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Yue Cui, Xiaojing Shi, Chao Guang, Zhishan Zhang, Chao Wang, Chen Wang. *Comparison of pressure-swing distillation and heterogeneous azeotropic distillation for recovering benzene and isopropanol from wastewater*. Pages 1-12.

Two methods of pressure-swing distillation (PSD) and heterogeneous azeotropic distillation (HAD) are investigated to recover benzene and isopropanol from wastewater. This ternary mixture can form two homogenous azeotropes (binary) and two heterogeneous azeotropes (binary and ternary), which all are sensitive to pressure. The proposed configurations are rigorously simulated and optimized based on the minimum total annual cost (TAC) via the sequential iterative procedure, and meanwhile the partial heat integration is taken into account respectively. The results show that both configurations of PSD are superior to the HAD configuration combining with PSD from the perspectives of economic and energy.

- **Keywords:** Pressure-swing distillation; Heterogeneous azeotropic distillation; Wastewater; Benzene; Isopropanol; Heat-intergration

Kai Wang, Chaonan Ding, Shuguang Jiang, Wu Zhengyan, Hao Shao, Weiqing Zhang. *Application of the addition of ionic liquids using a complex wetting agent to enhance dust control efficiency during coal mining*. Pages 13-22.

This study investigates the effects of a compound method that involves the use of anionic, cationic and nonionic surfactants. The compound composition of the isotropic ionic and compound across of the anisotropy ionic process was proposed. An ionic liquid was introduced as an auxiliary agent to improve wetting characteristics of the mixture, resulting in a compound of wetting agent A~I. Wetting agent A and E were selected because they were more effective than others by the capillary rise method. The contact angle on Da Ning coal sample was tested. For droplets of pure water, the contact angle was 72.1°. For droplets of wetting agent A, the contact angle was 23.5°. For droplets of wetting agent E, the contact angle was 14.4°. The effect of wetting ability for the wetting agents were analyzed, and four other coal sample test results were compared. In order to test the application effect of the wetting agents. The high-pressure spray system were analyzed and developed, an adjustable nozzle and wind scooper were designed with a secondary atomization function, which improved the ability to capture dust. The application results showed that the ionic liquid improved the dust effect. The atomization

effect of the circular nozzle was better than that of ellipse nozzle. When wetting agent E was added, the dust efficiency reached 90%, and the respiratory dust efficiency reached 87%. The new spray system consumes 30% less water than a traditional system, produces smaller droplets, and achieves higher dust control efficiency.

- **Keywords:** Compound method; Ionic liquid; Wetting agent; Dust capture; Secondary atomizing nozzle

Feng Li, Wenhe Wang, Jiang Xu, Jun Yi, Qingsheng Wang. *Comparative study on vulnerability assessment for urban buried gas pipeline network based on SVM and ANN methods*. Pages 23-32.

Vulnerability assessment is an effective way to identify systemic weaknesses, thus to provide scientific guidance to make management decisions and avoid potential accidents. Support Vector Machine (SVM) and Artificial Neural Network (ANN) have shown great superiority on vulnerability assessment in many fields. However, their applications on the relationship analysis between the state features of urban buried gas pipeline network and the corresponding vulnerability level have not yet been reported. This paper proposed a uniform framework of the novel application of SVM and ANN methods to vulnerability assessment of urban buried gas pipeline network, and performed a comparison between these two methods on various aspects. The analysis methodology follows a four-stage procedure. First, various indexes influencing vulnerability are selected and quantified for further data generation process, by which enough training and validation samples are obtained. The architecture, essential algorithms and optimized parameters for the application of these two methods are determined by the next process of model selection. The model selection phase for ANN is far more complex than that for SVM, which makes it easy for ANN to come to over-fitting. The third stage is to train SVM and ANN on the training set and to evaluate the performance on the executions of the validation set. The results show that the training outputs of SVM (MSE = 2.74E-4) are better fitted with the desired outputs than that of ANN (MSE = 1.92E-2). The SVM model (SMAPE = 0.79%) is able to output satisfying values when applied to unknown samples and is more accurate than the ANN model (SMAPE = 8.64%) in prediction. Finally, a sample gas pipeline network was used to demonstrate the feasibility and practicability of these two models, where the results are similar and consistent with the reality. The proposed methods can be used in practical applications to support better safety management.

- **Keywords:** Gas pipeline network; Vulnerability assessment; Risk management; Support vector machine (SVM); Artificial neural network (ANN)

Frank Huess Hedlund, Jan Boier Pedersen, Gürkan Sin, Frits G. Garde, Eva K. Kragh, Jérôme Frutiger. *Puncture of an import gasoline pipeline—Spray effects may evaporate more fuel than a Buncefield-type tank overfill event*. Pages 33-47.

This paper is concerned with evaporation of moderately volatile liquids, gasoline in particular, due to spray generation, liquid fragmentation and fountain effects following accidental puncture of a pressurized pipeline. Hazard analysis predicts that extensive evaporation will take place. The paper examines a typical fuel depot receiving gasoline from a ship at a nearby port via an above-ground pipeline. For comparative purposes, two types of accidental release during import are considered: 1) The receiving tank overflows in a worst-case Buncefield-type event (baseline). 2) The import pipeline is punctured and a jet of liquid discharges upwards. The paper examines pipeline import of three substances, hexane, octane and winter gasoline. Hazard analysis using the PHAST software suite indicates that the amount of fuel evaporated from the pipeline puncture scenarios greatly exceeds the amount evaporated in a tank overfill event for all three substances, gasoline in particular. Proper modelling of evaporation of wide-range multi-

component mixtures such as gasoline is challenging however. PHAST's simplified thermodynamic modelling of properties of mixtures may be a source of error. A PHAST-based stand-alone spray evaporation model with advanced thermodynamic capability is developed. Results indicate that PHAST does indeed overestimate evaporation of mixtures. Still, model output shows that evaporation following pipeline puncture may exceed the evaporation from a Buncefield-type tank overfill event by a factor of two or more. This finding is significant as evaporation from pipeline puncture scenarios appear largely overlooked in hazard analysis. The finding may lead to a fundamental re-appraisal of the hazard potential of fuel depots and pipelines.

- **Keywords:** Major accident hazard; Onshore pipelines; Spray release; Consequence models; Fuel depot; Worst design event

Mohsen Haghighi, Farhad Rahmani, Fatemeh Kariminejad, Rojiar Akbari Sene. *Photodegradation of lignin from pulp and paper mill effluent using TiO2/PS composite under UV-LED radiation: Optimization, toxicity assessment and reusability study*. Pages 48-57.

