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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 complexion 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−1 and pH of 1.2, the removal rates of Zn2+, Fe3+, and Ca2+ 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

Guang Xu, Edmund C. Jong, Kray D. Luxbacher, Harold M. McNair. *Effective utilization of tracer gas in characterization of underground mine ventilation networks*. Pages 1-10.

Tracer gases are an effective method for assessing mine ventilation systems, especially when other techniques are impractical. Based on previously completed laboratory and field experiments, this paper discusses some common and challenging issues encountered when using tracer gases in underground mines. The discussion includes tracer release methods, sampling and analysis techniques. Additionally, the use of CFD to optimize the design of tracer gas experiments is also presented. Finally, guidelines and recommendations are provided on the use of tracer gases in the characterization of underground mine ventilation networks. This work has informed the practical use of tracer gases in mines, and this body of knowledge is expected to contribute to more efficient and more common use of tracer gases by mine engineers, which will allow for

better characterization of mine ventilation system and improved safety. The findings can also be used when using the tracer gas technique in the evaluation of atmospheric environment and air quality investigation in buildings.

- **Keywords:** Tracer gas; Underground mine ventilation; Gas chromatography; Evacuated gas sampler; CFD modeling; Experimental optimization

Samaneh Torbati. *Artificial neural network modeling of biotreatment of malachite green by Spirodela polyrhiza: Study of plant physiological responses and the dye biodegradation pathway*. Pages 11-19.

Phytoremediation is an environmental friendly and sustainable means of pollutant remediation through the use of plants. The ability of duckweed (Spirodela polyrhiza L.) for decolorization of malachite green was evaluated. Effect of some operational parameters such as initial plant biomass, the reaction time, initial dye concentration, pH and temperature on dye removal efficiency was determined. The importance of each parameter was assessed by artificial neural network (ANN) modeling and the plant initial biomass and pH were found to be the most important factors. The findings indicated that ANN provided reasonable predictive performance (R2 = 0.98). The metabolic fate of the dye was proposed by identification of 6 intermediate compounds produced during this process by GC–MS technique. Some physiological responses of the plant were studied at 10 and 20 mg/L of the dye. The activities of antioxidant enzymes were increased at high concentration of the contaminant but there was a significant decrease in photosynthetic pigments content at 20 mg/L of malachite green.

- **Keywords:** Phytoremediation; Duckweed; Malachite green; Wastewater biotreatment

Shahab Karimifard, Mohammad Reza Alavi Moghaddam. *Enhancing the adsorption performance of carbon nanotubes with a multistep functionalization method: Optimization of Reactive Blue 19 removal through response surface methodology*. Pages 20-29.

The main aim of present study was to enhance the adsorption capacity of Reactive Blue 19 (RB19) onto multi-walled carbon nanotubes (MWCNTs), pretreated in a multistep functionalization process. The functionalization procedure consisted of microwave irradiation followed by sonication in dilute H2SO4. The properties of MWCNTs were investigated by X-ray diffraction, scanning electron microscopy, N2 adsorption isotherms (Brunauer–Emmett–Teller surface area analysis), Raman spectroscopy and Fourier transform infrared spectroscopy. The effective addition of desired functional groups resulted in a considerable increase of dye removal efficiency and adsorption capacity. For pristine and functionalized MWCNTs, the maximum adsorption capacities were found to be 53.33 and 211.02 mg/g, respectively. In addition to the main aim of this research, a statistical/mathematical approach – response surface methodology – was utilized to simulate and determine the optimum conditions of RB19 removal by functionalized MWCNTs using three selected parameters (adsorbent dose, initial dye concentration and pH). High R2-value (97.75%) and a good agreement between predicted R2-value (89.11%) and adjusted R2-value (95.72%) demonstrated an acceptable proportion of the experimental and predicted results. For maximum RB19 removal efficiency, eight optimum scenarios were also obtained and validated by further experiments.

- **Keywords:** Adsorption; Carbon nanotubes; Functionalization; Optimization; Reactive dye removal; Response surface methodology (RSM)

Mardhati Zainal Abidin, Risza Rusli, Azmi Mohd Shariff, Faisal Irshad Khan. *Three-Stage ISD Matrix (TIM) Tool to Review the Impact of Inherently Safer Design Implementation*. Pages 30-42.

