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Subramani S.E., Thinakaran N. *Isotherm, kinetic and thermodynamic studies on the adsorption behaviour of textile dyes onto chitosan. Pages 1-10.*

The present study was established to analyse the capability of Malachite Green (MG), Reactive Red (RR) and Direct Yellow (DY) dyes adsorption onto chitosan synthesized from prawn shells. The effect of process parameters such as adsorbent dosage, pH, contact time, temperature and initial concentration on dye adsorption were studied on the performance of dye removal. Chitosan was characterized by FTIR, SEM and BET analysis. The results showed that as the amount of the adsorbent was increased the percentage of dye removal increased correspondingly. Maximum dye removal was observed at pH 3. The isotherms such as Langmuir, Freundlich and Temkin and Redlich–Peterson were examined and the appropriate model was identified. The adsorption capacities of the synthesized chitosan was 166 mg/g for dye MG, 1250 mg/g for dye RR and 250 mg/g for dye DY. Dynamic adsorption studies show that the adsorption reaction was well represented by the pseudo-second-order kinetic process with intra particle diffusion being one of the rate limiting step. The thermodynamic study revealed that the adsorption of dyes on chitosan was feasible, spontaneous and exothermic process. Results indicated that the synthesized chitosan was shown to be a promising adsorbent for the removal of dyes from aqueous solutions.

- **Keywords:** Chitosan; Isotherm; Kinetics; Prawn shells; Thermodynamics; Dye removal; Wastewater treatment

Mousumi Basu, Arun K. Guha, Lalitagauri Ray. *Adsorption Behavior of Cadmium on Husk of Lentil. Pages 11-22.*

The adsorption behavior of cadmium on husk of lentil an agro-waste was investigated to understand the mechanism of adsorption as well as to explore its potential in removing cadmium from its aqueous solution. The adsorption process of lentil husk (LH) was found to be a function of pH of the solution, optimum being 5.0. The rate of adsorption of cadmium by LH was very fast initially and attained equilibrium within 60 min following pseudo second order rate kinetics. The study established that 1.0 g LH can adsorb 107.31 mg of cadmium and was successful to reduce the concentration of this metal from the effluent of battery industries. Adsorption process followed Langmuir isotherm model with uniform distribution of metal ions on the surface of the biomass as revealed from X-ray elemental mapping. In binary system the biomass displayed a preference in adsorption of lead over cadmium. The results of Fourier transform infrared (FTIR)

spectroscopy, scanning electron microscopy (SEM), chemical modification of functional groups and zeta potential measurement established the binding of cadmium to the biomass through electrostatic and complexation reactions.

- **Keywords:** Cadmium; Lentil husk; Zeta potential; Chemical modification; Adsorption isotherm; TGA

Baranitharan Mathalaimuthu, Dhanasekaran Shanmugam, Kalimuthu Kovendan, Murugan Kadarkarai, Gokulakrishnan Jayapal, Giovanni Benelli. *Coleus aromaticus* leaf extract fractions: A source of novel ovicides, larvicides and repellents against *Anopheles*, *Aedes* and *Culex* mosquito vectors? Pages 23-33.

Eco-friendly tools to manage mosquito young instar populations in an IPM framework are urgently required. Here, we analyzed six ethyl acetate and methanol fractions of *Coleus aromaticus* leaf extract using thin layer chromatography and GC-MS, in order to shed light on the main chemical constituents with toxicity on mosquitoes. The fractions were tested as ovicides, larvicides and repellents against the mosquito vectors *Anopheles stephensi*, *Aedes aegypti* and *Culex quinquefasciatus*. In GC-MS analysis, a total of nine compounds were identified in the methanolic extract composition, the main component was 11-octadecenoic acid, methyl ester. The highest larvicidal activity was observed for the methanol fraction 4 against *Ae. aegypti*, *An. stephensi* and *Cx. quinquefasciatus* with LC50 values of 23.90, 22.32 and 20.51 ppm. In the ovicidal experiments, 100% mortality was exerted by methanol fraction 4 tested at 40 ppm against *Ae. aegypti*, *An. stephensi* and *Cx. quinquefasciatus*. Furthermore, high repellence of methanol fraction 4 tested at 2.5 mg/cm² was observed in "arm in cage" tests for at least 320 min. We hypothesized that 11-octadecenoic acid, methyl ester was the main constituent responsible for the mosquitocidal and repellent activity of *C. aromaticus* fractions.

- **Keywords:** Acute toxicity; *Aedes aegypti*; *Anopheles stephensi*; *Culex quinquefasciatus*; GC-MS; Thin layer chromatography

Arvind Keprate, R.M. Chandima Ratnayake, Shankar Sankararaman. *Minimizing hydrocarbon release from offshore piping by performing probabilistic fatigue life assessment. Pages 34-51.*

