and it was determined to which extent as resulted from the subject process the dry mass and the dry organic mass (VS) content was changing in the sludge. Also, it was analyzed how the oxygen chemical demand (COD) was changing. The dry mass content in the thickened sludge was from 60 g/l to 160 g/l. After the process, this amount was from 35 to 76 g/l. Similarly, the organic mass content in a dry sludge mass changed from initial values within a range of 44–135 g/l to 23–60 g/l after the ATAD process. Also, the organic substance content expressed as COD decreased from 80 to 467 g O<sub>2</sub>/l in a thickened sludge to 51–261 g O<sub>2</sub>/l in the sludge after the process. The article presents conclusions from the result of the conducted study as well as personal experience.

- **Keywords:** Autothermal digestion; Organic substance in sludge; Sanitation of sludge; Sewage sludge processing; Sludge dry mass; Thermophilic aerobic digestion

**Angélica Escobar, Ángel Sathicq, Luis Pizzio, Mirta Blanco, Gustavo Romanelli. *Biomass valorization derivatives : clean esterification of 2-furoic acid using tungstophosphoric acid/zirconia composites as recyclable catalyst. Pages 176-186.***

2-Furoic acid esters, which are biomass derived, are used in the flavoring and fragrance industry or as synthesis intermediates in the pharmaceutical industry. A series of zirconia samples modified with different contents of tungstophosphoric acid (TPA) and two different preparation methods (ZrPEGTPA30T100, ZrPEGTPA60T100, ZrTPA30PEGT100, and ZrTPA60PEGT100) were synthesized from zirconium propoxide via sol-gel reactions using polyethylene glycol as template. They were characterized by different physicochemical techniques (BET, FT-IR, 31P MAS NMR and potentiometric titration), and their activities were tested in the synthesis of n-butyl-2-furoate as the model compound, among which ZrTPA30PEGT100, (mesoporous acid zirconia modified catalyst) was the most active catalyst. The effect of various parameters such as catalyst loading, mole ratio of 2-furoic acid to n-butanol, and temperature was studied under optimized conditions. Several other alkyl 2-furoates were produced from esterification of 2-furoic acid with different alcohols using these catalysts, and the effect of alcohol structure over the conversion reaction was considered. The use of a solid acid catalyst made the procedure environmentally benign. The catalysts ZrPEGTPA30T100 and ZrTPA30PEGT100 were reused without appreciable loss of the catalytic activity (three runs). The methodology represents a green and efficient alternative for the conversion of bio-based 2-furoic acid into valuable esters.

- **Keywords:** 2-Furoic acid; Alkyl-2-furoates; Heteropolyacids/zirconia composites; Fragrances; Flavors; Biomass valorization

**T. Anitha, P. Senthil Kumar, K. Sathish Kumar, B. Ramkumar, S. Ramalingam. *Adsorptive removal of Pb(II) ions from polluted water by newly synthesized chitosan-polyacrylonitrile blend: Equilibrium, kinetic, mechanism and thermodynamic approach. Pages 187-197.***

The adsorption of Pb(II) ions onto a biopolymer based composite, chitosan blended polyacrylonitrile (chitosan/PAN), has been studied in a batch mode operation. The operating parameters such as solution pH, adsorbent dose, initial Pb(II) ions concentration, contact time and temperature were experimentally optimized for the maximum removal of Pb(II) ions. The optimum conditions for the 99.82% removal of Pb(II) ions for an initial Pb(II) ions concentration of 10 mg/L was found to be: chitosan/PAN blend dose of 2 g/L, pH of 5.0, equilibrium time of 30 min and temperature of 30 °C. The adsorption isotherm data were fitted with the different adsorption isotherm

models such as Langmuir, Freundlich, Temkin and Dubinin–Radushkevich models to know the types of adsorption process. The results of the adsorption isotherm studies were applicable to confirm that the present adsorption system was favourable and the process was physisorption. The maximum monolayer adsorption capacity of chitosan/PAN for Pb(II) ions adsorption was found to be of 20.08 mg/g. The adsorption kinetics and mechanism were analyzed by pseudo-first order, pseudo-second order, intraparticle diffusion and Boyd kinetic models. The pseudo-second order kinetic model provide the best fit for Pb(II) ions-chitosan/PAN adsorption system which indicates that the adsorption process was controlled by chemisorption. The kinetic results further indicated that the adsorption process controlled was by either film or particle diffusion or both. The adsorption process was found to be of spontaneous and exothermic in nature. The overall results indicated that the prepared adsorbent may be an alternative to the already existing adsorbents.

- **Keywords:** Chitosan; Isotherms; Kinetics; Pb(II) ions; Polymer composite

**Utkarsh Maheshwari, Bhuvanesh Mathesan, Suresh Gupta. *Efficient adsorbent for simultaneous removal of Cu(II), Zn(II) and Cr(VI) : kinetic, thermodynamics and mass transfer mechanism. Pages 198-210.***

Present study deals with the development of a nano-porous adsorbent using neem bark for the simultaneous removal of Cu(II), Cr(VI) and Zn(II). The developed adsorbent is characterized using SEM, EDS and TGA. The effect of initial metal concentration, contact time, adsorbent dosage, temperature and pH are studied to see the performance of nANB for the metal ions removal. Various isotherm, kinetic and mass transfer models are validated with the experimental data and corresponding parameters are estimated. The maximum adsorption capacity of the developed adsorbent for Cu(II) and Zn(II) adsorption are found to be 21.23 and 11.904 mg g<sup>-1</sup>, respectively. The optimum parameter values for contact time, adsorbent dosage, temperature and pH are obtained as 48 h, 6 g L<sup>-1</sup>, 35 °C and 1.2, respectively, from the experimental results of Cu(II) and Zn(II) removal using nANB. The performance of nANB on the industrial effluent is evaluated by performing equilibrium batch experiments for the simultaneous removal of Cu(II), Cr(VI) and Zn(II) from an aqueous solution. The overall adsorption capacity of the nANB for the removal of multiple metal ions at 200 mg L<sup>-1</sup> of each is obtained as 38.95 mg g<sup>-1</sup> which is more than double for that obtained for individual metal ions.