Inherently safer and friendlier plant design offers a simpler, cheaper, safer solution that consumes less energy, requires less maintenance, and produces less waste and pollution. It is a solution that the chemical industry needs to continually adopt in the years ahead. Nevertheless, obtaining an inherently safer process/technology with respect to all potential hazards is quite unfeasible and may lead to conflicts in the alternative process selection. To resolve safety conflicts, thorough understandings of all the hazards associated with the process options are vital. This paper presents a systematic screening procedure for reviewing inherently safer design alternatives using a combination of three-stage ISD matrix tool and guide word approach. The proposed methodology was applied to the ammonia supply system with the objective to understand the trade-off of inherent safety toward the overall process. The results show that the proposed tool is capable of helping users understand the impact of modification toward the safety and implementation cost.

- **Keywords:** Three-stage ISD matrix; Trade-off; ISD conflict; Qualitative ISD review; Systematic screening procedure; Inherent safety

K. Sahithya, Devlina Das, Nilanjana Das. *Adsorptive removal of monocrotophos from aqueous solution using biopolymer modified montmorillonite–CuO composites: Equilibrium, kinetic and thermodynamic studies*. Pages 43-54.

The present study is focused on the adsorptive removal of monocrotophos (MCP), an organophosphate insecticide onto biopolymer modified montmorillonite (MMT)–CuO composites viz. MMT–CuO–Chitosan (Ch), MMT–CuO–Gum ghatti (Gg), and MMT–CuO poly lactic acid (PLA). Optimization experiments were conducted by varying five parameters viz., pH (3–12), contact time (2–30 h), temperature (10–50 °C), initial MCP concentration (20–140 mg L−1) and composite dosage (5–25 g L−1). The removal of MCP followed the order: MMT–CuO–PLA (83.99%) > MMT–CuO–Ch (71.6%) > MMT–CuO–Gg (62.1%) > MMT–CuO (40.8%). Equilibrium and kinetic studies revealed a heterogenous and physical mode of adsorption with the highest adsorption capacity 212.23 mg g−1. This was further confirmed by SEM analysis. Intraparticle diffusion and Boyd plot suggested that film diffusion was not the sole rate limiting process. Thermodynamic studies confirmed the spontaneous and endothermic nature of the process. FTIR analysis confirmed the major involvement of amines and carboxyl groups during MCP adsorption. EDX analysis confirmed the major participation of carbon atom followed by CuO nanoparticles and Si in the process. AFM analysis confirmed the homogenous distribution of CuO nanoparticles on the surface of MMT–CuO–PLA which validated the potentiality of PLA modified MMT–CuO composite for the remediation of MCP from aqueous environment.

- **Keywords:** Adsorption; Chitosan (Ch); Gum ghatti (Gg); Monocrotophos (MCP); Montmorillonite (MMT); Poly-lactic acid (PLA)

Z. Ahmad, Dipesh S. Patle, G.P. Rangaiah. *Operator training simulator for biodiesel synthesis from waste cooking oil*. Pages 55-68.

In this study, an operator training simulator (OTS) has been developed for the homogeneously catalyzed two-step biodiesel production from waste cooking oil (WCO). Biodiesel from WCO leads to cheaper production and also protects the environment by utilizing WCO effectively and producing non-polluting biodiesel. Currently, many biodiesel producers use homogeneous catalyst for biodiesel production due to faster reaction and

moderate operating conditions. Process safety and efficient process operations require skilled operators. OTS is crucial in operators' training as on-job training is often costly, risky and incomplete. The developed standalone OTS has been investigated for a number of abnormal process scenarios. Each scenario can be inserted by an Instructor as and when it is desired. This study demonstrates the capability of a commonly used process simulator 'Aspen Plus Dynamics' (APD) and 'Aspen OTS Framework' in OTS development for the complex biodiesel process. Process model is developed in a modular fashion that facilitates easy addition or removal of any unit operation(s) in case of process modifications in the future.