Topside piping is the major source of hydrocarbon release (HCR) on offshore oil and gas (OOG) platforms in the North Sea region. Since 21% of piping failures are caused by vibration induced fatigue (VIF), an accurate remnant fatigue life (RFL) assessment has the potential to minimize the chances of HCR from an operating piping system. BS-7910 gives two possible approaches for performing a RFL assessment: the S-N curve approach and the fracture mechanics (FM) approach. Since there are large number of uncertainties (such as uncertainty due to the crack growth model, future loading, material and geometric properties, etc.) involved in the RFL calculation process, therefore it is vital to consider the aforementioned sources of uncertainty in order to arrive at an accurate RFL estimate. Nevertheless, BS-7910 provides limited guidance on how to handle uncertainty in RFL assessment. The most common way of dealing with the aforementioned uncertainty is to evaluate RFL probabilistically. This manuscript thus explains the procedure of the probabilistic RFL assessment of offshore topside piping, with an emphasis on uncertainty quantification, propagation and management. Uncertainty quantification handles the identification and characterization of the different sources of uncertainty that may influence the future behavior of the piping component and, in turn, the RFL estimate. Thereafter, uncertainty propagation employs the formerly quantified uncertainties and utilizes the aforementioned information to estimate the RFL. Finally, uncertainty management deals with performing sensitivity analysis to find the individual contributors to uncertainty in the estimated RFL. A numerical case study illustrating the

deterministic and probabilistic RFL assessment of topside piping is presented. Afterwards, probabilistically predicted RFL is used to demonstrate the calculation of an inspection interval. Finally, the implications of probabilistically estimated RFL on HCR from process piping is discussed.

- **Keywords:** HCR; RFL; VIF; Uncertainty handling; Probabilistic Crack Growth; Offshore piping

Malak El-Gheriani, Faisal Khan, Dan Chen, Rouzbeh Abbassi. *Major accident modelling using spare data.* Pages 52-59.

In the field of risk and reliability analysis, the information available to acquire probabilities is usually insufficient (i.e. scarce, little). Utilizing a variety of information sources introduces many uncertainties associated with risk estimation. This is an obstacle in the prediction of major accidents which have significant consequences for human life and the environment, in addition to incurring financial losses. In order to get reasonable results and to support decision making in a cost effective manner, there is a need to aggregate the relevant data from different regions, operational conditions and different sectors (e.g. chemical, nuclear or mining). In this paper, a methodology is developed considering Hierarchical Bayesian Analysis (HBA) as a robust technique for event frequency estimation. Here, HBA is able to treat source-to-source uncertainty among the aggregated data for each event and provide a precise value for the parameter of interest (e.g. failure rate, probability or time to failure). The estimated event's parameter is reintegrated via probabilistic modelling techniques such as Bowtie analysis to estimate the probability of major accidents. The application of the proposed methodology to risk analysis is illustrated using a case study of an offshore major accident and its effectiveness is demonstrated over the traditional statistical estimators. The results illustrate that the developed methodology assists in making better estimates of the probabilities when dealing with sparse data. The ability to update the primary event and safety barrier probabilities as new data becomes available further enhances its usefulness.

- **Keywords:** Data scarcity; Probabilistic modelling; Hierarchical Bayesian Analysis; Risk analysis; Offshore; Major accidents

Sergi Garcia-Segura, Jin Anotai, Somporn Singhdech, Ming-Chun Lu. *Enhancement of biodegradability of o-toluidine effluents by electro-assisted photo-Fenton treatment.* Pages 60-67.

The treatment of highly recalcitrant and non-biodegradable solutions of 1 mM of o-toluidine has been comparatively treated by different water treatment technologies based on Fenton's reaction: conventional Fenton process, electro-assisted Fenton process and electro-assisted photo-Fenton process. The pollutant was mainly oxidized by the homogeneous OH released in situ by the Fenton's reaction. The electro-assisted photo-Fenton technology demonstrated better performance due to the faster electro-regeneration of iron(II) and the coupled photolysis of several by-products such as carboxylic acids attaining complete o-toluidine removal in 60 min of treatment. The study of the biodegradability enhancement after the treatment achieving values near to 0.4 of BOD5/COD ratio assessed the feasible application of electro-assisted photo-Fenton process as pre-biological treatment. In addition, a reaction pathway for o-toluidine mineralization by electro-assisted photo-Fenton's reaction is proposed.

- **Keywords:** Photo-Fenton; Anodic oxidation; RuO₂/IrO₂ Dimensional Stable Anodes (DSA); Water treatment technologies; Persistent organic pollutants; Electrochemical advanced oxidation processes; o-toluidine reaction pathway

Maryam Haddad, Laurent Bazinet, Oumarou Savadogo, Jean Paris. *A feasibility study of a novel electro-membrane based process to acidify Kraft black liquor and extract lignin. Pages 68-75.*

Lignin extraction from black liquor is of utmost importance for decreasing the load of the recovery boiler and consequently increasing the production capacity of Kraft process. A feasibility study of a novel acidification technique (acidification with electro dialysis using bipolar membrane (EDBM)) was carried out to drop the pH of Kraft black liquor and extract lignin. In order to evaluate the technical feasibility of the proposed method, the acidification of the Kraft black liquor was performed in two different pathways i.e. electrochemical acidification by means of EDBM process and chemical acidification using sulfuric acid. The results have indicated that the implementation of the proposed method resulting in use of less chemicals than the chemical acidification method and simultaneously production of caustic soda. The experiments performed in the course of this study addressed the advantages and challenges of this electro-membrane based process in the Kraft black liquor acidification application.