In the present study, the photodegradation of lignin was studied using TiO2/Polystyrene composite under UV-LED irradiation in a batch-recirculated photoreactor as a supplementary treatment for pulp and paper industries. TiO2/PS composite was synthesized by the solvent-casting method and was characterized by scanning electron microscopy (SEM) and EDX analysis. The 3-level, 3-factor Box-Behnken design was applied to study the effects of main operating parameters and optimization of process circumstances. Besides, COD reduction efficiency, toxicity assays, and reusability were also investigated. The predicted model had R2 and R2adj correlation coefficients of 0.97 and 0.99 respectively, which showed experimental results were very close to the predicted values. Furthermore, under the optimal conditions (reaction time = 72.5, volumetric flow rate = 230 mL/min and lignin = 51.8 mg/L) the lignin degradation efficiency was 93.98%. The maximum COD removal (89%) obtained by 250 mL/min volumetric flow rate and lignin concentration of 50 mg/L after 120 min reaction time. Bioassay using D. Magna exhibited that at the beginning of the process, the toxicity of solution increased but continuously decreasing after then to very low values achieved within 120 min of photodegradation. In addition, the reusability tests demonstrated that the TiO2/PS composite after 5 cycles has a good stability and photocatalytic activity.

- **Keywords:** Optimization; Photocatalytic process; Lignin; Toxicity; Polystyrene; Immobilized TiO2; Reusability

Daniele Perondi, Danielle Restelatto, Christian Manera, Marcelo Godinho, Ademir José Zattera, Antônio Cezar Faria Vilela. *The role of CaO and its influence on chlorine during the thermochemical conversion of shredder residue*. Pages 58-67.

Different wastes are generated by the steel industry, among them the shredder residue (SR). The main source of chlorine in SR is the polyvinyl chloride (PVC), which makes the use of this residue in a thermochemical process a great challenge. In this context, the addition of CaO in the pyrolysis process can decrease the release of acid gases, especially HCl. The objective of this work was to evaluate the role of CaO and its influence on Chlorine during the thermochemical conversion of SR. A fixed-bed pyrolysis reactor was used and the following variables were evaluated using a 2k factorial design: temperature, heating rate, inert gas flow (N2) and CaO/SR ratio. The chlorine retention in char was higher in the experiments conducted in the presence of CaO. A decrease of the metals retention in char was verified in the experiments conducted with CaO for the following metals: Co, Cu, Cr, Fe, Ni and Zn. Through the removal of chlorine, it would be possible to conduct the pyrolysis process at higher temperatures, increasing its energy efficiency

(EE). Therefore, the necessity to remove chlorine from SR before the pyrolysis process is evidenced, since from this the use of CaO would contribute to the EE increase and the metals retention in char, and consequently with the global desirability increase.

- **Keywords:** Shredder residue; Thermochemical conversion; Chlorine and CaO

Adeola Akeem Akinpelu, Md Eaqub Ali, Mohd Rafie Johan, R. Saidur, Muhamed Ali Qurban, Tawfik A. Saleh. *Polycyclic aromatic hydrocarbons extraction and removal from wastewater by carbon nanotubes: A review of the current technologies, challenges and prospects*. Pages 68-82.

Polycyclic aromatic hydrocarbons (PAHs) that increasingly emanating from natural and human activity sources are invisible pollutants and the presence of even minute amounts of these substances makes them undesirable due to their negative attributes. The PAHs extraction and removal from effluents are major steps for analysis and removal. Chemical, biological and physical approaches are used for the removal of PAHs from wastewater. However, some of these techniques have toxic by-products. Currently, physical approaches such as liquid-liquid solvent extraction, filtration, and adsorption appear to be the best methods due to their safety, affordability, universal nature and ease of operation. However, some of the materials used in the currently available physical methods face the challenges of fouling, low recovery, their relatively long extraction time and high usage of toxic solvent. To overcome these limitations, and for the cleaner production of water, the incorporation of carbon nanotubes (CNTs) into existing physical procedures without distorting their existing structural architectures is proposed. CNTs are considered because hydrophobic hollow pores of CNTs absorb most aromatic pollutants while allowing the friction-free passage of water without consuming much energy. The functionalization of CNTs with various receptors and groups further permit the selective trapping of pollutants of interest. The ability of the proposed methods to cheaply and sustainably remove PAHs from contaminated water will make hitherto carcinogenic polluted water cleaner for public consumption. This comprehensive article presents an extensive literature review of CNTs and their use for various physical techniques. It further presents CNT as a central focus, with an in-depth critical analysis of the state-of-the-art trends of PAH removal using CNTs, current hurdles and future challenges, so that it could be used as a reference manual adding scientific value for developing any future methods for water purification and the removal of any aromatic pollutants.

- **Keywords:** Ultrafiltration; Nanofiltration; Forward osmosis; Reverse osmosis; Polyaromatic hydrocarbon

T. Poznyak, I. Chairez, A. Poznyak. *Output-based modeling of catalytic ozonation by differential neural networks with discontinuous learning law*. Pages 83-93.

The aim of this study was to develop an adaptive state estimator with discontinuous parameter adjustment law for the catalytic ozonation system. A nonlinear transformation defined an equivalent system presented in chain-of-integrators form with uncertain structure in the dynamics of the last state. A step-by-step state estimator using a sequence of super-twisting algorithms (STAs) estimated the unmeasured states of the uncertain system. A class of differential neural network (DNN) with discontinuous learning law served to estimate the uncertain section of the catalytic process. The learning method was developed by implementing a strong lower-semi-continuous Lyapunov function. The method used to generate the laws that adjusted the weights, also yields the estimation of the parameters included in the catalytic ozonation system. A set of numerical simulations demonstrated the application of the DNN-based state observer to solve the estimation of the non-measurable information in the catalytic

ozonation system. The available output signal was the concentration of the ozone gas at the output of the reactor. This was the only information used by the observer. The state estimator with discontinuous learning laws was also evaluated with experimental information obtained by a catalytic ozonation system using NiO as catalyst and phtalic acid as model contaminant. The effect of aggregating the DNN in the observer structure was compared with the observer using only the sequence of STA. The superior performance of the observer developed in this study was confirmed by evaluating the mean square error of the identification error.

- **Keywords:** Non-parametric modelling; Neural networks; Catalytic ozonation; Adaptive observer; Discontinuous learning laws

Carlos Amor, Jorge Rodríguez-Chueca, Joana L. Fernandes, Joaquín R. Domínguez, Marco S. Lucas, José A. Peres. *Winery wastewater treatment by sulphate radical based-advanced oxidation processes (SR-AOP): Thermally vs UV-assisted persulphate activation*. Pages 94-101.

Winery wastewater is characterized by the presence of organic and inorganic contaminants with significant environmental impact if released without proper treatment. Thus, the application of sulphate radical-based advanced oxidation processes (SR-AOP) in winery wastewater treatment, with emphasis on the removal of organic matter, has been investigated. Several experiments were performed to assess the influence of temperature, UV-C radiation and transition metals in the thermal and photolytic/photocatalytic activation of sodium persulphate. COD removal was higher in the UV-C/S2O82- process than in the heat/S2O82- using an initial COD concentration of 600 mg O2 L-1. After a reaction time of 90 min (at pH = 7.0), using 15 mM of S2O82- driven by a UV-C lamp allowed achieving 59% of COD removal while the heat/S2O82- process attained a removal of only 41%. Afterwards, combining the thermal activation with transition metals, and using the optimal operational conditions ([S2O82-]/[Cu2+] = 1, pH = 7.0 and 90 min of reaction time), 61% of COD removal was obtained. Additional experiments with higher S2O82- concentrations and longer reaction time led to 96% and 71% of COD and TOC removal, respectively. To attain this target was used 25 mM of S2O82-, at pH 7.0 during a reaction time of 240 min. This removal rate proved to be higher than the achieved with hydroxyl radical-based advanced oxidation processes (HR-AOPs). Under the same optimal conditions, using 25 mM of H2O2 achieved 22% of COD removal and UV-C/Fe2+/H2O2 experiments obtained 48%. Overall, SR-AOP experiments, particularly UV-C assisted processes, have proven to be very effective in COD removal and can be seen as a promising technology to use in winery wastewater treatment.