- **Keywords:** Multiple metal ions; Adsorption; Characterization; Heavy metals; Isotherms; Textile industry

**Taher yousefi, Shahnaz Yavarpour, Seyed Hamed Mousavi, Meisam Torab-Mostaedi, Reza Davarkhah, Hossein Ghasemi Mobtaker. *Effective removal of Ce(III) and Pb(II) by new hybrid nano-material : HnPMo12O40@Fe(III)xSn(II)ySn(IV)1-x-y. Pages 211-220.***

Recently, hybrid materials have been very promising in the adsorption/separation of various metal ions due to their unique characteristics. Two important factors are regarded as strategies to synthesize a new material with greatly improved adsorption properties: nanoscale synthesis and hybridization. The novel hybrid inorganic materials HnPMo12O40@Fe(III)xSn(II)ySn(IV)1-x-y were synthesized using the metal ions (Sn(II), Sn(IV), Fe(III)) and heteropolyacid (H3PMo12O40) as precursors by facile chemical method. X-ray diffraction (XRD), differential scanning calorimetry (DSC) and thermogramimetric analysis (TGA), as well as transmission electron microscopy (TEM), were employed to characterize the product's structural and morphology features. The size of the product estimated from TEM images is significantly smaller than 20 nm. A series of adsorption tests were conducted to analyze the sorption capacity of hybrid for the Pb(II) and Ce(III) ions. The adsorption capacities of 240 mg g<sup>-1</sup> and 130 mg g<sup>-1</sup>



were observed for Pb(II) and cerium(III), respectively. The kinetics of both metal ions was experimentally studied and the obtained rate data were analyzed using simple kinetic models. The results revealed that the pseudo second-order sorption mechanism is predominant and the overall rate constant of each sorption process appears to be controlled by chemical sorption process. The thermodynamic studies show that the sorption of each ion is an endothermic process and spontaneous in nature and increasing temperature improves adsorption performance. The results show that the new nano-hybrid is a promising material for adsorption of Pb(II) and Ce(III).

- **Keywords:** Cerium(III); Lead(II); Nanostructures; Adsorption; Hybrid

**Luca Marmo, Norberto Piccinini, Enrico Danzi. *Small magnitude explosion of aluminium powder in an abatement plant : a telling case.* Pages 221-230.**

On the 16th June 2000, an aluminum dust deflagration occurred in a small factory in the north-west of Italy. The explosion took place in an aluminum dust collecting and abatement unit that served a surface polishing plant. The collecting unit was made up of several ducts that conveyed dust into a manifold, which was connected to a cyclone and a bag filter. The cost of the deflagration cost was six injured workers, and relevant damage to the plant machinery, the process building and to other surroundings buildings. Although aluminum dust explosions are well known and have been well documented in the literature, this case study can be considered interesting because of its complex dynamics, which started with a first weak explosion that then evolved into a more severe chain of explosions. This article has drawn upon the official documents written during the investigation and the technical reports prepared by a number of expert witnesses. The data collected during the investigation have made it possible to determine the causes and dynamics of the accident and to calculate the strength of the explosion, on the basis of the distribution of the damage and the launching distance of the fragments. The magnitude of the damage seems to indicate that the amount of dust that took part in the explosion corresponds to the dust that settled on the bag filters.

- **Keywords:** Dust explosions; Abatement plant; Multiple explosions; Delivered energy

**Hetang Wang, Deming Wang, Yan Tang, Qingguo Wang. *Foaming agent self-suction properties of a jet-type foam preparation device used in mine dust suppression.* Pages 231-238.**

In this study, we introduce a jet-type foam preparation device for use in mine dust control, which can enhance the reliability and applicability of the foam production process compared with conventional foam generators. In order to elucidate the foaming agent self-suction properties of this novel foam generator, we used a self-built experimental setup to investigate the effects of the working pressure and outlet pressure on negative pressure (vacuum degree) during foaming agent suction, as well as the functional relationship between negative pressure and the foaming agent by adding parameters. We also studied the effects of the valve opening degree on the foaming agent flow rate and addition ratio. The results showed that the working pressure and outlet pressure affected the formation of negative pressure in a positive linear manner and a negative linear manner, respectively. Thus, the negative pressure increased linearly as the working pressure increased, whereas it decreased in a linear manner as the outlet pressure increased. There was also a quadratic relationship between the vacuum degree and foaming agent quantity with the piecewise characteristics of the growth process, where they increased slowly with a lower vacuum degree but increased rapidly with a higher vacuum degree. After creating a moderate negative pressure with the water jet, the foaming agent could be added automatically at a low flow rate with a low ratio via the

regulating valve on the liquid suction hose. This study provides basic information that should facilitate the application of this novel foam preparation technique.