- **Keywords:** Biodiesel; Waste cooking oil; Process safety; Operator training simulator; Aspen Plus Dynamics; Aspen OTS framework

Jiwan Singh, Byeong-Kyu Lee. *Kinetics and extraction of heavy metals resources from automobile shredder residue*. Pages 69-79.

Automobile shredder residue (ASR) has been considered as risky waste due to presence of high concentration of toxic metals, which can pose an environmental threat of being leached out under acidic conditions in the landfill. The present study investigated the extraction of Zn, Cu, Pb and Cd from ASR using water over a range of pH (2–8), temperature (25–55 °C), liquid/solid (L/S) ratio (10–100 mL g−1) and particle size (0.0–4.75 mm). The extraction kinetics of Zn, Cu, Pb and Cd from ASR using water were also analyzed by the shrinking core model (SCM) and second-order reaction model. The extraction rates of metals from ASR were improved by increasing different temperatures and liquid to solid ratios. A maximum extraction of metals was achieved at pH—2, temperature—25 °C and liquid to solid ratio—100 mL g−1. Metal extractions were not efficient at alkaline pH of water. The smallest size fraction of ASR was highly recommended for extraction of heavy metals rather than the larger fractions. The extraction data were best fitted (R2 ≥ 0.95) by the second order reaction model, but not by the SCM (R2 < 0.95).

- **Keywords:** ASR; Heavy metals; Kinetics; L/S ratio; pH; Temperature

Sirikan Maneesuwannarat, Alisa S. Vangnai, Mitsuo Yamashita, Paitip Thiravetyan. *Bioleaching of gallium from gallium arsenide by Cellulosimicrobium funkei and its application to semiconductor/electronic wastes*. Pages 80-87.

The aim of this work was to screen and characterize heterotrophic bacteria for gallium arsenide (GaAs) leaching. Ga in the form of GaAs has been extensively used as a semiconductor substrate material. The advantage of using microbes for gallium recovery is the fact that this method is a safer, environment-friendly and includes energy-saving processes, which can leach metals at relatively low concentrations. Eight bacterial isolates were isolated from cadmium-, and arsenic-contaminated soil in the presence of GaAs. Pad I and NKS III showed the highest efficiency in Ga leaching at approximately 63–81% after 15 and 30 days, respectively. The analysis of 16S rDNA sequences indicated that strain Pad I was close to strain NKS III; it was characterized and identified as Cellulosimicrobium funkei (C. funkei). Further investigation revealed that the ability of Ga leaching from GaAs by this bacterium involved amino acids. This process occurred in a weak base pH range. The results show a potential application of C. funkei to leach Ga from semiconductors or electronic wastes. The in-depth mechanism of bacterial leaching of Ga from GaAs was also investigated.

- **Keywords:** Cellulosimicrobium funkei; Gallium arsenide; Semiconductor; Bioleaching; Electronic waste

Jiwan Singh, Kuduru Janardhan Reddy, Yoon-Young Chang, Seon-Hong Kang, Jae-Kyu Yang. *A novel reutilization method for automobile shredder residue as an adsorbent for the removal of methylene blue: Mechanisms and heavy metal recovery using an ultrasonically assisted acid*. Pages 88-97.

This study investigates the recovery of heavy metals (Zn, Cu, Mn, Fe, Ni, Pb and Cr) from automobile shredder residue (ASR) using an ultrasound-assisted acid. The discovered recovery efficiencies of the metals were in the following order: Zn (98.1%) > Ni (92.8%) > Mn (87.4%) > Cu (84.1%) > Pb (80.2%) > Cr (80.1%) > Fe (19.9%). The residue after the extraction of heavy metals was used to remove methylene blue (MB) from an aqueous solution. The chemical characteristics of the surface of the adsorbent were examined through X-ray diffraction, Fourier transform infrared spectroscopy (FT-IR), and point-of-zero charge determination. The adsorption kinetics of MB on the ultrasonically treated ASR (UTASR) with respect to the initial dye concentration, pH, adsorbent dose and temperature were investigated. The adsorption of MB on UTASR was assessed on the basis of equilibrium and kinetic studies. The adsorption kinetic data was well fitted to a pseudo-second order kinetic model. Equilibrium isotherms were analyzed by Langmuir and Freundlich isotherms. The Langmuir isotherm was found to be a better fit of the MB adsorption data. Ultrasound with nitric acid had a synergistic effect when it was used to extract heavy metals from ASR.