- **Keywords:** Advanced Oxidation Processes; winery wastewater; persulphate; thermal activation; SR-AOPs; UV radiation

José J.N. Alves, Antônio T.P. Neto, Antônio C.B. Araújo, Heleno B. Silva, Sidinei K. Silva, Claudemi A. Nascimento, Aurélio M. Luiz. *Overview and experimental verification of models to classify hazardous areas*. Pages 102-117.

The extent of a hazardous area is the distance over which an explosive atmosphere may occur. The main objective of this study is to investigate the accuracy of mathematical models to determine the extent of hazardous area in industrial facilities where explosive gases are used. The accurate prediction of the extent of a hazardous area is important for both process safety and economy. Underestimating hazardous areas can lead to explosions, and overestimating them incurs unnecessary cost. In this study, the authors compared the extent of hazardous areas predicted using analytical models with those obtained from a computational fluid dynamics CFD model. The latter was verified through experiments, and successfully predicted the characteristic barrel pattern at the exit of the

leaking orifice, typical of choked flow. The emission and dispersion of three flammable gases (hydrogen, methane, and ethylene) from five orifices of different diameters under different stagnation conditions were predicted. The results show that the extent of hazardous areas predicted by the analytical models was overestimated, but was accurately predicted by the CFD model. Of the analytical models tested, the models proposed in Italian Guide CEI 31–35 and by Ewan and Moodie yielded the closest results to those of the CFD model.

- **Keywords:** Gas leakage; CFD; Hazardous area; Modeling and simulation; Flammable gas

Saif Ullah Khan, Dar Tafazul Islam, Izharul Haq Farooqi, Sohail Ayub, Farrukh Basheer. *Hexavalent chromium removal in an electrocoagulation column reactor: Process optimization using CCD, adsorption kinetics and pH modulated sludge formation*. Pages 118-130.

In this study, hexavalent chromium [Cr (VI)] removal from aqueous solutions by electrocoagulation, using iron electrodes, was optimized for process variables: applied current, initial pH, initial chromium concentration and application time. A four-factor central composite design (CCD) together with response surface methodology (RSM) was used for investigating the effects of the process parameters on response variables: hexavalent chromium removal efficiency and energy consumed per gram removal of chromium. The optimum conditions were determined to be pH 3.0, 1.48 A applied current, 49.96 ppm initial Cr(VI) concentration and application time of 21.47 min for 100% Cr (VI) removal. The corresponding value of energy consumption was found to be 12.97 W-hour per gram removal of Cr (VI). Adsorption kinetics study showed that the removal followed pseudo-first order kinetics and the adsoption fitted the langmuir isotherm very well. Moreover, the sludge generated under the optimized conditions showed the best settling characteristics between the pH range of 6–9.

- **Keywords:** Electrocoagulation process; Hexavalent chromium removal; Central composite design; Response surface methodology; Power consumption; Adsorption kinetics

Wanli Li, Xiangxin Xue. *Emission reduction research and formation of hexavalent chromium in stainless steel smelting: Cooling rate and boron oxide addition effects*. Pages 131-143.

During the stainless steel smelting process, the control of the slag skimming process affects the formation of hexavalent chromium in the stainless-steel slag. However, the hazardous problem of hexavalent chromium in stainless-steel slag has been a major factor limiting its resource utilization. In this paper, by studying the enrichment form of chromium in stainless-steel slag and the formation mechanism of hexavalent chromium, the cooling system and the content of additives were controlled in the slag skimming process to reduce the formation of hexavalent chromium. Different means of characterization including TG-DSC, phase diagram, FT-IR, XPS, potential-pH equilibrium diagram and HJ 687-2014 method were used to characterize the presence and content change of hexavalent chromium in solid and leachate. Results showed that hexavalent chromium formation mechanism was related with the chromium diffusion in two typical Cr-containing components in stainless-steel slag. A slow cooling rate can reduce the emission of Cr(VI) in stainless-steel slag. A lower addition of boron oxide content made a lower emission of hexavalent chromium.

- **Keywords:** Stainless-steel slag; Hexavalent chromium; Cooling rate; Boron oxide addition; Digestion

Jianhua Zhou, Bei Li, Daqing Ma, Haipeng Jiang, Bo Gan, Mingshu Bi, Wei Gao. *Suppression of nano-polymethyl methacrylate dust explosions by ABC powder*. Pages 144-152.

The suppression effects of ABC powder on 100 nm polymethyl methacrylate (PMMA) dust explosions with different mass densities were experimentally studied. Results showed that the suppressed flames were dim and the flame propagation was slowed down with the addition of ABC powder. When the proportion of suppressant increased, the average propagation velocity was decreased. After adding 30% ABC powder to 650 g/m3 PMMA dust cloud, the maximum suppression ratio for velocity was 93%. After adding 10% ABC powder, the temperatures of PMMA dust cloud with the mass densities of 250 g/m3, 450 g/m3 and 650 g/m3 were decreased to 19.8%, 27.4% and 33.1%, respectively. Meanwhile, the critical suppression proportion of PMMA dust explosion with three mass densities were 25%, 35% and 35%. Thermal analysis results showed that the addition of suppressant could increase the thermal stability of PMMA. The suppression mechanisms were comprised of physical suppression and chemical suppression which reflected on the consumption of H and OH radicals. The chemical kinetic models indicated that PO2 and HOPO played a catalytic role in the combination of H and OH.

- **Keywords:** Nano-PMMA dust explosion; Explosion suppression; Flame propagations; Suppression mechanisms

Saikat Chowdhury, Geon-Ha Kim, Yong Sik Ok, Nanthi Bolan. *Effect of carbon and nitrogen mobilization from livestock mortalities on nitrogen dynamics in soil*. Pages 153-160.

Carcass decomposition in the soil can be an important source of nutrients such as nitrogen (N) by affecting N turnover in soils. The objective of this research was to estimate N input from decaying swine carcasses, thereby evaluating the impact of carrion decomposition on N dynamics in soil. Carcass decomposition using recently culled (<6 h) swine carcasses was carried out in a reactor filled with agricultural soil. Soil samples, collected four times (at 0, 10, 30 and 60 days after carcass placement) from the reactor were used in a tracer experiment to quantify the changes in soil nutrients and N dynamics. Tracer incubation experiments were carried out for seven days using 14C-labelled L-alanine (C3H7NO2) to investigate key N cycling processes in the soil. Mortalities were a significant source of N and carbon (C), providing an average of 42 and 236 g/kg, respectively, to the soil directly below the decomposing carcasses. There was also a significant and long-term input of amino acids (ca. 11 mg/kg) into the soil. The abundance of N increased the microbial turnover of labile N substances in the tracer experiment. Based on results from this study, it has been demonstrated that decaying carcasses provide a significant and long-lasting localized resource with the potential to contribute to soil N cycling. Therefore, it is important to develop guidelines on the management of carcass burial farmland using soil from burial pits as a nutrient supplement where biosecurity is assured.