- **Keywords:** Dust suppression; Foam; Foaming agent; Outlet pressure; Self-suction; Vacuum degree

**Malesh Shah, Jeeban Poudel, Hyun Kwak, Sea Cheon Oh. *Kinetic analysis of transesterification of waste pig fat in supercritical alcohols. Pages 239-244.***

The kinetic analysis method using non-isothermal technique was proposed to determine the kinetic parameters for the transesterification reaction of waste pig fat in supercritical alcohols. To investigate the transesterification of waste pig fat, the waste pig fat to alcohol ratio (w/w) was varied from 1:1.5 to 1:2.5 between the temperatures 220 and 290 °C at an interval of 10 °C in a 25 mL batch reactor. The products were analyzed by gas chromatography mass spectrometry. To verify the effectiveness of the proposed kinetic analysis method, the experimental values were compared with the values calculated using the kinetic parameters obtained from this work. It was found that the proposed kinetic analysis method gave reliable kinetic parameters for the transesterification of waste pig fat in supercritical alcohols. Further, it was found that the apparent activation energy for supercritical ethanol was lower than the value for supercritical methanol.

- **Keywords:** Kinetic analysis; Transesterification; Supercritical alcohols; Waste pig fat; Supercritical methanol; Supercritical ethanol

**Abdelhamid Cherfi, Mohamed Achour, Malika Cherfi, Samia Otmani, Assia Morsli. *Health risk assessment of heavy metals through consumption of vegetables irrigated with reclaimed urban wastewater in Algeria. Pages 245-252.***

Municipal wastewater reclamation and reuse provides a valid and effective way to face water crisis in many countries around the world. In this paper, a performance survey on the urban wastewater treatment plant (UWWTP) of the city of Boumerdes has been conducted in order to assess the potential of reuse of its treated waters. The study reveals that the plant is operated efficiently and complies with the related discharge standards in terms of organic matter and heavy metals. Three vegetable species (potato, tomato and cucumber) were planted and irrigated with treated waters issued from Boumerdes plant and subsequently analyzed for the purpose of assessing their heavy metals content. The concentrations of Cu, Zn, Pb and Cr were observed in range of 2.5–3.0, 0.5–0.6, 1.8–12.5 and 0.9–6.2 mg/kg (dry wt.), respectively. The survey showed, paradoxically, that all vegetables irrigated with reclaimed waters are much less contaminated with metals than similar vegetables purchased in different Algerian markets. Furthermore, the assessing of the potential health risk for consumers has showed that irrigation with treated waters can reduce the estimated daily intake (EDI) and the target hazard quotient (THQ) for all metals by more than 85%. This study reveals that no adverse effects on resident's health could be expected from consumption of vegetables irrigated with treated wastewaters.

- **Keywords:** Heavy metals; Reclaimed water; Vegetables; Health risks assessment; Estimated daily intake (EDI); Target hazard quotient (THQ)

**Yiu Fai Tsang, Lei Wang, Hong Chua. *Effects of high ammonia loads on nitrogen mass balance and treatment performance of a biotrickling filter. Pages 253-260.***

A biotrickling filter packed with coal slag as packing medium was continuously used for more than 9 months under high ammonia loading rates of up to 140 g/m<sup>3</sup>/h. Nitrogen mass balance and microbial community analysis were conducted to evaluate the inhibitory effects of high ammonia concentration and metabolic by-products on the rates of nitrification. Ammonia removal efficiency reached above 99% at an empty bed retention time of as low as 8 s when inlet concentrations were below 350 ppm. The maximum and critical elimination capacities of the biotrickling filter were 118 g/m<sup>3</sup>/h and 108.1 g/m<sup>3</sup>/h, respectively. Kinetics analysis results showed that less than 2.5 s was required for the biotrickling filter with pH control to treat ammonia at concentrations of up to 500 ppm in compliance with the Taiwan EPA standard (outlet NH<sub>3</sub> < 1 ppm). Results of mass balance and microbial community analysis indicated that complete removal was mainly contributed by the activities of autotrophic ammonia oxidizing bacteria and not by physical absorption or adsorption at low loading rates. However, at high inlet loadings, ammonium became the dominant by-product due to inhibitory effects of high ammonia concentration on the bacterial community.

- **Keywords:** Ammonia removal; Biotrickling filter; Inhibitory effects; Coal slag

**Yang Li, Hua Zhang, Li-Ming Shao, Pin-Jing He. *Preparation of a metal-phosphate/chromium oxide nanocomposite from Cr(III)-containing electroplating sludge and its optical properties as a nanopigment. Pages 261-267.***

A nanocomposite composed of metal-phosphates and chromium oxide was prepared from a Cr(III)-containing electroplating sludge (CES) by a facile three-step (extraction–precipitation–calcination) process. Optimal process parameters were determined, and the structure of the metal-phosphate/chromium oxide nanocomposite (MPCON) was investigated by field-emission scanning electron microscopy, Fourier transform infrared spectroscopy, X-ray diffraction, and X-ray photoelectron spectroscopy. The results show that the optimal extraction pH is 2.0. The MPCON presents a polyhedral morphology with average particle size of around 100 nm. The components of MPCON vary from AlPO<sub>4</sub>/Cr<sub>2</sub>O<sub>3</sub> to Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>/AlPO<sub>4</sub>/Cr<sub>2</sub>O<sub>3</sub> at different solution pH during precipitation. Meanwhile, the optical performance of the nanocomposite as a pigment is discussed. The reflectance of MPCON-6.5 in the near-infrared range is around 56%, making it a strong prospect to be used as a functional pigment in energy-efficient buildings. This study proposes a novel recycling process for the conversion of CES into high-value products, which is beneficial for the treatment of waste.