- **Keywords:** Ultrasound; Automobile shredder residue; Metals recovery; Adsorption; Methylene blue; Mechanism

C.S. Gomes, J.S. Piccin, M. Gutterres. *Optimizing adsorption parameters in tannery-dye-containing effluent treatment with leather shaving waste*. Pages 98-106.

In the dyeing step in tanneries, it is necessary to add dyes till the fibrous texture of leather is deeply colored. That results in colored wastewater, which complicates the wastewater treatment. Adsorption is an advanced treatment operation that can increase the final wastewater quality. In this study, solid waste from tanneries, i.e., chromium-tanned leather shaving waste, was used as the adsorbent to treat dye-containing effluents generated through a wet end process, carried out in a pilot-scale tannery drum to investigate the possibility of using this technique as pretreatment in the wastewater process. Adsorption trials were conducted in laboratory-scale tannery drums to recreate the tannery conditions. Multiresponse optimization was used to optimize the adsorption parameters. Plackett–Burman factorial design was used to initially eliminate some factors from the seven selected important parameters: adsorbent concentration, pH, temperature, dye concentration, rotation speed, time, and particle size. Four important factors were selected: adsorbent concentration, pH, dye concentration, and rotation speed. Thereafter, a central composite rotatable design (CCRD) experiment was performed with desirability functions to achieve the optimal conditions, and to determine the maximum adsorption capacity at equilibrium (qe) and dye removal (R). The optimized responses were determined to be R = 87.37% and qe = 24.74 mg g−1. Finally, a confirmation study was executed in pilot-scale by using optimized levels of parameters which showed well response to the predicted model.

- **Keywords:** Wastewater treatment; Tannery dye; Adsorption; Hazardous waste; Desirability function; Optimization

P. Baltrėnas, A. Chlebnikovas. *Investigation into a new generation multi-channel cyclone used for removing lignin particulate matter from gas under conditions of an aggressive environment*. Pages 107-119.

A multichannel cyclone is new generation air treatment equipment that can remove fine stiff particles of up to 2 μm from air flow and reach the general effectiveness of 95%. The carried out research is aimed at establishing parameters for the dynamics of the gas–vapour two-phase flow in the cyclone and treatment efficiency removing stiff lignin particulate matter, i.e. under the increased humidity and temperature of the purified flow. The article describes the peculiarities of parameters for the cyclone—separator and analyses the results of the cyclones having different inner structures under conditions of an aggressive environment. The flow polluted with lignin particulate matter has been treated under simulation conditions in the laboratory, at the gas flow temperature of 28–30 °C and gas flow humidity of 85–95%. Under an average vapour-PM flow velocity of 12 m/s in the cyclone polluted with ultra-dispersive 20 μm lignin particulate matter and conditions of the aggressive environment, treatment efficiency equals 82.5%.

- **Keywords:** Cyclone; Particulate matter; Aggressive environment; Humidity; Aerodynamic; Efficiency

Somayeh Sohrabi, Faranak Akhlaghian. *Modeling and optimization of phenol degradation over copper-doped titanium dioxide photocatalyst using response surface methodology*. Pages 120-128.

In this research paper, Box–Behnken design (BBD) combined with response surface methodology (RSM) has been applied to optimize phenol photocatalytic degradation. In this process, nano-structured copper-doped titanium dioxide was used as the photocatalyst. The experiments were conducted in the presence of H2O2 and under the UV irradiation. The operational factors were initial phenol concentration, reaction time, and Cu/TiO2 dosage. The effects of process variables as well as their binary interactions were modeled. High values of the determined R2 coefficients of the model (>0.99) confirm that the proposed equation fits the experimental data accurately. The fundamental objective of this work was to determine the most important parameter of the mentioned process. The ANOVA results enunciated that the significance of the parameters is as follows (the most to the least significant): Cu/TiO2 dosage > time > initial phenol concentration.