- **Keywords:** Bipolar membrane; Electrodialysis; Kraft black liquor; Lignin extraction; Electrochemical acidification; Chemical acidification

Zhiguo Zeng, Enrico Zio. *An integrated modeling framework for quantitative business continuity assessment. Pages 76-88.*

Systems are increasingly exposed to threats of disruptive events, e.g., failures, natural disasters, terrorist attacks, etc. A proactive approach is needed to protect the business and reduce the potential losses caused by these disruptive events. Business Continuity Management (BCM) is a way to integrate the recovery process within the preventive framework of risk assessment. Such integrated risk management strategy offers great potential benefits. However, the complexity of applying it in practice is such that existing BCM strategies are mainly based on qualitative methods only, which limits the potential added values. To support quantitative BCM, in this paper we define a set of quantitative business continuity metrics. The defined metrics are based on the estimated losses incurred by the disruptive event in the whole business process. For this, the business process is divided into four sequential phases, i.e., protection phase, mitigation phase, emergency phase and recovery phase. For each phase, a specific modeling method is developed and an integrated modeling framework is constructed for the business continuity. Simulation can, then, be used to quantify the business continuity metrics. The developed methods are applied to assess the business continuity of an oil storage tank farm.

- **Keywords:** Business continuity management; Risk analysis; Event tree; Event consequence diagram; Semi-Markovian model; Oil storage tank farm

Nader Biglarijoo, Seyed Ahmad Mirbagheri, Majid Bagheri, Majid Ehteshami. *Assessment of effective parameters in landfill leachate treatment and optimization of the process using neural network, genetic algorithm and response surface methodology. Pages 89-103.*

In this paper, the Fenton process was found to be an effective technique to treat leachates when the drawbacks of this process were minimized by choosing proper catalyst, considering effective parameters and introducing optimum conditions. Analytic hierarchy process (AHP) was used to select the favorable catalyst between FeSO_4 and FeCl_2 . Meanwhile, central composite design was used for test design of the experiments along with response surface methodology (RSM) and artificial neural network (ANN) for modeling. The effective variables included pH, $[\text{H}_2\text{O}_2] / [\text{Fe}^{2+}]$, Fe^{2+} dosage and initial COD concentration while removal COD, sludge to iron ration (SIR) and organic

removal to sludge ratio (ORSR) were considered as targets. For all three targets, the effective factors were considered using sensitivity analysis. Finally, response surface methodology and genetic algorithm (GA) were used for optimization of the process. According to AHP sensitivity analysis results, priority percentage for FeCl₂ and FeSO₄ were 64% and 36%, respectively. Comparing RSM and ANN, it was found that ANN provided higher prediction ability while both models were statistically adequate (with $R^2 > 0.90$). The effective factors for COD removal, SIR and ORSR were respectively as follows: Fe²⁺ dosage, pH and $[H_2O_2] / [Fe^{2+}]$. The main focus of optimization was to achieve high removal efficiencies for COD when generated sludge is still low. Hence, results from RSM and GA indicated that both methods proposed approximately similar operational conditions. In the end, a practical formula was proposed for BOD₅/COD ratio enhancement for each leachate.

- **Keywords:** Leachate treatment; Fenton process; Response surface methodology; Artificial neural network; Genetic algorithm; Analytic hierarchy process

Pankaj Raizada, Jyoti Kumari, Pooja Shandilya, Rashi Dhiman, Virender Pratap Singh, Pardeep Singh. *Magnetically retrievable Bi₂WO₆/Fe₃O₄ immobilized on graphene sand composite for investigation of photocatalytic mineralization of oxytetracycline and ampicillin. Pages 104-116.*

Supported photocatalysis is emerging as an effective technology to overcome the inherent drawback of metallic photocatalyst. In the present work, heterojunctioned Bi₂WO₆/Fe₃O₄ was synthesized by hydrothermal method. Bi₂WO₆/Fe₃O₄ was supported over graphene sand composite (GSC) by in situ wet impregnation method to report Bi₂WO₆/Fe₃O₄/GSC nanocomposite. The morphological and compositional characteristics of prepared Bi₂WO₆/Fe₃O₄/GSC nanocomposite were explored by FESEM, TEM, HRTEM, FTIR, XRD, EDX and UV-vis spectral analysis. The photocatalytic efficiency of synthesized Bi₂WO₆/Fe₃O₄/GSC composites was evaluated for mineralization of oxytetracycline (OTC) and ampicillin (AMP) under solar light. The adsorption of both OTC and AMP onto Bi₂WO₆/Fe₃O₄/GSC followed pseudo second order kinetics. The synergistic adsorption and photocatalysis (A + P) was most efficient process for oxytetracycline and ampicillin removal and resulted in higher degradation of antibiotics. During A + P process, OTC and AMP were mineralized to CO₂, H₂O and NO₃⁻ ions. Power law model was applied to explore the kinetics of mineralization process. The super paramagnetic nature of photocatalyst was revealed by hysteresis curve. Bi₂WO₆/Fe₃O₄/GSC nanocomposite displayed improved adsorption capacity and easy separation from reaction mixture with significant recycle efficiency for 10 successive catalytic cycles.