- **Keywords:** Electroplating sludge; Resource recovery; Chromium oxide; Nanocomposite; Nanopigment; Optical performance

**Qi Yang, Yu Zhong, Hua Zhong, Xin Li, Weixiong Du, Xiaoming Li, Ren Chen, Guangming Zeng. *A novel pretreatment process of mature landfill leachate with ultrasonic activated persulfate : Optimization using integrated Taguchi method and response surface methodology. Pages 268-275.***

A novel advanced oxidation process (AOP) using ultrasonic activated persulfate oxidation was used to pretreat mature landfill leachate. The effects of different operating variables (e.g., the initial S<sub>2</sub>O<sub>8</sub><sup>2-</sup> concentration, pH, temperature, ultrasonic power and reaction time) on the oxidation performance were investigated regarding the total organic carbon (TOC) removal efficiency, and the variables were optimized using the integrated Taguchi method and response surface methodology (RSM). Based on the Taguchi method under L<sub>16</sub> (4<sup>5</sup>) arrays and a grey relational analysis, the most significant variables included the initial S<sub>2</sub>O<sub>8</sub><sup>2-</sup> concentration, temperature and reaction time. The concentrations of these variables were further optimized using RSM. Using the integrated optimization method,

the optimal conditions included an initial S<sub>2</sub>O<sub>8</sub><sup>2-</sup> concentration of 8.5 mM, a reaction temperature of 70 °C and a reaction time of 2.46 h, which resulted in a TOC removal efficiency of 77.32%. The experimental results showed that the enhanced TOC removal from mature landfill leachate by sono-activated persulfate oxidation could be attributed to the combined effects of ultrasonic catalysis and sulfate radical-AOP. Overall, ultrasonic activated persulfate oxidation is a promising method for the pretreatment of landfill leachate.

- **Keywords:** Mature landfill leachate; Optimization; Persulfate; Response surface methodology; Taguchi method; Ultrasonic

**Yi Wang, Shuiyu Sun, Fan Yang, Shenyong Li, Jiaqi Wu, Jingyong Liu, Sheng Zhong, Jiajun Zeng. *The effects of activated Al<sub>2</sub>O<sub>3</sub> on the recycling of light oil from the catalytic pyrolysis of waste printed circuit boards.* Pages 276-284.**

The effects of employing activated Al<sub>2</sub>O<sub>3</sub> during the catalytic pyrolysis of waste printed circuit boards (WPCBs) are investigated, focusing on the recycling of light oil. Variations in the pyrolysis process are studied through analysis of the phase distribution, water content and boiling point fractions of the resulting products. Product composition and carbon number distribution are analyzed using gas chromatography techniques. The use of activated Al<sub>2</sub>O<sub>3</sub> increases the light oil fraction and also reduces the quantity of brominated products formed. It was determined that the best yield of light oil and most efficient debromination resulted from catalytic pyrolysis at 600 °C. Applying catalyst-to-feed ratios in the range of 1.0–1.5 also maximizes the yield of light oil. The major oil fraction resulting from catalytic pyrolysis has a boiling point range of 0–250 °C and carbon number range of C<sub>6</sub>–C<sub>9</sub>, showing for use as a potential fuel after suitable treatment such as hydrogenation. At a higher catalyst-to-feed ratio of 2.0, activated Al<sub>2</sub>O<sub>3</sub> generates a high proportion of light oil fractions containing a significant quantity of chemicals such as phenol (52.67% at 600 °C), although an overall lower yield of oil is obtained. The oil produced in this manner may also be used as a raw material feedstock for the production of various other useful chemicals.

- **Keywords:** WPCB; Catalytic pyrolysis; Recycling; Activated Al<sub>2</sub>O<sub>3</sub>; Debromination

**Soraya Hosseini, Jidon Janaun, Thomas S.Y. Choong. *Feasibility of honeycomb monolith supported sugar catalyst to produce biodiesel from palm fatty acid distillate (PFAD).* Pages 285-295.**

Carbon coated monolith was prepared by sucrose solution 65 wt.% via dip-coating method. Sulfonation of incomplete carbonized carbon coated monolith was carried out in order to synthesize solid acid catalyst. The textural structure characteristics of the solid acid catalyst demonstrated a low surface area and pore volume. Palm fatty acid distillate (PFAD), a by-product of palm oil refineries, was utilized as oil source in biodiesel production. The esterification reaction subjected to different reaction conditions was performed by using the sulfonated carbon coated monolith as heterogeneous catalyst. The sulfonation process had been performed by using vapour of concentrated H<sub>2</sub>SO<sub>4</sub> that was much easier and efficient than liquid phase sulfonation. Total acidity value of carbon coated monolith was measured for unsulfonated sample (0.5 mmol/g) and sulfonated sample (4.2 mmol/g). The effect of methanol/oil ratio, catalyst amount and reaction time were examined. The maximum methyl ester content was 89% at the optimum condition, i.e. methanol/oil molar ratio (15:1), catalyst amount (2.5 wt.% with respect to PFAD), reaction time (240 min) and temperature 80 °C. The sugar catalyst supported on the honeycomb monolith showed comparable reactivity compared with the sugar catalyst powder. However, the catalyst reusability studies showed decrease in FFA% conversion from 95.3% to 68.8% after four cycles as well as the total acidity of catalyst dropped

from the value 4.2 to 3.1 mmol/g during these cycles. This might be likely due to the leaching out of SO<sub>3</sub>H group from the sulfonated carbon coated monolith surface. The leaching of active species reached a plateau state after fourth cycle.