- **Keywords:** Carcass decomposition; Leachate; Agroecosystem; Dissolved organic matter; Nutrient dynamics

Sasan Sahraie, Hamed Rashidi, Peyvand Valeh-e-Sheyda. *An optimization framework to investigate the CO2 capture performance by MEA: Experimental and statistical studies using Box-Behnken design*. Pages 161-168.

The absorption of carbon dioxide gas by monoethanolamine (MEA) in the packed tower is the most common method for the CO2 capture. The present study describes the set-up and operation of a laboratory-scale CO2 capture unit in detail, as the closed cycle of the

absorption/desorption process continuously operated at the different operating conditions. The effect of six independent variables was investigated on CO2 absorption in three levels. To analyse the results, Response Surface Box-Benhken design method was applied. The absorption unit was evaluated in terms of absorption percentage (Φ), the overall gas phase mass transfer coefficient (KGaV), and the specific heat duty of the reboiler (η). The results of the analysis indicated that the MEA concentration in the solvent had the most significance, whereas the input solvent temperature had the least effect upon the overall gas phase mass transfer coefficient. The response surface optimization was also carried out to determine the optimal operating conditions to maximize KGaV and minimize η. The results demonstrated that at an inlet solvent temperature of 45 °C, solvent flow rate of 1.25 L/min, gas flow rate of 100 L/min, reboiler heat load 1.4 kW, MEA concentration 30 wt.%, and the CO2 concentration of 15 vol.%, η was at the minimum value of 3.88 MJ/kg CO2, while KGaV was at the maximum value of 4.59 kmol/m3.h.kPa.

- **Keywords:** CO2; Absorption percentage; Overall mass transfer coefficient; Experimental design; Energy optimization

Xuecai Xie, Gui Fu, Yujingyang Xue, Ziqi Zhao, Ping Chen, Baojun Lu, Song Jiang. *Risk prediction and factors risk analysis based on IFOA-GRNN and apriori algorithms: Application of artificial intelligence in accident prevention*. Pages 169-184.

Risk prediction of disasters is one of the most effective ways to prevent accidents. To solve the problems in multi-factor complex disaster prediction, this paper proposes a new method for risk prediction and factorial risk analysis. Coal and gas outburst accidents were selected as research objects. First, a new coal and gas outburst prediction model was established that consists of 4 levels and 14 factors. Then, the Improved Fruit Fly Optimization Algorithm (IFOA) and the General Regression Neural Network (GRNN) algorithm were combined to establish the IFOA-GRNN prediction model. After that, the sensitivity analysis method was applied to the analysis of the sensitive factors of coal and gas outbursts. Finally, an apriori algorithm was used to mine the disaster information. The method proposed in this paper was applied to the Pingdingshan No. 8 Min. The application results show that the IFOA-GRNN algorithm proposed in this paper has an accuracy rate of 100% for the prediction of accident risk levels. Compared with the Back Propagation (BP), GRNN and FOA-GRNN algorithms, IFOA-GRNN has the characteristics of a smaller prediction error, higher stability and faster convergence. The sensitivity analysis method can judge the sensitive factors of coal and gas outbursts without knowing the mechanisms of the accident. The a priori algorithm can perform good data mining on the combination of high frequency factors leading to accidents and the relationships between the coal and gas outburst levels and factors. The data mining results are very helpful for the prevention and management of coal and gas outbursts.

- **Keywords:** Risk prediction; Factors risk analysis; IFOA-GRNN algorithms; Apriori algorithms; Artificial intelligence; Accident prevention

I. Bradley, D. Willoughby, M. Royle. *A review of the applicability of the jet fire resistance test of passive fire protection materials to a range of release scenarios*. Pages 185-191.

In 2017 the UK Health and Safety Executive commissioned a report (MH/17/27) on the suitability of the ISO 22899-1:2007 jet fire resistance test (JFRT) as a means of demonstrating performance of Passive Fire Protection (PFP) materials or systems to a range of jet fire scenarios. The aim was to address current industry concerns regarding the suitability of the test for characterising PFP materials response in' high heat flux' scenarios. The characterisation of a jet fire in terms of a single heat flux value is found to

be an inadequate means of specifying the severity of the hazard. Instead, a detailed description of the nature of the release should be provided. To this end the flame characteristics are compared that influence PFP materials response for a range of release scenarios, including gas, flashing liquids, crude-oil, gas-liquid mixes (two-phase), hydrogen, cryogenic releases and releases into confined areas. The applicability of the JFRT to the various release scenarios is assessed through comparison of the conditions within the scenarios to those within the large-scale natural gas release scenario used during validation of the JFRT.

- **Keywords:** Fire; Jet fire; 22899; Fires; Fire resistance; Passive fire protection; Fire protection; PFP

Purvali Chaudhari, Bharatvaaj Ravi, Pranav Bagaria, Chad Mashuga. *Improved partial inerting MIE test method for combustible dusts and its CFD validation*. Pages 192-199.

The Minimum Ignition Energy (MIE) is an important dust hazard parameter that guides the elimination of possible ignition sources in solids handling facilities. Partial inerting is a dust explosion mitigation technique implemented in industries, where the dust cloud MIE is increased, reducing the risk of an accidental explosion. Previous work has shown that purging the MIE apparatus Hartmann tube before testing is essential for obtaining accurate MIE values, but have not discussed the importance of the effective purge time required. Through experimentation and CFD modeling, this study has attempted to refine the existing MIE testing standard for partial inerting applications by introducing purge time as an essential parameter. In this study, oxygen sensor measurements were conducted to determine that the purge time for the MIKE3 apparatus should be > 40 s. Additionally, an ANSYS Fluent CFD purging model was developed, which confirmed the experimentally determined purge time. Using this improved methodology, an accurate partial inerting data set was obtained for the combustible dusts Anthraquinone, Lycopodium clavatum and Calcium Stearate.

- **Keywords:** Dust explosion; Partial inerting; Minimum ignition energy; Computational fluid dynamics

Ainil Hawa Mohamad Fauzi, Adeline Seak May Chua, Li Wan Yoon, Tadashi Nittami, Hak Koon Yeoh. *Enrichment of PHA-accumulators for sustainable PHA production from crude glycerol*. Pages 200-208.