- **Keywords:** Bi₂WO₆; Fe₃O₄; Supported photocatalysis; Magnetic recovery; Antibiotic removal

Gang Zhou, Qi Zhang, Ruonan Bai, Tao Fan, Gang Wang. *The diffusion behavior law of respirable dust at fully mechanized caving face in coal mine: CFD numerical simulation and engineering application. Pages 117-128.*

Fully mechanized caving face (FMCF) serves as an important part of underground mining system in coal mines. The respirable dust of high concentration produced at FMCF seriously pollutes the underground working environment, and is hazardous to the physical and mental health of miners. In addition, the movement and flow of respirable dust are complicated in the underground environment and add difficulty to dust prevention. In the present work, the diffusion behavior of respirable dust at 5303 FMCF Tangkou Coal Mine of the Zibo Mining Group is studied by combining CFD simulation and field measurement. The results show that the respirable dust generated by back drum

rushes into sidewalk space. Influenced by turbulence, the respirable dust from coal caving moves quickly into the sidewalk and pollutes this area. On the basis of the results and on-site condition, a comprehensive system for respirable dust control at FCMF has been proposed. With the application of the comprehensive system, the mean settlement rate of respirable dust reaches 91.06% in the main operation area for field technicians. The result demonstrates high efficiency of dustproof effect.

- **Keywords:** Fully mechanized caving face; Respirable dust; Diffusion behavior law; CFD numerical simulation; Spray and dust reduction; Engineering application

Binqi Rao, Genqing Huang, Xilong Lu, Yanjian Wan, Zhenghai Jiang, Dong Chen, Xiaodong Liu, Aoming Liang. *An ultrahigh-pressure filtration and device design and optimiz study on high dry dewatering of sludge.* Pages 129-137.

In this article, a new dewatering device was designed to achieve high dry sewage sludge through proposing a new ultrahigh-pressure (UHP) technique with adding very few flocculant cationic polyacrylamide (CPAM). The design of the new dewatering device was based on the compression characteristic curve, which was obtained from the experiment on compression characteristics of sludge and the final moisture content. The mechanics and motion analysis were carried out for two key components, i.e. the toggle force amplifier and the disc spring. It showed that the compression ratio (Cr) of sludge between 40%–72% and the moisture content (Wt) of sludge cakes was below 50% with some sludge cake even below 20% by using 3 MPa pressure filtration. The moisture content of sludge was much lower than that of the routinely used device such as diaphragm frame filters. The force of the combination of toggle force amplifier and disc spring of the new device showed a 20-fold increase, and the dynamics property of the new device fits very well to the sludge compression characteristic curve.

- **Keywords:** Sludge; Ultrahigh-pressure(UHP); High dry dewatering; Compression characteristics; Toggle force amplification mechanism

Behrouz Hemmatian, Eulàlia Planas, Joaquim Casal. *Comparative analysis of BLEVE mechanical energy and overpressure modelling.* Pages 138-149.

The mechanical effects of a BLEVE are overpressure and ejection of fragments. Although fragments reach much longer distances, peak overpressure can be very strong over a certain area. Diverse authors have proposed methodologies for the estimation of the explosion energy and peak overpressure from these type of explosions, based on different thermodynamic and physical assumptions. Here these methodologies are commented and compared. Their predictions, which show an important scattering, are checked by comparison with two sets of experimental data taken from the literature. The results obtained indicate that none of the models take into account Reid's theory. The models based on ideal gas behaviour and constant volume energy addition, isentropic expansion and isothermal expansion give quite conservative (i.e., high) values of both energy released and overpressure, while those assuming real gas behaviour and adiabatic irreversible expansion give lower values, much closer to the real/experimental ones. The diverse uncertainty factors affecting the prediction of peak overpressure are also commented.

- **Keywords:** Vessel explosion; Explosion energy; Blast overpressure; Pressure wave; Filling degree; Liquid flash

Lavinia Tofan, Ion Bunia, Carmen Paduraru, Carmen Teodosiu. *Synthesis, characterization and experimental assessment of a novel functionalized*

macroporous acrylic copolymer for gold separation from wastewater. Pages 150-162.

Gold (Au) is one of the precious metals whose availability, use and recovery represent important problems from the economic and environmental point of view. The synthesis of the novel acrylic copolymer bearing dimethylaminobenzaldehyde functional groups (AS-5BA) was carried out in three stages. The structure of the synthesized material was evidenced by infrared spectroscopy (IR) and its morphology by scanning electron microscopy (SEM), while the elemental composition was determined through X-ray photoelectron spectroscopy (XPS). The AS-5BA functionalized copolymer was used for gold sorption from chloride solution by the batch method. The effects of HCl medium acidity, initial Au(III) concentration, and contact time on the Au(III) retention were studied. The maximum Au(III) sorption capacity was evaluated as 87.75 mg/g. The copolymer under study exhibited strong selectivity for the gold in the binary Au(III)-Co(II), Au(III)-Mn(II) and Au(III)-Cd(II) solutions. Gold could be quantitatively desorbed from the loaded sorbent with acidic solution of thiourea at ambient temperature. The developed AS-5BA copolymer was successfully applied to recover gold from a wastewater collected from a gold jewellery manufacturing plant. The AS-5BA functionalized acrylic copolymer with N as donor atoms has good durability as well as good efficiency for its repeated use for gold removal from aqueous solutions.