- **Keywords:** Biodiesel; Carbon coated monolith; Palm fatty acid distillate; Solid acid catalyst; Sucrose; Sulfonation

**N.A. Oladoja, R.O.A. Adelagun, A.L. Ahmad, I.A. Ololade. *Phosphorus recovery from aquaculture wastewater using thermally treated gastropod shell*. Pages 296-308.**

In tandem with the quest for the development of sustainable strategies for the recovery of P from P-rich aqua waste streams, thermally treated gastropod shell (GS) was investigated as a reactive material for P-recovery from aquaculture wastewater (AQW). The enhanced defects in the surficial physiognomies, imparted by the thermal treatment process, accounted for the higher P-recovery efficiency. This contradicted the claim that the conversion of the carbonate form of calcium to the oxide form was the reason for the higher P-recovery efficiency of thermally treated calcium rich materials. The fittings of the time-concentration profiles of the P-recovery process to different kinetic models and the determinations of the thermodynamic parameters of the precipitation reaction showed that both adsorption and precipitation were the underlying mechanism of the P-recovery process, using the thermally treated GS. In addition to the removal of P, substantial amount of the total nitrogen in the AQW was also removed. The evaluation of the effects of the P-recovery process on the quality characteristics of the AQW showed that there was significant improvement in the overall physicochemical characteristics.

- **Keywords:** Phosphorus recovery; Aquaculture wastewater; Nutrients; Resource recovery; Gastropod shell; Eutrophication

**Areeb Shehzad, Mohammed J.K. Bashir, Sumathi Sethupathi, Jun-Wei Lim. *An overview of heavily polluted landfill leachate treatment using food waste as an alternative and renewable source of activated carbon*. Pages 309-318.**

Landfill leachate is a complicated refractory wastewater which contains huge amount of organic compounds and ammonia. Recently, the adsorption technology exploiting on activated carbon has gained promising importance in the treatment of landfill leachate due to its simplicity in design and low preparation cost of activated carbon in addition to high treatment efficiency. In this study, the physical and chemical characterizations of fabricated activated carbon derived from renewable sources such as food waste were highlighted to shed a brighter understanding on their performance in removing pollutants from landfill leachate. The impacts of activating conditions, such as carbonization temperature, retention time and impregnation ratio were thoroughly studied and compared between conventional and microwave heating methods. The significance of the produced food waste derivative-based activated carbon is expected to contribute toward a sustainable environment by overcoming the ramification of landfill leachate menace particularly via the removal of non-biodegradable organic compounds. Conclusively, the expansion of food waste in the field of adsorption science represents a potentially viable and powerful tool, leading to superior improvement of pollution control and environmental conservation.

- **Keywords:** Landfill leachate; Adsorption; Activated carbon; Food waste; Microwave and conventional heating; Waste management; Organic compounds; Wastewater treatment

**Alper Alver, Emine Baştürk, Ahmet Kılıç, Mustafa Karataş. Use of advance oxidation process to improve the biodegradability of olive oil mill effluents. Pages 319-324.**

In this study, recalcitrant total phenol (TPh) and organic matter removal were investigated at olive mill wastewater (OMW) in sequential Coagulation and Fenton system. This study focused on different operational parameters such as pH, H<sub>2</sub>O<sub>2</sub>, and Fe<sup>2+</sup> dosages, and [Fe<sup>2+</sup>]/[H<sub>2</sub>O<sub>2</sub>] ratios. The optimum conditions were determined as; pH = 3; [Fe<sup>2+</sup>] = 2.5 g/L; [Fe<sup>2+</sup>]/[H<sub>2</sub>O<sub>2</sub>] = 2.5. A higher treatment efficiency was achieved at sequential Coagulation and Fenton system (COD, 65.5%) and TPh, 87.2%), compared to coagulation process (COD, 51.4%; total organic carbon (TOC), 38.6% and total nitrogen (TN) 52.1%). This study demonstrated that the Coagulation and Fenton process has a potential for efficient removal of phenolic pollutants from wastewater.

- **Keywords:** Olive mill; Coagulation; Fenton; Phenol; Advanced oxidation

**R. Ramazani, S. Mazinani, A. Hafizi, A. Jahanmiri. Equilibrium solubility of carbon dioxide in aqueous blend of monoethanolamine (MEA) and 2-1-piperaziny-ethylamine (PZEA) solutions : experimental and optimization study. Pages 325-332.**

In order to study the influence of 2-(1-piperaziny)-ethylamine (PZEA) as a promoter on the solubility of CO<sub>2</sub> in aqueous monoethanolamine (MEA) solution, the equilibrium solubility of CO<sub>2</sub> (mole CO<sub>2</sub>/mole blend solution) in MEA + PZEA aqueous solutions were measured experimentally using a vapor-liquid equilibrium (VLE) equipment at constant total blend concentration of 2.5 mol dm<sup>-3</sup> in temperatures ranging from 30 to 50 °C and initial partial pressures between 30 and 70 kPa. The response surface methodology (RSM) based on central composite design (CCD) was used to explore the relationship between three independent parameters (1: molar ratio of PZEA to MEA, 2: initial partial pressure of CO<sub>2</sub> ( P CO<sub>2</sub> ), 3: temperature) on the CO<sub>2</sub> loading capacity. Analysis of variance (ANOVA) showed a good agreement between experimental data and statistical model. The maximum CO<sub>2</sub> loading capacity occurred at 0.8 (2 M PZEA + 0.5 M MEA) molar ratio of PZEA to MEA.