Polyhydroxyalkanoates (PHAs) as biodegradable polymers produced by microorganisms with thermo-plastic properties are of high interest. In this study, PHA-accumulators were cultivated using crude glycerol and activated sludge in a sequencing batch reactor (SBR) with the aerobic dynamic feeding (ADF) strategy. This study aimed to enrich PHA-accumulators by evaluating the stability of the cultivation reactor followed by the effect of organic loading rate (OLR). The cultivation reactor was stable while maintaining a steady feast/famine (F/F) ratio. The increase of OLR from 360 mgC/(L·d) to 1000 mgC/(L·d) led to the increment of biomass concentration from less than 0.7 g/L to 2 g/L. The enriched mixed culture produced a maximum PHA content of 80 wt% in biomass dry weight with a production yield of 0.7 mg C PHA/mg C. The mixed culture were found to accumulate both 3-hydroxybutyrate (3HB) and 3-hydroxyvalerate (3 HV) monomers at a HB:HV molar ratio of 60:40. Based on fluorescence in situ hybridization (FISH) analysis, Alphaproteobacteria and Betaproteobacteria were the most dominant species during peak PHA production. This method provides an option for resource recovery operation in converting waste to value-added products.

- **Keywords:** Aerobic dynamic feeding; Sequencing batch reactor; Crude glycerol; Mixed microbial culture; Organic loading rate; Polyhydroxyalkanoates (PHA)

James M. Illingworth, Brian Rand, Paul T. Williams. *Non-woven fabric activated carbon produced from fibrous waste biomass for sulphur dioxide control*. Pages 209-220.

Waste fibrous biomass (flax) has been processed using non-woven textile techniques to produce a fibrous fabric material. The biomass fabric was then processed to produce activated carbons which retained their structure and flexibility. The carbons produced in a range of process conditions possessed a range of different surface areas and porosities. The activated carbons produced by chemical activation at different temperatures had high surface areas, ranging from 126 m2 g−1 for the activated carbon produced at 450 ºC to 1177 m2 g−1 produced at 800 °C activation temperature. At increased hold times at 800 °C the surface areas increased further, for example reaching 1656 m2 g−1 at 2 h hold time. The activated carbons were found to be very microporous, containing very small micropores. The produced activated carbons were then investigated in terms of the removal of sulphur dioxide in a bench scale continuous flow reactor. The SO2 adsorption results showed that for the waste biomass fibre carbons, uptake of SO2 from the gas stream was found to be dependent on the degree of activation. As the micropore volume and surface area of the samples increased, the SO2 adsorption capacity also increased, observing a linear relationship. The adsorption of SO2 by the waste derived activated carbons was significantly higher when compared to commercially obtained activated carbons. This appeared to be related to the pore size distribution of the samples, with the waste biomass activated carbons possessing a greater number of ultra-micropores than the commercial samples. Increase in the temperature of the activated carbon bed led to a marked decrease in the adsorption of SO2. Uptake of SO2 was also shown to be dependent on the concentration of the SO2 inlet feed gas, where higher SO2 concentrations led to enhanced uptake. The advantages of using textile processing techniques to produce a non-woven fabric activated carbon enabling different forms to be produced related to the end-use application has great potential for resource recovery.

- **Keywords:** Biomass; Waste; Activated carbon; Sulphur dioxide; Resource efficiency; Environment

Rulin Liu, Weimin Cheng, Yanbin Yu, Qingfeng Xu, Aiwei Jiang, Tong Lv. *An impacting factors analysis of miners' unsafe acts based on HFACS-CM and SEM*. Pages 221-231.

Based on the human factor analysis and classification system (HFACS) model, this paper describes human factor analysis and classification system for coal mines (HFACS-CM). It is based on actual situations found in coal mines and includes characteristics relating to safe mining activities. Subsequently, a questionnaire was designed according to the factors affecting unsafe acts identified in the model, and the survey data collected was analysed to assess its reliability and validity. Building on these efforts, a structural equation model (SEM) was constructed to analyse the hierarchical structure relationship of the HFACS-CM model. This was used to categorize and verify the types of factors that affected miners' unsafe acts, and reveal the significant influences on unsafe acts of miners. Finally, from the aspects of the external environment, organizational influences, unsafe leadership, and preconditions four aspects, a comprehensive prevention and control system for miners' unsafe acts is proposed. The results show that, in accordance with the effect analysis, the external environment has the greatest direct and indirect impact on unsafe acts; as for the overall effect, from the most impactful factor to the least impactful factor are external environment, unsafe leadership, preconditions for unsafe acts, and organizational influences. From the model path structure, the unsafe leadership and preconditions for unsafe acts play an important role. They do not exert any direct influence on unsafe acts, yet serve as intermediate variables significantly affecting the miners' unsafe acts.

- **Keywords:** HFACS-CM; SEM; Path analysis; Unsafe acts; Pre-control system

Sakshi Batra, Dipaloy Datta, Nitin Sai Beesabathuni, Nihit Kanjolia, Shibayan Saha. *Adsorption of Bisphenol-A from aqueous solution using amberlite XAD-7 impregnated with aliquat 336: Batch, column, and design studies*. Pages 232-246.

Bisphenol-A (BPA) was removed from water solution using washed (WX7) and impregnated (IX7) Amberlite XAD-7 resin with Aliquat-336 (A336). 0.5 g (IX7-0.5) and 1 g (IX7-1) of A336 per g of WX7 were loaded on the resin. Characterization of prepared adsorbents was done by FTIR, FE-SEM, EDS, BET. Point of zero charge study was also conducted to find the point at which the surface of adsorbent became neutrally charged. Equilibrium and kinetic experiments in the batch mode were carried out to observe the influence of contact time, amount of adsorbent, the initial concentration of BPA, pH, temperature, and ionic strength of solution (NaCl and Na2SO4) on the adsorption. IX7-1 showed comparatively better removal efficiency than that of IX7-0.5 or WX7. 5 g L-1 was determined to be the optimum mass of adsorbent (WX7, IX7-0.5, and IX7-1). Equilibrium (Langmuir, Freundlich, Temkin, and Dubinin-Radushkevich) and kinetic (pseudo-first-order, pseudo-second-order, intraparticle diffusion, and Elovich) models were fitted to the experimental results. Used IX7-1 was regenerated up to 5 times, and showed almost the same removal and good reusability of impregnated resin even after 5th cycle. Studies in a fixed bed column were also done by changing the flow rate, the height of the bed, and initial BPA concentration to evaluate the performance of IX7-1. Models like Thomas, Adham Bohart, and BDST were used to predict the column behavior, and to estimate the parameters for the scale-up of the process. Finally, the economic analysis of prepared resin was done, and the cost of impregnated resin (IX7-1) was found to be $2.055/g.

- **Keywords:** Adsorption; Amberlite XAD-7; Aliquat 336; Bisphenol-A; Extractant impregnated resin

Xinhong Li, Guoming Chen, Yuanjiang Chang, Changhang Xu. *Risk-based operation safety analysis during maintenance activities of subsea pipelines*. Pages 247-262.