- **Keywords:** Gold; Acrylic copolymer; Dimethylaminobenzaldehyde; Wastewater

Sudipta Goswami, Priya Banerjee, Siddhartha Datta, Aniruddha Mukhopadhyay, Papita Das. Graphene oxide nanoplatelets synthesized with carbonized agro-waste biomass as green precursor and its application for the treatment of dye rich wastewater. Pages 163-172.

This study is the first report of biochar obtained from rice straw biomass as a green precursor for cost effective wide scale synthesis of graphene oxide nanoplatelets (GONPs). These GONPs were further implemented for adsorption crystal violet (CV) from aqueous solutions. Few selected experimental parameters were optimised using Central Composite Design feature of Response Surface Methodology (RSM). The GONPs were characterized with surface SEM, TEM, FTIR, XRD and AFM. Results indicated biochar as a sustainable alternative for graphite in GONP synthesis and GONPs to be a clean ecofriendly adsorbent effective in highly reduced dosage and time of contact.

- **Keywords:** Agro waste; Rice straw biomass; Carbonization; Graphene oxide nanoplatelets; Adsorption efficiency; Response surface methodology optimization

Boonyawan Yoosuk, Pornthip Methakhup, Pattarapan Prasassarakich. Binary sorption of CO₂ and H₂S over polyamine modified fumed silica pellets in a double stage fixed-bed system. Pages 173-179.

Low cost fumed silica (fSi) modified by polyethyleneimine (MW of 800) at 40 wt.% (fSi-PEI800-40) appears to be a promising sorbent for the binary sorption of CO₂ and H₂S. This study aimed to pelletize this powder sorbent using an extrusion method with starch, polyvinyl alcohol (PVA) or bentonite clay as a binder. The effect of the amount and type of the binder on the mechanical strength and the CO₂ and H₂S binary sorption performance of the sorbent were evaluated. The molecular weight of binder appeared to have an important effect on the sorbent's strength, where PVA at 5 wt.% gave the pelletized sorbent the highest mechanical strength (0.892 MPa) but a slightly lower sorption capacity for CO₂ and H₂S than did bentonite clay. The sorption capacity decreased with increasing levels of binder because strong interactions between the binder and particles resulted in particle aggregation. The pre-treatment conditions and flow rate of the mixed gas (CH₄/CO₂/H₂S/N₂) were investigated in an up-scale system.

The pelletized sorbents could be regenerated at a mild temperature (90 °C) for at least 18 reuse cycles, and so the fSi-PEI800-40/PVA5% sorbent has a high potential for application in the acid gas treatment process.

- **Keywords:** Amine; Fumed silica; Pellet; Binder; CO₂ removal; H₂S removal

Othman Charles S. Al Hamouz, Oluwafemi S. Akintola. Removal of lead and arsenic ions by a new series of aniline based polyamines. Pages 180-190.

A new series of aniline based polyamines were produced via mannich polycondensation reaction of aniline, formaldehyde and various alkyldiamines. The synthesized polyamines were characterized by solid ¹³C NMR, FT-IR and elemental analysis. Crystallinity and Surface morphology was investigated by powder X-ray diffraction and SEM-EDX. Thermal stability was tested by thermogravimetric analysis. Adsorption properties toward lead (II) and Arsenic (V) ions was studied by model solutions at controlled conditions (pH, time, temperature and initial concentration). An-Buta polymer showed higher efficacy toward the removal of lead and arsenic ions and was selected to be used in the treatment of wastewater samples and showed efficient removal % of ~99% and % 85 for lead (II) and Arsenic (V) ions respectively. The results reveal the high potential of the synthesized polyamines to be potential adsorbents for wastewater treatment.

- **Keywords:** Polyamines; Wastewater treatment; Lead ions; Arsenic ions; Adsorption; Mannich polycondensation; Adsorbent

Seyed Mohammadreza Miraboutalebi, Soheil Kordmirza Nikouzad, Mohammad Peydayesh, Nima Allahgholi, Leila Vafajoo, Gordon McKay. Methylene blue adsorption via maize silk powder: Kinetic, equilibrium, thermodynamic studies and residual error analysis. Pages 191-202.

The potential of maize silk powder (MS) as a natural, widely available and low-cost agricultural waste in order to adsorb methylene blue (MB) from an aqueous solution has been studied. The adsorbent surface morphology has been studied using SEM and FTIR. The effect of operating conditions such as contact time, solution pH and initial MB concentration and the important frequently missed parameters such as salt effect (using NaCl and Na₂HPO₄), temperature effect (for ΔH° , ΔG° and ΔS°), solution pH and detailed error analysis have been determined. A rate study indicated the process followed pseudo-second order kinetics. The adsorption equilibrium was modeled for best fit using ten commonly-used isotherm models and the Jovanovic equation gave the best correlation of the experimental data.

- **Keywords:** Methylene blue adsorption; Maize silk; Isotherm; Error analysis; Nonlinear regression

N. Tafreshi, S. Sharifnia, S. Moradi Dehaghi. Box-Behnken experimental design for optimization of ammonia photocatalytic degradation by ZnO/Oak charcoal composite. Pages 203-210.