- **Keywords:** Cu/TiO2 photocatalyst; Degradation; Modeling; Experimental design; Optimization; RSM

Ozge Turkay, Sibel Barisci, Anatoli Dimoglo. *Assessment of parameters influencing the electro activated water character and explanation of process mechanism*. Pages 129-136.

The physicochemical properties of electro activated water (EAW) are highly affected by process conditions. In this context, the effects of parameters such as brine concentration, electrolysis time and current for EAW generation have been investigated using Response Surface Methodology (RSM). The predictive model for each response had high accuracy relative to R2 values, namely, 0.85 for the oxidation reduction potential (ORP) and 0.94 for the free chlorine concentration (FCC). According to results, the brine concentration was the most significant factor that affected EAW character. Moreover, electrolysis time and brine concentration have synergetic effect on FCC. The mechanism of the EAW production was evaluated through the cyclic voltammogram (CV) of different brine concentrations on the graphite electrode. With the concentration increased anodic and cathodic peaks could be observed notably. Possible reaction pathways were evaluated on the cathode and anode sides. The formation of Cl2, O2, H2, Cl−, OH−, H+ were determined by CV measurements.

- **Keywords:** Electro activated water; Free chlorine; Response surface methodology; Cyclic voltammetry; Anolyte; Catholyte

M. Suffo, E. Neboť. *Proximity as an integral factor in the evaluation of the territorial risk under the European Seveso Directive: Application in Andalusia (South Spain)*. Pages 137-148.

In this work, a geostatistical analysis of multivariate character is performed, which is based on the distance between establishments affected by the European Seveso Directive and the type of vulnerable receptors categorized as human, environmental or material. This study reinforces the importance of including the value of proximity, besides others already known and used, such as dangerousness, vulnerability and probability/frequency, in the evaluation of the chemical and environmental risk or simply in the evaluation of territorial compatibility. Data used in the study were a sample taken in the region of Andalusia (Southern Spain) during the year 2013. Likewise, based on the descriptive tables of frequencies, in terms of average proximities, a double ranking of territorial compatibility is provided for the land use and planning (LUP), which affects to establishments, dangerous substances and vulnerable receptors. The multivariate analysis based on the projection on a factorial plane of the correspondences reveals hidden relationships of proximity between vulnerable receptors and their relationship with the territorial strata, in a simple and intuitive way. Results obtained here suggest that the methodology can be extrapolated to any other study area, taking into account their particular environmental conditions.

- **Keywords:** Proximity; Territorial-compatibility; Vulnerable receptors; Chemical risk; Correspondence-analysis; Seveso Directive

Amin Nawahda. *An assessment of adding value of traffic information and other attributes as part of its classifiers in a data mining tool set for predicting surface ozone levels*. Pages 149-158.

This study seeks to examine to what extent traffic information can improve the prediction of surface ozone levels from mobile sources when coupled with a state of the art air quality monitoring system and the application of data mining tools. For the purpose of the experiment an open-path Deferential Optical Absorption Spectroscopy (DOAS) instrument is used and 10 min video samples obtained from Sohar's main highway (SHW) (Sultanate of Oman). This traffic information is collated to recognize, classify, and count three types of vehicles passenger car; light duty vehicle; and heavy duty vehicle. The DOAS is deployed to measure the following gases; ambient nitrogen dioxide (NO2); ozone (O3); sulfur dioxide (SO2); and BTX (benzene, toluene, xylene) across SHW. The ambient concentrations of these gases are measured in situ at time resolutions that vary from 30 s to 1 min along with simultaneous measurements of meteorological parameters. The Waikato Environment for Knowledge Analysis (WEKA) (Witten and Frank, 2005) software was used for the data mining part of the study. To identify which classifiers in WEKA would be the most suitable in predicting surface O3 levels the following five indexes were used: correlation coefficient (CC); mean absolute error (MAE); root mean square error (RMSE); relative absolute error (RAE); and root relative squared error (RRSE). It was found that the Bagging and M5P classifiers were the most robust when compared to others within the software when measured against the fives indexes. It was identified that with the additions of time and day of the week as well as changing of the parameters as part of the classifiers in WEKA the robustness of the predictions was not enhanced significantly. However, the findings did illustrate that the analysis of traffic information does improve the robustness of the prediction of surface O3 levels.