Maintenance activities are essential to restoring the structural integrity of damaged subsea pipelines. However, many risk factors exist in maintenance operations and may result in some unexpected incidents. This paper proposes a novel methodology to risk analysis during maintenance operations of subsea pipelines, integrating Job Safety analysis (JSA) with Bayesian network (BN). In this approach, JSA method is used to find risk factors and consequences existing in maintenance operations. These identified factors and consequences are classified into several types. Subsequently, some individual BNs are developed for each type of influencing factor and consequence. Meanwhile, the flowchart of maintenance operation is transformed into a main BN directly. Eventually, a complete BN model is established by adding individual BNs to the main BN. The fuzzy-based approach is utilized to determine the probabilities of basic factors, which are used as the prior briefs in the model to conduct a robust probability reasoning. This methodology could be utilized to perform a safety analysis of maintenance operations. It can also serve as a helpful tool to reduce the potential of accident occurrence. Its applicability and effectiveness are illustrated through two typical cases of maintenance operations.

- **Keywords:** Risk analysis; Maintenance operations; Subsea pipelines; Job safety analysis; Bayesian network

Zhilin Xi, Xiaodong Wang, Xiaoli Wang, Li Wang, Ding Li, Xiangyu Guo, Liwei Jin. *Polymorphic foam clay for inhibiting the spontaneous combustion of coal*. Pages 263-270.

Polymorphic foam clay (PFC) was proposed to retard the spontaneous combustion of coal. It is mainly synthesized using foaming clay and auxiliary solutions. When the ratio of foaming clay solution to auxiliary solution was ˜1.0 wt. %, the generated PFCs had the best performance. The sol-gel foams that could be obtained as gas were injected into the synthetic solution, which had an excellent wettability on the coal surface due to the synergistic action of polyethylene oxide and sodium dodecyl sulfate. PFCs were obtained with the reaction of organic acids and sodium silicate, and their times of liquidity and self-hardening loss were 180 and 225 s, respectively. The mechanisms of PFC inhibiting the spontaneous combustion of coal were analyzed by a simultaneous differential scanning calorimeter/thermogravimetric analyzer, an XP-550C polarizing microscope linked to a CK 300 thermal station, scanning electron microscopy, a simultaneous differential thermogravimetric scanning calorimetric analyzer linked to a mass spectrometer and X-ray photoelectron spectroscopy. Before 239 °C, the PFC was always in an endothermic state, so it could adsorb significant heat produced by the low-temperature oxidation of coal to cool the coal body. The fused PFC also could form a thin whole colloid clay layer to cover the coal surface and effectively seal gaps and cracks in the coal from oxygen ingress, thereby preventing coal from contacting oxygen. The colloid clay could retain water to increase the moisture of the coal body, resulting in the prevention of the generation of new alkyl groups from cycloalkanes and bridge bond breakage, thereby decreasing the concentration of active groups in the coal. The colloid clay possessed organic acidity that could consume active free radicals.

- **Keywords:** Coal self-oxidation; Extinguishing fire; Oxygen consumption; Polymorphic foam clay; Thermoplastic powder

Wei Tan, Chaojie Li, Kang Wang, Guorui Zhu, Liyan Liu. *Geometric effect of buildings on the dispersion of carbon dioxide cloud in idealized urban street canyons*. Pages 271-280.

This paper focused on the dispersion of carbon dioxide (CO2) cloud due to large accidental release in urban areas. A three-dimensional urban model was designed and applied to capture the circulation flow and channeling flow in street canyons. The effects of building height, aspect ratio and roof shape on CO2 cloud dispersion were studied by wind tunnel experiment and Computational Fluid Dynamics (CFD) method. Building Reynolds number was calculated to ensure Reynolds number independence and turbulent flow. The results of model evaluation indicate that 100% of the predictions were within a factor of two of the experimental measurements (FAC2), and the relative mean bias (MG) was about 7%. CO2 behaved as a dense gas, whose volume fraction was more than 30% near the ground and about 5% in the upper region, respectively. Only 0.5% of CO2 removed from the canyon was through the top opening. Increasing windward-side building height enhanced vertical recirculation, thus reduced CO2 volume fraction from 22.9% (equal to 422 g/m3) to 14.5% (267 g/m3). Increasing aspect ratio to 3/2 could take greater amount of air into the canyon through the larger area of the openings, and then reduced CO2 volume fraction to 15.9% (293 g/m3).

- **Keywords:** Geometric effect; Flows in street canyons; CO2 dispersion; Urban micrometeorology

Shi-xiang Song, Yang-fan Cheng, Xiang-rui Meng, Hong-hao Ma, Hong-yun Dai, Jie-tong Kan, Zhao-wu Shen. *Hybrid CH4/coal dust explosions in a 20-L spherical vessel*. Pages 281-287.

Explosion characteristics and influential factors of hybrid CH4/coal dust explosions are studied using a 20-L spherical explosion vessel. Experimental results show that the maximum explosion pressure and maximum rate of pressure rise increase in the initial phase and then decrease as the coal dust or CH4 concentration increases. The optimum concentrations of coal dust and CH4 are 200 g/m3 and 5 vol.%, respectively, when the

initial pressure is equal to the atmospheric pressure. Moreover, the maximum explosion pressure keeps rising with the increasing initial pressure, and the maximum rate of pressure rise also shows an increasing trend. In addition, the optimum concentration of hybrid mixture varies with the initial pressure. The explosion risk of hybrid CH4/coal dust is much higher than that of pure coal dust in all dust concentrations, but it is only higher than that of pure coal dust explosion at high CH4 concentrations.

- **Keywords:** Hybrid mixture explosion; Coal dust; CH4; Initial pressure; Coal mining

Binqi Rao, Youfa Zhu, Mingzhou Yu, Xilong Lu, Yanjian Wan, Genqing Huang, Xiaoyu Su, Xiaodong Liu. *High-dry dewatering of sludge based on different pretreatment conditions*. Pages 288-297.

Reducing the moisture content (Mc) of sludge contributes greatly to subsequent treatment and disposal. An ultrahigh-pressure (UHP) and thin-cake-press (TCP) dewatering device was designed to achieve high-dry sludge using technique involving the addition of little or no cationic polyacrylamide (CPAM). The relationships between the Mc of the cake and compression pressure, dewatering time, sludge quality and category, pressurization mode, pretreatment methods and the thickness of the cake were studied. The compression pressure, dewatering time, sludge quality and category, thickness of the cake and pretreatment methods substantially influence the Mc of the cake, while the pressurized mode has almost no influence on the Mc of the cake. The time of pressure drop (TOPD) reflects, to a certain extent, the dewatering performance of sludge. The Mc of municipal sludge can reach to 45% or 39.47% with 60 or 90 min of dewatering time, respectively, and 12 MPa compression pressure, achieving a cake thickness of 3.2 mm and 3.1 mm, respectively. Sludge with high organic matter content is more difficult to dehydrate, and the dewatering performance of municipal sludge is considerably worse than that of river sludge and electroplating sludge. Pretreatment methods can change the dewatering performance of sludge. Microwave and freeze-thaw pretreatments are favorable for dewatering performance, while ultrasound and magnetic field pretreatment are disadvantageous for dewatering. After microwave pretreatment, the Mc of municipal sludge can reach a minimum value of 28%. Mc has a positive correlation with the thickness of the cake; the thinner the sludge cake is, the lower the moisture content is. Thus, the thin-cake-press and microwave pretreatments are effective methods for high-dry dewatering. Sludge has good compression characteristics, and the compression ratios (Cr) of municipal activated sludge and river sludge are 79% and 59%, respectively.