Box-Behnken experimental design method was used to optimize the experimental conditions of photocatalytic removal of ammonia from synthetic wastewater by ZnO/Oak charcoal photocatalyst. The hybrid photocatalyst was synthesized by impregnation method and characterized by XRD, FTIR and FESEM analyses. The results of analyses showed the suitable dispersion of ZnO over the support surface. Also, the FESEM analysis confirmed the good features of the Oak charcoal as either support or adsorbent. pH (4–12), catalyst dosage (0.5–2 g/L) and initial ammonia concentration (85–850 mg/L) were the main parameters affecting the ammonia removal. The results of experiments were

modeled by a second-order polynomial equation. The high value of the determination coefficient ($R^2 = 99.6$ and adjusted $R^2 = 98.9\%$) revealed that the experimental data fitted well with the proposed model. The maximum efficiency of ammonia removal was obtained about 80% at optimum conditions of initial ammonia concentration of 153.9 mg/L, catalyst dosage of 1.59 g/L and solution pH 10.5. Based on the results of analysis of variance, the significance order of the independent parameters was as follows: initial ammonia concentration > catalyst dosage > solution pH.

- **Keywords:** Ammonia removal; Photocatalyst; ZnO; Oak charcoal; Experimental design; Box-Behnken; Optimization

Sue Yee Khor, Kian Yu Liam, Wei Xin Loh, Chee Ying Tan, Lik Yin Ng, Mimi H. Hassim, Denny K.S. Ng, Nishanth G. Chemmangattuvalappil. *Computer Aided Molecular Design for alternative sustainable solvent to extract oil from palm pressed fibre. Pages 211-223.*

Palm pressed fibre (PPF) is one of the by-products from palm oil milling process which is conventionally burned as fuel to produce energy to support the milling operation. PPF typically contains 5–6% of residual palm oil, which can be further recovered as by-product before using it as fuel in boiler. Therefore, it has propagated great interest in developing technologies to extract the residual oil from PPF. Based on the currently available technologies, hexane cold extraction is the most established method for recovering the residual oil. However, the extracted residual oil via hexane is not suitable for food applications due to the toxicity of hexane. Besides, the low recovery of carotene from the residual oil is another major concern of using hexane as solvent in the cold extraction. Therefore, there is a need to identify an alternative solvent to recover the residual oil from PPF. In this work, Computer Aided Molecular Design (CAMD) technique is adapted to identify alternative solvents which possess the most desirable attributes for this application. This application of CAMD is unique because it is important to optimize the physical properties of the potential solvent along with safety and health attributes in order to use in food industries. Moreover, the safety and health indexes depend on the physical properties of the final solvent and the abrupt changes of these indexes must be tracked simultaneously with the changes in properties. The proposed approach can identify alternative solvents that extract residual oil from PPF with the highest retention of carotene. To trade off the optimisation objective of the recovery of carotene and total health and safety impacts, fuzzy optimisation based approach for solvent design has been developed.

- **Keywords:** Chemical product design; Computer Aided Molecular Design; Palm pressed fibre; Oil extraction; Multi-objective optimisation; Health Indexes

Cindy Natalia Arenas, Alexander Vasco, Mariluz Betancur, Juan Daniel Martínez. *Removal of indigo carmine (IC) from aqueous solution by adsorption through abrasive spherical materials made of rice husk ash (RHA). Pages 224-238.*

A spherical material made of rice husk ash (RHA) was developed as alternative to the pumice used in the denim washing process via stone wash. The novelty of this work lies in the fact that besides to have shown abrasive properties, this material was also able to remove the Indigo Carmine (IC) contained in textile wastewater effluents. Hence, the stone wash process and the adsorption of IC can be performed at the same time in the washing machine. Thus, this work shows an experimental study on the removal of IC by using this novel material in order to identify the adsorption parameters involved. The experimental campaign was conducted in a discontinuous system. The adsorbent dose (m), soaking time (t), initial concentration (C_0) and temperature (T) were assessed on the treatment of a synthetic wastewater containing IC. Optimum conditions were found

to be 40 g 300 mL⁻¹ (m) and 300 min (t), while as lower the Co, the higher removal of IC (Y), although the adsorption capacity (q) decreases. Likewise, the adsorption process was favorably influenced by an increase in the temperature of the solution. Surface characterization was also conducted before and after adsorption by FT-IR, SEM and EDX. Kinetics, isotherms and thermodynamics studies were carried out to describe the experimental data. This work is in line with new environmentally friendly processes in order to zero effluent discharge and demonstrates the potential application of the RHA for conducting both: the stone wash process and the removal of pollutant dyes from wastewater.

- **Keywords:** Indigo carmine; Adsorption kinetics; Adsorption isotherms; Thermodynamic adsorption; Waste materials; Rice husk ash

Shuaijun Dong, Xinxiao Lu, Deming Wang, Hetang Wang, Keming Zheng, Qian Shi, Mingjie Chen. *Experimental investigation of the fire-fighting characteristics of aqueous foam in underground goaf.* Pages 239-245.

An experimental platform was built to investigate how aqueous foam extinguishes fire in the upper area of a goaf. A temperature-programmed oxidation testing method was used to illustrate the inhibitory effect of foam. The results showed that foam has good accumulation characteristics, cooling performance, blocking effect, and inhibition. Foam extinguishes the fire in the upper area of a goaf and cools the entire goaf from bottom to top; it even diffuses into the interior of the high-temperature zone and extinguishes any hidden fire in the porous medium. In addition, foam blocks all the cracks in the goaf, thus blocking the air supply and maintaining a constant negative pressure in the goaf. By restricting chemical reactions between coal and oxygen, foam increases the crossing point temperature and reduces CO generation and thus prevents the further oxidation of coal.