- **Keywords:** Ozone; Bagging; DOAS; Prediction; Traffic; Sohar

Kakasaheb Y. Nandiwale, Vijay V. Bokade. *Optimization by Box–Behnken experimental design for synthesis of n-hexyl levulinate biolubricant over*

***hierarchical H-ZSM-5: An effort towards agricultural waste minimization*. Pages 159-166.**

The present study is devoted to develop efficient catalytic process for conversion of agricultural waste feedstock to value added chemicals. In this context, the n-hexyl levulinate, a renewable biolubricant was synthesized by esterification of biomass derived levulinic acid (LA) with n-hexanol in a closed batch system. Hierarchical-HZ-5 (modified H-ZSM-5) was used as a heterogeneous acid catalyst. There are no reports available on the synthesis of n-hexyl levulinate biolubricant using renewable levulinic acid. The process variables such as catalyst to LA ratio (X1), n-hexanol to LA molar ratio (X2), reaction time (X3) and reaction temperature (X4) were optimized by response surface methodology (RSM), using the Box–Behnken model. Analysis of variance was done to check the suitability and significance of the quadratic model. The yield of n-hexyl levulinate obtained was 97% with 100% selectivity at optimum process parameters. The RSM analysis predicted that catalyst to LA ratio is most significant (value of p < 0.0001) and n-hexanol to LA molar ratio is least significant (value of p = 0.0064) process parameter in esterification. The quadratic model established was revealed to be suitable and statistically precise with correlation value (R2) of 0.9837 to predict the yield of n-hexyl levulinate.

- **Keywords:** Agricultural waste feedstock; Esterification; Hierarchical-HZ-5; n-Hexyl levulinate; Optimization; Response surface methodology

Orlando J. Ugarte, V'yacheslav Akkerman, Ali S. Rangwala. *A computational platform for gas explosion venting*. Pages 167-174.

Explosions occurring in enclosures can be found in many technological applications such as internal combustion engines and typical chambers contacting combustibles. However, it is also possible to reach these events in facilities and buildings because of the leakage of a flammable gas, with usually devastating consequences. In this respect, vents are designed to relief the explosion-associated overpressures by allowing part of the fuel mixture gas to evacuate as the flame propagates. In the present work, a computational model is developed to analyse such vented explosion scenarios. The model solves the corresponding governing equations in a single-zone approximation, including the external explosion produced once the vented mixture is ignited by the expanding flame, to calculate the attained overpressures in relation to the domain geometry and burning conditions. A parametric study is performed varying the container dimensions and shapes, given by cuboids and cylinders with central and rear ignition locations, as well as the concentrations of a hydrogen-air fuel mixture. Moreover, different flame velocity expressions are employed to account for a variety of effects influencing the flame dynamics. A mitigating effect of the vent on the enclosure explosion intensity is demonstrated, thereby relating the different conditions to the attained burning regime, essential for the establishment of safety considerations in these partially confined enclosures.

- **Keywords:** Vented explosions; Enclosures; External explosion; Hydrogen; Overpressures

Shahram Nekouei, Farzin Nekouei, Inderjeet Tyagi, Shilpi Agarwal, Vinod Kumar Gupta. *Mixed cloud point/solid phase extraction of lead(II) and cadmium(II) in water samples using modified-ZnO nanopowders*. Pages 175-185.

The extraction of trace amounts of Pb(II) and Cd(II) using dispersed ZnO nanopowders functionalized by chelating reagent 4,4'-[(4-Fluorophenyl)methylene]bis(3-methyl-1-phenyl-1H-pyrazol-5-ol) (FMBM) as a novel sorbent has been reported. The impact of pH,

adsorbent concentration, non-ionic surfactant, eluting solution, incubation time, equilibration temperature, sample volume and interfering ions on analytical performances was elucidated and investigated. Under optimal experimental conditions, the limit of detections (LOD) were found to be 0.15 and 0.21 μg L−1 for Pb(II) and Cd(II), respectively. The developed method, validated with certified reference materials (CRM), was successfully used in determining the concentrations of the two metal ions in various water samples.