- **Keywords:** Sludge; High-dry dewatering; Ultrahigh-pressure; Moisture content; Pretreatment; Thin-cake-press

Kangxin Zhang, Jingfa Li, Bo Yu, Dongxu Han, Yujie Chen. *Fast prediction of the replacement process of oil vapor in horizontal tank and its improved safety evaluation method*. Pages 298-306.

The residual oil vapor in storage tanks must be replaced before the process of maintenance, cleaning and renovation. In engineering practice, the replacement operation of oil vapor is always implemented empirically, which is inefficient and more prone to accidents. To ensure the safety and efficiency, we employ the numerical method to investigate the replacement process of oil vapor considering coupled factors, and the simulation results are applicable to horizontal tanks with different structures and different capacities. Furthermore, to meet the requirement of real time calculation in engineering, a large amount of numerical simulation results are taken as samples, and trained by neural network, thus the maximum concentration of oil vapor can be predicted quickly in any horizontal tanks. Moreover, to apply the above research results in actual field, a safety evaluation method combining advantages of computer fast prediction and on-site detection is put forward, which conquers the problem that on-site detection is difficult to

measure the highest concentration of oil vapor in the tank. The results of this work will provide reference to achieve efficient and safe replacement of oil vapor in horizontal tanks.

- **Keywords:** Storage tank; Oil vapor; Fast simulation; Orthogonal test; Safety evaluation

Se-Won Kang, Changyoon Jeong, Dong-Cheol Seo, Sang Yoon Kim, Ju-Sik Cho. *Liquid fertilizer production by alkaline hydrolysis of carcasses and the evaluation of developed fertilizer in hot pepper cultivation*. Pages 307-312.

Alkaline hydrolysis was used to develop a liquid fertilizer which was then applied to hot pepper plants in field in order to assess its potential to be used as a fertilizer. The treatments were control (Cn), developed liquid fertilizer (DLF), inorganic fertilizer (NPK), and DLF + NPK treatments. The chemical properties of the final DLF product were a pH of 10.2, TN of 2.26%, and K of 6.12%, respectively. The length and weight of the plant in hot pepper cultivation were higher in the order of DLF + NPK > NPK > DLF > Cn treatment. The fresh weight of hot pepper under DLF + NPK treatment increased by 312% compared to control. Although the DLF showed a significant increase in fruit length and fruit fresh weight in the hot pepper cultivation compared to the control, the effect of DLF treatment on plant growth was limited due to the unbalanced N-to-P ratios in the DLF. In the potting experiment, the DLF could potentially be used as a supplement to inorganic fertilizer, demonstrating that alkaline hydrolysis is a promising technique for recycling bio-hazardous materials such as infected animal carcasses into value-added liquid fertilizer.

- **Keywords:** Liquid fertilizer; Agricultural recycling; Alkaline hydrolysis; Pig carcass; Hot pepper

Wasi Ur Rahman, Anam Fatima, Abdul Hakeem Anwer, Moina Athar, Mohammad Zain Khan, Naseem Ahmad Khan, Gopinath Halder. *Biodiesel synthesis from eucalyptus oil by utilizing waste egg shell derived calcium based metal oxide catalyst*. Pages 313-319.

Heterogeneous catalysts have emerged as potential alternatives to their homogenous counterparts, since they could successfully overcome the shortcomings encountered in homogenous catalytic trans-esterification of tri-acyl glycerides. In the present study, application of pure as well as doped CaO derived from waste chicken egg shells was studied for conversion of oil into biodiesel. Waste eggshells were calcined at 900 °C to get CaO which was then incorporated into transition metals by incipient wet impregnation method. The catalyst prepared has been characterized by Scanning electron microscope (SEM), Thermogravimetric analysis (TGA), Fourier-transform infrared spectroscopy (FTIR), and X-ray diffraction (XRD) techniques. The basicity and surface area of catalysts were ascertained in order to figure out the catalytic activity. The conversion of oil to Fatty acid methyl esters (FAME) has been confirmed by Thin-layer chromatography (TLC) and the percentage yield of eucalyptus biodiesel was verified by Gas chromatography with Flame ionization detector (GC-FID). The catalytic property of these mixed metal oxides has been studied in trans-esterification of Eucalyptus Oil. Zn-CaO (waste egg shell) was observed to be the most promising catalyst providing with appreciable yield of bio-diesel (FAME) among all the three catalysts. Transesterification was carried out at different process variables to optimize the best reaction conditions. Employing waste chicken egg shell derived CaO doped with transition metals (Zn, Cu) as catalyst puts forward the economic and efficient scheme for trans-esterification of Eucalyptus oil for biodiesel generation.

- **Keywords:** Biodiesel; Heterogeneous catalyst; Trans-esterification; Eucalyptus oil

Jinlong Zhao, Hongqing Zhu, Hong Huang, Maohua Zhong, Rui Yang. *Experimental study on the liquid layer spread and burning behaviors of continuous heptane spill fires*. Pages 320-327.

Spill fires usually occur with liquid fuel storage and transportation, which may pose a threat to process safety and environmental protection. Analysis on the liquid layer spread and burning behavior is vital for preventing and mitigating spill fire accidents. In the study, a number of heptane continuous spill fire experiments on a fireproof glass sheet were conducted to better understand the spreading and burning of continuous spill fires. In the experiments, the liquid surface area, burning rate and heat transfer between liquid layer and the glass sheet were analyzed. The results showed that the heptane burning rate of spill fires was lower than that for pool fires of the same burning size. The experimental data showed that the radiative penetration through the liquid layer was mainly responsible for the lower burning rate at the quasi-steady burning phase. Based on the heat transfer process, a modified burning rate model of spill fires by considering the heat loss of liquid layer was developed and validated by the experimental data.

- **Keywords:** Spill fires; Process safety; Burning rate; Radiative penetration; Semi-empirical model

Laleh Mahmoudian-Boroujerd, Ayoub Karimi-Jashni, Seyed Nezamedin Hosseini, Mahdi Paryan. *Optimization of rDNA degradation in recombinant Hepatitis B vaccine production plant wastewater using visible light excited Ag-doped TiO2 nanophotocatalyst*. Pages 328-338.

As widespread distribution of recombinant DNA of genetically modified microorganisms is a threat to the environment, the aim of this research is to investigate the efficiency of photocatalytic degradation of recombinant DNA under visible light. Using response surface methodology, a comprehensive evaluation of Ag doped-TiO2 photocatalytic degradation of recombinant DNA in Hepatitis B surface antigen production plant wastewater was performed. Photocatalytic synthesis parameters including dopant content, calcination temperature, and heating rate were investigated to model and optimize the recombinant DNA degradation efficiency. The Ag doped-TiO2 nanoparticles synthesis validation was accomplished by XRD, UV–vis diffuse reflectance spectra, FESEM and energy-dispersive X-ray spectroscopy. A quadratic polynomial equation, developed by response surface methodology, with the correlation coefficient (R2) of 0.969 ensured the good fitness of the predicted data with the experimental results. The sensitivity analysis of model indicates that the square of silver content and calcination temperature have the greatest effect on the response, while the heating rate is the least important parameter. Furthermore, the optimum conditions of Ag content of 2.1%, calcination temperature of 485 °C, and heating rate of 8 °C/min resulted in 80.7% rDNA degradation experimentally.