- **Keywords:** Carbon dioxide; Equilibrium solubility; Monoethanolamine; 2-(1-Piperaziny)-ethylamine; Design of experiment; Response surface methodology

**Tian Zhipeng, Zhang Bingru, He Chengjun, Tang Rongzhi, Zhao Huangpu, Li Fengting. The physiochemical properties and heavy metal pollution of fly ash from municipal solid waste incineration. Pages 333-341.**

Fly ash originating from municipal solid waste incineration (MSWI) is potentially hazardous waste and is harmful to the surrounding area once it enters the environment. In this study, we measured the physiochemical properties of fly ash derived from domestic waste incineration as well as the leaching toxicity of heavy metals in fly ash was contained. The results suggested that the porosity of fly ash is relatively high, and the leaching concentration of heavy metals can be greatly reduced through densification strategies in which fly ash is stabilized by chemical agents. The adsorption-desorption curve of fly ash had an obvious hysteresis loop that belongs to the H<sub>2</sub>-type hysteresis loop. Fly ash was typically mesoporous, and the silicate in fly ash was relatively stable. Its glass phase contents were higher—this allowed it to be used in ceramic tile decoration. In addition, Pb and Cd were the major heavy metals in fly ash. These heavy metals were mainly distributed in the residue. Heavy metals were easily leached out under strong acid or alkaline conditions.

- **Keywords:** Fly ash; Characteristics; Heavy metals; Leaching toxicity

**Mohamad Ali Fakhari, Amir Rahimi, Mohammad Sadegh Hatamipour, Ali Fozooni. *Non-isothermal modeling of simultaneous CO<sub>2</sub> and SO<sub>2</sub> removal in a semi-dry spouted bed reactor. Pages 342-353.***

In the present study, a comprehensive non-isothermal model is developed to study the performance of a spouted bed reactor (SBR), in which CO<sub>2</sub> is removed at the presence of SO<sub>2</sub> by using NaOH solution. For this aim, the stream-tube model is applied for hydrodynamics of solid and gas phases, and then by using the conservation laws of mass and energy, the governing equations for gas and solid phases are derived and solved numerically. The effects of variation of different operating parameters and process conditions are evaluated, and by comparing the model results with the gathered experimental data, the maximum, minimum and average error are obtained. The results indicate that the CO<sub>2</sub> removal efficiency increases by increasing the inlet CO<sub>2</sub> concentration and by decreasing the inlet SO<sub>2</sub> concentration, ratio of superficial gas velocity to minimum spouting velocity and inlet gas temperature. Also, the modeling overall results indicate that by increasing the bed diameter and static bed height, CO<sub>2</sub> absorption efficiency increases.

- **Keywords:** Non-isothermal mathematical model; Spouted bed reactor; Simultaneous CO<sub>2</sub> + SO<sub>2</sub> removal; streamtubes

**Fisseha Andualem Bezza, Evans M. Nkhalambayausi Chirwa. *Biosurfactant from Paenibacillus dendritiformis and its application in assisting polycyclic aromatic hydrocarbon (PAH) and motor oil sludge removal from contaminated soil and sand media. Pages 354-364.***

A novel biosurfactant was produced by strain CN5, identified as Paenibacillus dendritiformis isolated from creosote contaminated wood treatment plant soil. The biosurfactant produced by the strain was identified as lipopeptidal after attenuated total reflectance Fourier transform infrared (ATR-FTIR), thin-layer chromatography (TLC), and liquid chromatography tandem mass spectrometry (LC-MS/MS) analysis. The MS/MS analysis of the biosurfactant showed that it has an amino acid sequence of Cys-Gly-Ala-Gly-Ile-Asn-Leu and a long chain fatty acid of molecular mass 522 Da. The biosurfactant exhibited 74% and 82% emulsification index (E<sub>24</sub>) with hexane and cyclohexane respectively, and it showed high thermal, pH and saline stability over a wide range of temperature, pH and salinity. The ability of the biosurfactant to desorb PAH from spiked soils and motor oil from spiked sands was tested in batch experiments and it desorbed more than 96% of phenanthrene, 83% of pyrene from the contaminated soil in 5 days and 81% of heavy used motor oil sludge from the spiked sands in 24 h. This suggests the potential application of the biosurfactant for the removal of PAHs and motor oil sludge from contaminated media and enhancing their bioremediation by increasing bioavailability and possible application of the biosurfactant for enhanced oil recovery.

- **Keywords:** Biosurfactant; Desorption; PAH; Paenibacillus dendritiformis; Enhanced oil recovery

**Lamia Vernières-Hassimi, Sébastien Leveneur. *Alternative method to prevent thermal runaway in case of error on operating conditions continuous reactor. Pages 365-373.***

Thermal runaway was studied in a continuous tubular pilot reactor under steady-state regime. Different accident scenarii were conducted by making some errors on reactant concentrations and/or temperature feed. To prevent thermal runaway, control by direct contact by solvent injection was used at different reactor locations. This injection allowed controlling the maximum reaction temperature. A simplified analytical method to estimate the maximum reaction temperature along the reactor was used. Benefit of this

control method was the diminution of computational time. Furthermore, by injecting solvent to control maximum reaction temperature, there is no need to shut down the unit. The control method was validated experimentally.