- **Keywords:** Combined solid phase; Cloud point extraction; Pb(II) and Cd(II); ZnO nanopowders; Flame atomic absorption spectrometry

Jae-Young Lee, Tae-Soon Kwon, Ji-Yeon Park, Saehae Choi, Eui Jin Kim, Hyun Uk Lee, Young-Chul Lee. *Electrokinetic (EK) removal of soil co-contaminated with petroleum oils and heavy metals in three-dimensional (3D) small-scale reactor*. Pages 186-193.

Electrokinetic (EK) soil remediation is a known powerful technology for decontamination of organic and inorganic pollutants or their combination. Classically, one- and two-dimensional (1D and 2D) EK cells have been utilized for remediation of a variety of co-contaminated soils. Preparatory to scale up or practical EK applications, in the present study, three-dimensional small-scale (3D) EK cells on the batch scale were tested for remediation of petroleum-oil- and heavy-metals co-contaminated soil. In the results, with 0.10 M KH2PO4 as the anolyte for 21 days, removal efficiencies of better than 95% of TPH, more than 50% of As species and ~20% of Cu species were achieved, though the removal of the Pb and Zn species was relatively inefficient, at less than 20%. Currently, new electrolyte designs and a scaled-up EK cell operation are being planned for obtainment of data on real-soil-remediation feasibility.

- **Keywords:** Three-dimensional (3D) small-scale; Electrokinetic (EK); Co-contamination; Petroleum oils; Heavy metals; Soil remediation

Ulker Asli Guler, Mehtap Ersan, Eliza Tuncel, Feride Dügenci. *Mono and simultaneous removal of crystal violet and safranin dyes from aqueous solutions by HDTMA-modified Spirulina sp*. Pages 194-206.

The process of mono and binary removal of crystal violet and safranin dyes by Spirulina sp. (blue-green algae) modified with cationic surfactant is evaluated. The surfactant used was hexadecyltrimethylammonium bromide (HDTMA). Spirulina sp. was cultivated in Zarrouk's medium. The adsorptive properties of the modified Spirulina sp. (HDTMA-algae) were tested as a function of pH (2–10), contact time (5–180 min), temperature (25–45 °C), and initial dye concentrations (25–300 mg/L) and characterized with FTIR, SEM, EDX, XRD and BET analyses. The specific surface area of HDTMA-algae was 0.1990 m2/g. The data were fitted to non-linear Langmuir, Freundlich, and Dubinin–Radushkevich (D–R) isotherm models and non linear pseudo-first-order and pseudo-second-order kinetic models. The adsorption was 75% and 88% at pH 2 for Crystal Violet and Safranin dye, respectively. The maximum adsorption capacities were 101.87 mg/g and 54.05 mg/g and the kF values were 0.96 L/g and 3.56 L/g for Crystal Violet and Safranin, respectively. The kinetics of Crystal Violet and Safranin dyes onto HDTMA-algae were best described by the pseudo-second-order kinetic model. The negative values of free energy and enthalpy change indicated the feasibility, spontaneity, and exothermic nature of the adsorption process. Also, binary adsorption of Crystal Violet and Safranin dyes onto HDTMA-algae from binary dye mixtures is compared.

- **Keywords:** Adsorption; Algae; Surfactant; Dye; Characterization

S. Kavitha, P.B.Catherin Stella, S. Kaliappan, Ick Tae Yeom, J. Rajesh Banu. *Enhancement of anaerobic degradation of sludge biomass through surfactant-assisted bacterial hydrolysis*. Pages 207-215.

In the present paper, the study focuses on the effects of sodium dodecyl sulfate (SDS) surfactant on the release of extracellular polymeric substance (EPS) followed by pretreatment with a thermophilic protease-secreting bacterial strain on WAS (waste activated sludge). This in turn enhanced the subsequent anaerobic biodegradability. The extracellular polymeric substances were released using SDS (0.03 g/g SS of dosage) to stimulate the bacterial pretreatment. The thermophilic bacterial pretreatment results indicated that deflocculated (EPS released with SDS and pretreated with bacteria) sludge showed higher Suspended Solids (SS) reduction of about 27% and Chemical Oxygen Demand (COD) solubilization of about 24%, whereas flocculated (pretreated with bacteria alone) showed SS reduction of about 18% and COD solubilization of about 16%. The biogas production potential of deflocculated, flocculated, and raw (untreated) samples was found to be 2.5211 L/(gVS), 1.7677 L/(gVS), and 0.6140 L/(gVS), respectively. As a result, the EPS release followed by disintegration of sludge by bacteria enhanced the biogas production.