- **Keywords:** Recombinant DNA; Genetically modified microorganisms; Pichia pastoris; Real-time PCR; Photocatalytic degradation; Ag-doped TiO2

Shengnan Wu, Laibin Zhang, Jianchun Fan, Yangfan Zhou. *Dynamic risk analysis of hydrogen sulfide leakage for offshore natural gas wells in MPD phases*. Pages 339-351.

Leakage of high-pressure sour gas wells is one of many challenges for offshore drilling operations, which may cause serious consequences due to poisonous H2S gas diffusion in the platform with limited working space. This study presents a new method for dynamic risk analysis of H2S leakage in such sour gas fields during managed pressure drilling

phases. This method can model the influence of uncertainty from accident probability and consequences, being reflected in failure rates and unmodeled factors. The accident cause-consequence analysis via BT modeling for H2S release is conducted, integrating dynamic characteristics with probability estimation based on the inference of dynamic Bayesian networks (DBNs). The individual risk under different consequence scenarios is performed by the DBN modeling as well as death probability prediction at key monitoring points dynamically. A case study focused on specific Chinese offshore wells is analyzed to demonstrate the feasibility of the proposed method. The results show that the vulnerable factors with higher values are worth being addressed for prevention. In addition, the tolerable duration in total risk with the upper bound is approximated from 4.5 to 15 min between individual risk values of 1.0E − 4 and 1.0E − 6, as well as the exposure time after 15 min deserves more attention in risk emergency management.

- **Keywords:** Hydrogen sulfide leakage; Dynamic Bayesian network; Uncertainty analysis; Death probability; Individual risk

Asma Tarhouni, Malek Ben Zid, Ons Talbi, Monia Elbour, Saloua Sadok, Nourhène Mihoubi Boudhrioua. *New integrated process for production of edible and fishmeal powders from sardines: Drying kinetics and quality attributes*. Pages 352-365.

The edible parts of fishes (fleshes with / without skeleton) as well as the by-products (heads and viscera) are processed into two types of powders intended for human consumption and aqua feeding respectively. Sardine fleshes were blanched in water (100 °C, 30 s), air-dried at different temperatures (50, 60 and 70 °C) and then ground to fine powders. Sardines by-products were cooked in water (90 °C, 20 min), air-dried at 75 °C and then ground to fine powder. The drying kinetics of fleshes and by-products were evaluated and fitted to five mathematical models. The effects of pretreatments and drying temperatures on the physicochemical, techno-functional properties (water and oil retention capacities), microbiological quality and quality degradation indicators (biogenic amines, TVB-N and TBARS) of the obtained powders were examined. Results showed that drying of fleshes and by-products occurred in the falling rate period. The examined models were found to fit adequately to the experimental data with the exception of two term model. Drying and blanching do not affect protein content. Even though these operations lead to decreased fat and mineral contents, the obtained powders are rich on protein and ω-3 fatty acids (EPA and DHA). Microbiological analysis showed that drying of blanched sardine flesh at 60 °C and cooked by-products at 75 °C provides safe end-products.

- **Keywords:** Integrated process; Drying; Blanching; Quality; Sardine; Byproducts

Tanveer Ali Sial, Muhammad Numan Khan, Zhilong Lan, Farhana Kumbhar, Zhao Ying, Jianguo Zhang, Daquan Sun, Xiu Li. *Contrasting effects of banana peels waste and its biochar on greenhouse gas emissions and soil biochemical properties*. Pages 366-377.

The huge quantity of banana peels waste from juice industries and fruit markets every day is indicating a potential bio-resource which is major task for environment safety. It can be converted into useful material instead of being dumped in landfill site, and reduce the environment and economic problems. In this study, we compared the influence of banana peels waste and its biochar on greenhouse gas emissions, soil enzyme activities and chemical properties of soil at 90 days incubation period. There were five treatments of amendments: no amendment (Control), banana peel 1% (P1), banana peel 2% (P2), biochar 1% (B1) and biochar 2% (B2). Results indicated that biochar amendment significantly decreased cumulative nitrous oxide (N2O) emissions (37.1%–54.8%), whereas banana peels amendment did not significantly decrease cumulative N2O

emissions (1.3%–5.3%) as compared to control. Biochar application decreased the soil ammonium nitrogen (NH4+-N) and nitrate nitrogen (NO3−-N) with an increasing rate. Cumulative carbon dioxide (CO2) emissions for B1 and B2 treatments decreased 20.0% and 24.0% in comparison to the banana peel amendment, respectively. Cumulative methane (CH4) emissions were higher in peel waste than biochar amendment. Soil enzyme activities (urease, invertase and alkaline phosphatase) were significantly increased by biochar amendment. In contrast, banana peel amendment increased soil ammonium nitrogen, soil microbial biomass carbon (MBC) and microbial biomass nitrogen (MBN), β-glucosidase and urease activities. We concluded that banana peels waste conversion to biochar should be an alternate method of disposal since its application resulted in the reduced greenhouse gas emissions and improved the soil biochemical properties. This biochar should be further tested under field conditions to confirm the potential for mitigating of GHG emissions and soil biochemical properties.

- **Keywords:** Banana peels; Biochar; Greenhouse gases; Soil biochemical changes

Mohd Ridhwan Adam, Takeshi Matsuura, Mohd Hafiz Dzarfan Othman, Mohd Hafiz Puteh, Mohamad Arif Budiman Pauzan, A.F. Ismail, Azeman Mustafa, Mukhlis A. Rahman, Juhana Jaafar, Mohd Sohaimi Abdullah. *Feasibility study of the hybrid adsorptive hollow fibre ceramic membrane (HFCM) derived from natural zeolite for the removal of ammonia in wastewater*. Pages 378-385.

The excessive presence of ammonia has led to serious potable water scarceness worldwide. This work aims to fabricate natural zeolite based hollow fibre ceramic membrane (HFCM) via phase inversion and sintering techniques for the ammonia removal in wastewater. The physical properties of the fabricated HFCM were investigated through morphologies, mechanical strength, dope suspension viscosity and pure water permeation also the performance test using synthetic wastewater. It was found that 5 cm, 15 mL/min and 1050 °C were the best fabrication conditions for the air – gap distance, bore fluid flow rate and sintering temperature, respectively. The membrane also revealed desired asymmetric structure, sufficient mechanical strength (50.92 MPa) and excellent pure water permeation flux (249.57 L/m2 h). Additionally, the ammonia removal gave an outstanding performance of 90% rejection. These findings show that natural zeolite based HFCM has a great potential to be developed as a single – step ammonia removal in wastewater.

- **Keywords:** Natural zeolite; Hollow fibre ceramic membrane (HFCM); Phase inversion/sintering technique; Ammonia removal; Membrane adsorption