- **Keywords:** Fast exothermic reaction; Thermal runaway; Continuous reactor; Maximum temperature; Control; Process safety

**A. Ebrahimi, M. Ehteshami, B. Dahrazma. *Isotherm and kinetic studies for the biosorption of cadmium from aqueous solution by Alhaji maurorum seed.* Pages 374-382.**

Cadmium is an extremely toxic metal commonly found in industrial regions. Anthropogenic activity is the most important factor causing its interference to water, soil and air resources. The aim of many researches is to present remediation strategy or to remove cadmium from contaminated resources through an economical and efficient method. Cadmium adsorption from aqueous solution using Alhaji maurorum seed adsorbent has been investigated and optimized in this study. Moreover, isotherm and kinetics of adsorption process was studied. The seeds are washed by distilled water after separation from the plant, and then dried in room temperature for 48 h. They are powdered by grinder and passed through sieve no.18 as well. Adsorption process was optimized in 4 steps regarding pH, contact time, adsorption dose and initial concentration of cadmium effects. The cadmium concentration in solution was measured using ICP-OES method. The results of optimization tests showed that the optimum condition of cadmium adsorption (85.5% removal) occurs at pH of 6.5 with 20 g/L of adsorption dose for 45 min. In addition, the efficiency of adsorption process increases as the cadmium concentration reduces in the initial solution. Adsorption process follows the pseudo second-order kinetics and Freundlich isotherm with correlation coefficients of 0.999 and 0.99, respectively. According to the findings of this analysis, it was concluded that A. maurorum seed is a good biological adsorbent for adsorbing cadmium from aqueous solution.

- **Keywords:** Cadmium; Adsorption kinetic; Adsorption isotherm; Alhaji maurorum seeds; Modeling; Freundlich isotherm

**Chiung-Yi Cheng, Kuang-Li Cheng, Terng-Jou Wan, Wei-Nung Kuo, Feng-Jen Chu, Chi-Min Shu. *Effects of applied voltage on hydrogen production rate of a single reactor BML with Clostridium sp.* Pages 383-389.**

This study aimed to explore the influences of single-chamber systems with different applied voltage on bio-hydrogen (H<sub>2</sub>) production. The reactor used was the bio-electrochemically assisted microbial reactor (BEAMR) membrane-less (BEAMR-membrane-less, BML). The microbial dark fermentative H<sub>2</sub> production method was adopted. After the hot screening process and the DNA sequencing, the domesticated dominant microflora was Clostridium sp. This study discussed the influences of the cases with (continuous and intermittent) and without applied voltage separately. The results showed that, the H<sub>2</sub> production rate of the case with intermittent applied voltage (117 mL/h g VSS) of 0.24 V was increased of 1.7 folds higher than the without applied voltage (69 mL/h g VSS) and 1.3 folds higher than the case with continuous applied voltage (88.2 mL/h g VSS) of 0.24 V. The produced H<sub>2</sub> concentration with intermittent applied voltage was 18.9% (18.6–19.1%) higher than the without applied voltage, while there was no significant difference with continuous applied voltage.

- **Keywords:** Applied voltage; Hydrogen (H<sub>2</sub>) production rate; BEAMR-membrane-less (BML); Clostridium sp.; Bio-electrochemically; Dark fermentative



**Hesham Hamad, Mona Abd El-latif, Abd El-Hady Kashyout, Wagih Sadik, Mohamed Feteha. *Optimizing the preparation parameters of mesoporous nanocrystalline titania and its photocatalytic activity in water : physical properties and growth mechanisms. Pages 390-398.***

Titania nanomaterial with an anatase structure and 5.6 nm crystallite size and 280.7 m<sup>2</sup> g<sup>-1</sup> specific surface areas had been successfully prepared by sol-gel/hydrothermal route. The effect of pH as a type of autoclave and calcination was studied. Crystallite size and phase composition of the prepared samples were identified. X-ray diffraction analyses showed the presence of anatase with little or no rutile phases. The crystallite size of the prepared TiO<sub>2</sub> with acidic catalyst was both smaller than that prepared with basic catalyst, and was increasing after acidic calcinations by a factor 4–5. Basic calcinations produced a specific increase of 1.5. Rutile ratio and the particle size were increased after calcination at 500 °C. However, TiO<sub>2</sub> powder synthesized using a basic catalyst persisted the anatase phase and a loosely aggregation of particles. Anatase TiO<sub>2</sub> as prepared with acidic catalyst in Teflon lined stainless steel autoclave demonstrated the highest photocatalytic activity for degradation of 2,6-dichlorophenol-indophenol under ultraviolet irradiation with t<sup>1/2</sup> 0.8 min.

- **Keywords:** Nanostructures; Sol-gel growth; Hydrothermal; Titania; X-ray diffraction; Photocatalytic activity

**Niantao Xue, Li Wang, Tianlong Zheng, Jianhua Wang, Qunhui Wang. *Biodegradation of sulfite in flue gas absorbent by using a biotrickling filter at anaerobic condition. Pages 399-405.***

A biotrickling filter (BTF) packed with a ball-shaped fiber packaging material was tested in terms of its ability to remove sulfite (SO<sub>3</sub><sup>2-</sup>) in a flue gas absorbent. Trickling rates of 9.0 m<sup>3</sup>/(m<sup>2</sup> h) to 18 m<sup>3</sup>/(m<sup>2</sup> h) are recommended at Na<sub>2</sub>SO<sub>3</sub> concentrations greater than 4.5 g/L. An increase in COD/SO<sub>3</sub><sup>2-</sup> ratio could accelerate desulfurization, and COD/SO<sub>3</sub><sup>2-</sup> ratios ≥1.8 were appropriate. A 100% reduction of SO<sub>3</sub><sup>2-</sup> could be achieved at strict anaerobic conditions while maintaining the oxidation-reduction potential (ORP) at about -430 mV in the work. NH<sub>4</sub><sup>+</sup>-N was quickly consumed then converted to NO<sub>3</sub><sup>-</sup>-N, which functioned as an electron acceptor at anaerobic condition and was reduced to N<sub>2</sub>. The value of pH dropped from 8.19 to the lowest, 7.73, when the SO<sub>3</sub><sup>2-</sup> removal efficiency was 99%. A positive relationship was observed between the SO<sub>3</sub><sup>2-</sup> reduction and alkalinity. SO<sub>3</sub><sup>2-</sup> was fully removed at 3 h when the alkalinity reached the maximum. Overall, the BTF could efficiently reduce SO<sub>3</sub><sup>2-</sup> in a simulated flue gas absorbent, and it could be used for the biodegradation of sulfite in a simulated flue gas absorbent to replace the regeneration step of dual-alkali FGD.