- **Keywords:** Suspended solids; Sodium dodecyl sulfate; Bacterial pretreatment; Thermophilic protease; Chemical oxygen demand; Enzyme activity

H. Harfouchi, D. Hank, A. Hellal. *Response surface methodology for the elimination of humic substances from water by coagulation using powdered Saddled sea bream scale as coagulant-aid*. Pages 216-226.

Removal of organic substances from water by coagulation with alum and ferric salts were studied by means of conventional jar-test procedures. The novelty of this work is the use of powdered Saddled sea bream scale as coagulant-aid for enhancing the coagulation process with a low concentration of alum (Al2(SO4)3·18H2O). Performance of usual coagulation process depends on the chemical structure of organic components as phenol (PHL), salicylic acid (SA), phthalic acid (PHA) and humic substances (HS), their initial concentrations, coagulant dose, pH medium, and other operational conditions. The response surface methodology (RSM) was applied to optimize the coagulation process for the elimination of humic substances from water. Initial HS concentration, alum dose, rapid and slow mixing speed, powdered fish scales (PFS) mass and pH were the factors considered in the design. A quadratic model was developed to express the removal efficiency of HS (response Y) as function of the six parameters. The high values of R2 and R2 adjusted coefficients verify a good correlation between the observed and the predicted response values.

- **Keywords:** Coagulation; Coagulant-aid; Humic substance; Powdered Saddled sea bream scale; Response surface methodology (RSM); Natural organic matter

Abdul Raman Abdul Aziz, P. Asaithambi, Wan Mohd Ashri Bin Wan Daud. *Combination of electrocoagulation with advanced oxidation processes for the treatment of distillery industrial effluent*. Pages 227-235.

The treatment of distillery industrial effluent by means various combinations of electrocoagulation with Advanced Oxidation Processes (AOPs) such as ozonation, electrocoagulation, peroxi–electrocoagulation, photo–electrocoagulation, ozone–electrocoagulation and peroxi–photo–electrocoagulation process on the removal of percentage color, COD and energy consumption. The effects of various operating parameters such as ozone flow rate (5 to 15 LPM), initial effluent pH (2 to 10), current density (0.10 to 0.50 A/dm2) and H2O2 concentration (50 to 500 mg/L) on the removal of pollutant were studied in this study. Moreover comparison of all the processes in terms

of color removal, COD removal and energy consumption was also carried out. The experimental results showed that100% of color and COD removal could be achieved by ozone–electrocoagulation process with an energy consumption of 5.7 kW h/m3 within four hours of reaction time. The extent of color and COD removal was analyzed using a UV/vis spectrophotometer and closed reflux method.

- **Keywords:** Electrocoagulation; Distillery effluent; Ozonation; Photo; Color and COD removal; Power consumption

Khalid AL Nabhani, Faisal Khan, Ming Yang. *Technologically Enhanced Naturally Occurring Radioactive Materials in oil and gas production: A silent killer*. Pages 237-247.

This paper reviews the literature that identifies Naturally Occurring Radioactive Materials (NORM) in oil and gas production. It further explains how processes associated with the recovery of oil and gas enhances NORM'S concentration and also develops Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM). It redefines TENORM from technical and scientific perspectives and explains how spectral gamma ray logging technology helps to prove the presence of NORM as an indication of oil and gas presence. This article provides a better understanding of TENORM waste disposal practices that poses serious health and environmental risks. It makes a strong argument for the importance of TENORM risk assessment and management through process safety approaches. Finally, it identifies the knowledge and technical gaps related to TENORM in oil and gas production, which require further studies and research.

- **Keywords:** TENORM; Radionuclide; Nuclear; Geochemistry; Risk assessment