- **Keywords:** Mine fire; Goaf; Foam; Extinguishment; Control

Can-Hui Deng, Ji-Lai Gong, Lin-Lin Ma, Guang-Ming Zeng, Biao Song, Peng Zhang, Shuang-Yan Huan. *Synthesis, characterization and antibacterial performance of visible light-responsive Ag₃PO₄ particles deposited on graphene nanosheets.* Pages 246-255.

A visible light-responsive graphene oxide–Ag₃PO₄ (GO–Ag₃PO₄) was prepared using a facile electrostatically driven self-assembly method. Ag₃PO₄ particles were uniformly deposited on the surface of graphene oxide (GO) sheets. The GO–Ag₃PO₄ composite was more active in photocatalytically killing both Gram-positive and Gram-negative bacteria compared with pure Ag₃PO₄. The significantly enhanced photocatalytic and bactericidal performance of GO–Ag₃PO₄ composite could be attributed to (i) the more active adsorption sites on the GO surface for bacteria, and (ii) the reduced recombination of photogenerated electron–hole pairs relying on the excellent electronic conductivity and store electricity of GO. According to the results, most of Escherichia coli (E. coli) bacteria were killed within 30 min under visible light irradiation, while Staphylococcus aureus (S. aureus) bacteria were almost completely killed within only 25 min. The difference could be due to the outer membrane of E. coli, which made them more resistant to the cell membrane damage caused by GO–Ag₃PO₄ than S. aureus lack of the outer membrane. In addition, the radical capture experiments confirmed the involvement of active holes and reactive oxygen species (ROS) in the antibacterial process of GO–Ag₃PO₄. All the results demonstrated that the synthesized GO–Ag₃PO₄ composite, as a visible light-responsive antibacterial material, has a great promising for water disinfection.

- **Keywords:** Graphene oxide; Ag₃PO₄; Visible light; Disinfection; Photocatalytic mechanism; Reactive oxygen species

Nafiz Tamim, Delphine M. Laboureur, Ray A. Mentzer, A. Rashid Hasan, M. Sam Mannan. *A framework for developing leading indicators for offshore drillwell blowout incidents.* Pages 256-262.

Offshore operations have always been very challenging due to technological and operational complexities in combination with harsh environmental conditions. Geological uncertainties, high pressure flammable fluids in the presence of ignition sources, complicated structural layouts, limited response time allowance, difficulty of control and communication are some of the critical factors that pose clear threats toward safe operations and may result in high consequence events, e.g., blowouts. Developing well specified risk indicators is difficult due to such highly correlated factors and multifaceted operations. Leading indicators, which are able to identify critical events that could lead to high consequence events, have proven to be an effective tool that can help the operators in their decision making to react earlier to an event and to reduce the risk of an incident. Most of the research dedicated to leading and lagging indicators are applicable to the petrochemical industry, and there is not yet an agreement on a definition and classification of leading indicators for drilling related blowouts. This paper discusses the approaches of different organizations and institutes on leading indicators characterization and development. The drilling industry is compared with the aviation industry to identify potential elements for developing a comprehensive leading indicators framework. A workable definition of leading indicators is proposed considering the intricacy of offshore operations. Leading indicators are broadly categorized into two classes which are further segmented into different groups. Proposed categorization is analyzed with a blowout case study and simple decision support algorithms are proposed for predicting kick which is a major precursor to blowouts.

- **Keywords:** Leading indicators; Risk metrics; Offshore blowouts; Risk assessment; Kick prediction; Case study; Decision support algorithm

Eugenia Diana Mukhim, Tasneem Abbasi, S.M. Tauseef, S.A. Abbasi. *Domino effect in chemical process industries triggered by overpressure: Formulation of equipment-specific probits.* Pages 263-273.

The use of probits is essential for the study of domino effect in chemical process industries, to enable the assessment of the probability of escalation of accidents. This paper reports a more comprehensive and reliable method for formulating the probits than has been accomplished by the earlier reported methods. It is based on a larger data set, a finer level of classification of the equipment and a different method of linking the qualitative description of the damage to the quantitative probability. The probits thus obtained have significantly higher coefficients of determination (R^2) than those obtained by the previous authors, indicating a much better interpretation of the past data for calculating the probits. In most cases, the R^2 was greater than 0.9.

- **Keywords:** Domino effect; Explosion; Overpressure; Blast wave; Escalation probability; Probits

Dušan P. Nikezić, Zoran J. Gršić, Dragan M. Dramlić, Stefan D. Dramlić, Boris B. Lončar, Slavko D. Dimović. *Modeling air concentration of fly ash in Belgrade, emitted from thermal power plants TNTA and TNTB.* Pages 274-283.