- **Keywords:** Biotrickling filter; Flue gas absorbent; Flue gas desulfurization (FGD); Dual-alkali FGD; Sulfite absorbent; Anaerobic condition

**H.P. Gajera, R.P. Bambharolia, Darshna G. Hirpara, S.V. Patel, B.A. Golakiya. *Molecular identification and characterization of novel *Hypocrea koningii* associated with azo dyes decolorization and biodegradation of textile dye effluents. Pages 406-416.***

The potential of six fungi (three basidiomycetes biocontrol agent – Trichoderma spp. and three ascomycetes phytopathogens) were evaluated for decolorization and biodegradation of five azo dyes (Red HE7B, Reactive Violet-5, Red Black-B, Light Navy Blue HEG, Dark Navy Blue H2GP) used for textile industries. The fungi were isolated from effluent contaminated plant rhizosphere near textile dyeing industrial area and identified as Trichoderma viride, Trichoderma koningii, Trichoderma harzianum, Aspergillus niger, Aspergillus flavus, and Fusarium oxysporum based on macro and micro-morphological

descriptors. *T. koningii* was recognized as the best decolorizer based on the average decolorization rate of five azo dyes followed by *A. niger*. These two fungal isolates were studied further for biodegradation of textile dye effluents. Fungal biodegradation was assessed by HPLC profile and physicochemical analysis. The biological oxygen demand and chemical oxygen demand of effluents were efficiently reduced by *T. koningii* compared with *A. niger*. *T. koningii* JAU8 isolate was characterized by 28S rRNA gene sequence using ITS markers. Comparison of test strain against known sequences of 28S rRNA gene databases was evident 86% similarity. Molecular approach identified a new strain *Hypocrea koningii* (teleomorphs of anamorphic *Trichoderma*), untested before for bioremediation purposes, proved to have a high potential in decolorizing azo dyes.

- **Keywords:** Fungal isolates; Azo dyes; Biodegradation; Textile effluents; HPLC profile; 28S rRNA gene

**Zimo Lou, Jin Zhu, Zhuoxing Wang, Shams Ali Baig, Li Fang, Baolan Hu, Xinhua Xu. *Release characteristics and control of nitrogen, phosphate, organic matter from spent mushroom compost amended soil in a column experiment.* Pages 417-423.**

Spent mushroom compost (SMC) is a co-product of edible mushroom which contains abundant nutrients including organics, nitrogen (N) and phosphorous (P). This study is related to the release potential of nitrogen, phosphate and organic matter from SMC amended soil in column-based experiments. Results showed that due to SMC application,  $\text{NH}_4^+-\text{N}$  and  $\text{NO}_3^{--}\text{N}$  concentrations in leachate decreased by 92.5% and 76.3%, respectively, while EC and COD<sub>Cr</sub> concentrations increased by 84.2% and 481.9%, respectively, as compared to chemical fertilizers. Moreover, a minor loss of TN<sub>cum</sub> (65%) and TP<sub>cum</sub> (almost equal value) exhibited good nutrient retention capacity. Leaching test results demonstrated that the mixed application of SMC and chemical fertilizers could alleviate excessive COD<sub>Cr</sub> level in SMC leachate. The release process of nutrients in SMC amended soil could be described by first/first order mixed model, indicating that nutrients leached from SMC follow a two-stage pattern.

- **Keywords:** Spent mushroom compost; Column test; Nitrogen; Phosphate; Organic matter

**Moussa Abbas, Mohamed Trari. *Kinetic, equilibrium and thermodynamic study on the removal of Congo Red from aqueous solutions by adsorption onto apricot stone.* Pages 424-436.**

The preparation of activated carbon from apricot stone (ASAC) activated with  $\text{H}_3\text{PO}_4$  and its ability to remove the basic dye Congo red (CR) used in the textile industry in aqueous solution are reported in this study. The FTIR spectroscopy is used to get information on the interactions between the ASAC adsorbent and CR. A series of contact time experiments were undertaken in stirred batch to assess the effect of the system variables. The results showed that ASAC can be successfully used the wastewater treatment. A comparison of two models on the overall adsorption rate showed that the kinetic of adsorption was better described by the pseudo-second order model. The adsorption data of CR onto ASAC are determined and correlated with common isotherms equations. The small values of the Root Mean Square Error (RMSE) obtained for the Langmuir and Dubinin-Radushkevich models indicate the best fitting of the curves. The monolayer adsorption capacity of CR is found to be 32.85  $\text{mg g}^{-1}$  at 25 °C and 23.42  $\text{mg g}^{-1}$  at 65 °C at pH ~ 13. The thermodynamic parameters indicate a spontaneous and endothermic nature of the adsorption process. The positive entropy ( $\Delta S^\circ$ ) shows that the randomness increases at the solid-solution interface during the CR adsorption, indicating that some structural exchange occurs among the active sites of the adsorbent and CR molecules.

- **Keywords:** Apricot stone; Congo Red; Kinetic; Isotherm; Adsorption; Thermodynamic