The aim of the study was to estimate if dust/fly ash emitted into the atmosphere from chimneys and the ash disposal sites of the thermal power plants Nikola Tesla A and B in Obrenovac could increase the concentration of PM10 in New Belgrade. TNTA and TNTB are close to Belgrade (population of 2.5 million) and it is important to estimate the amount of the pollution emitted into the atmosphere from these sources. The pollution

from chimneys is estimated from yearly amounts of discharge, while the lifting of ash/coal dust was parameterized by the model. The used model is the straight-line Gaussian plume model written in the Fortran programming language. The first estimation was done using mathematical modeling for the idealized situation with prescribed winds and stability. The second estimation was done using the observed meteorological data for the whole year of 2009. With strong winds (over 40 km/h), dust will reach Belgrade in dozens of minutes, while during moderate winds (~10–30 km/h), it would take about one hour to reach it. In these cases atmosphere is close to the neutral stability class. In case of weaker winds and stable atmosphere, the increase of air dust concentration in Belgrade would start after a few hours (6–10). Regarding the other two sources of pollution, coal handling piles and ash deposit sites, during strong winds (>40 km/h) and neutral stability, fly ash would reach Belgrade in several dozen of minutes.

- **Keywords:** Fly ash; Dust; Ash disposal site; Thermal power plant; Atmospheric dispersion; Gaussian model

Maryam Hosseini, Mohammad Haghghi, Davood Kahforoushan, Mahdi Zarrabi. *Sono-dispersion of ceria and palladium in preparation and characterization of Pd/Al₂O₃-clinoptilolite-CeO₂ nanocatalyst for treatment of polluted air via low temperature VOC oxidation. Pages 284-293.*

Pd/Al₂O₃-clinoptilolite-CeO₂ nanocatalyst was successfully synthesized via ultrasound assisted wet impregnation method to be utilized for total oxidation of toluene. Chemical analysis like XRD, FESEM, EDX, BET and FTIR techniques are used to determine physicochemical properties of synthesized samples. Chemical analysis confirms the presence of all the elements in natural and treated clinoptilolite. XRD patterns prove the formation of ceria as a crystalline phase with an average crystallite size of 19.5 nm. FESEM images show the surface nanometric size of catalyst particles. EDX analysis indicates homogeneous dispersion of elements over nanocatalyst. BET surface area presented large surface for nanocatalysts. The results confirm the positive effect of ultrasound irradiation on surface morphology and elemental dispersion. Catalytic performance tests indicated high removal efficiency of nanocatalyst in total oxidation of toluene. High conversion at low temperatures (200–225 °C) and thermal stability are reasons for this observation.

- **Keywords:** Pd/Al₂O₃-clinoptilolite-CeO₂; Ultrasound; Nanocatalysts; Toluene; Total oxidation

Maryam Ahmadi, Mohammad Haghghi, Davood Kahforoushan. *Influence of active phase composition (Mn, Ni, Mn_xNi_{10-x}) on catalytic properties and performance of clinoptilolite supported nanocatalysts synthesized using ultrasound energy toward abatement of toluene from polluted air. Pages 294-308.*

Toluene removal out of waste gas streams was fulfilled through catalytic oxidation over series of Mn_xNi_{10-x}/clinoptilolite nanocatalysts with different Mn/Ni ratios. The samples were synthesized using sonochemical method and examined in total oxidation of toluene. The nanocatalysts were characterized by XRD, FESEM, EDX, FTIR and BET techniques. XRD data was confirmed the formation of Mn₂O₃ and NiO as the crystalline phases for single and mixed oxides nanocatalysts. Furthermore, EDX analysis manifested homogenous dispersion of elements on ultrasound irradiated nanocatalysts. Basically, reaction data illustrated that all bimetallic nanocatalysts had lower temperature activity compared to monometallic nanocatalysts. Results indicated that there are significant synergetic effects of bimetallic on reduction of oxidation temperature. Mn₇%Ni₃%/clinoptilolite nanocatalyst had the best performance among synthesized

samples. Toluene removal efficiency on this nanocatalyst was completed at 225 °C. Stability test of nanocatalyst demonstrated that the removal efficiency has remained constant for 1440 min.

- **Keywords:** Mn; Ni; Clinoptilolite; Toluene; Total oxidation

Maryam Hosseini, Mohammad Haghghi, Payam Margan, Hossein Ajamein. *Comparative sonochemically synthesis of CeO₂-doped Pd/c clinoptilolite and Pd/Al₂O₃ nanocatalysts used in total oxidation of toluene at low temperatures for polluted air treatment. Pages 309-318.*

A series of palladium based nanocatalysts which were loaded on CeO₂ doped alumina or clinoptilolite supports were synthesized by the ultrasonic assisted impregnation method. The influence of different ceria doped supports via total oxidation of toluene was investigated. Therefore, physiochemical properties of prepared nanocatalysts were evaluated by XRD, FESEM, BET and FTIR analyses. The FESEM images stated that synthesized naocatalysts had nanometric particles. The average size of catalyst particle was obtained to be 34.5 nm. BET analysis introduced a considerable rise in clinoptilolite surface area after treatment and demonstrated large surface area for Al₂O₃ and its composites. CeO₂ acts not only as a fine support due to its stability and surface area, but also had catalytic role because of its reducibility properties. Among synthesized catalysts, Pd/Al₂O₃-CeO₂ sample resulted the lowest particle size, highest surface area and consequently highest oxidation performance and stability.

- **Keywords:** Pd/CLT-CeO₂; Pd/Al₂O₃-CeO₂; Nanocatalysts; Toluene; Total oxidation; Air treatment