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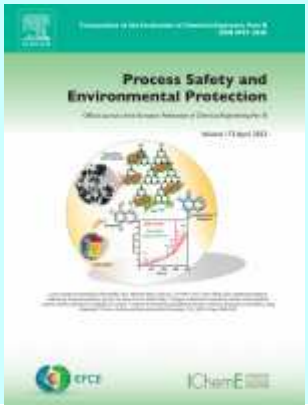

Morteza Zadkarami, Ali Akbar Safavi, Krist V. Gernaey, Pedram Ramin, Oscar A. Prado-Rubio. *Designing a fault detection classifier framework for an industrial dynamic ultrafiltration membrane process using wavelet-based feature analysis*. Pages 1-19.

In recent years, due to the increase in population and the number of industrial sites, water reclaim has become more relevant. Dynamic membrane filtration systems can play an important role for water reuse. Therefore, process monitoring of dynamic membrane systems is of great importance to ensure the water quality while considering environmental and economic factors. The exploitation of on-line monitoring of dynamic membrane systems in industrial operation is challenged by intentional disturbances such as backflush and backshock (i.e. used as cleaning strategies) and unintentional input fluctuations. Consequently, process inherent behaviour is hidden within very complex sensors signals. Therefore, critical flux identification or fouling characterization for process monitoring is not straightforward, leading to suboptimal operation. The present study establishes a fault detection framework from a classification viewpoint, capable of handling industrial data that is prone to noise and disturbances, while offering an effective yet straightforward approach. The case study is a pilot-scale dynamic ultrafiltration process which has been tested previously within an industrial facility for produced water reclamation. The dataset contains 18 experiments, where three of the experiments are faulty. These experiments were implemented in an oil recovery facility located in the Orinoquía region, Colombia. A feature analysis approach based on wavelets is developed to identify the key characteristics of the installed sensors while alleviating the noise effects. The process conditions are pinpointed by feeding the extracted features into several widely used classification methods including Multilayer Perceptron Neural Network (MLPNN), Support Vector Machine (SVM), and Principal Component Analysis (PCA) based classifiers. The results indicated that the MLPNN classifier has the highest detection accuracy of 99.7% with a low percentage of false alarms. The framework developed in this study is a vital part of a membrane system digitalization strategy, which can be integrated into automated surveillance strategies for monitoring of membrane systems toward effective fault detection.

- **Keywords:** Fault detection; Dynamic ultrafiltration; Produced water management; Wavelets analysis; Classification

Sulong Zhu, Chengkang Gao, Guo Tian, Dengting Guo, Shupeng Li, Xiaojun Li. *Mercury flow network and its emission reduction in the steelworks*. Pages 20-27.

The steel industry is an important source of anthropogenic mercury (Hg) emissions. Hg is harmful to human health, causing symptoms such as dizziness, pneumonia, and renal failure. So, how do we reduce Hg emissions from the steelworks? What possibilities exist for Hg emission reduction? Firstly, in this study, the flow paths of Hg in the steelworks were described quantitatively using the substance flow analysis method, and the characteristics of the input and output of Hg-containing subjects were analyzed. Secondly, based on the Hg flow network, the circulation characteristics of Hg and the emission characteristics of Hg-containing pollutants were analyzed in the steelworks. Finally, according to the distribution of Hg in the steelworks, the emission reduction potential was examined at the source and end-of-pipe. The results showed that Hg, which mostly originated from coal, limestone, and iron ore concentrate in the steel production process, was mostly exported with waste gas and wastewater, primarily in the form of waste gas. The input, circulation, and output of Hg were 362.77, 3.25, and 392.55 mg/t crude steel (CS), respectively. Through source reduction and end-of-pipe treatment, the reduction rates of pollutants in the steelworks were 28.74% and 75.37%, respectively.

- **Keywords:** Substance flow analysis; Hg; Flow path; Waste discharge; Emission reduction

Fugui Hong, Cheng Ji, Jingzhi Rao, Chang Chen, Wei Sun. ourly ozone level prediction based on the characterization of its periodic behavior via deep learning. Pages 28-38.

Surface ozone has become one of the most important air pollutants in recent years, posing a huge threaten to human health. The accurate prediction of ozone pollution, especially when ozone concentration exceeds permissible standard, has become an important research topic in the field of air quality management, where data-driven methods are widely used. Among these methods, the long short-term memory neural network (LSTM) has received significant attention in ozone forecasting for its ability in modeling long-term time dependence. However, from the time series perspective, short-term nonstationary characteristics resulted from periodic trends of ozone data have not been sufficiently considered by LSTM. To address this issue, we propose a novel deep learning-based prediction method named multi-order difference embedded LSTM (MDELSTM). Through statistical analysis of ozone time series, a multi-order difference strategy is employed to extract the periodic information. By embedding it into LSTM layers, a brand-new deep learning prediction model with the ability to extract both long-term stationary information and short-term periodic information is constructed for ozone forecasting. The proposed method is verified through the Los Angeles air quality dataset between 2013 and 2017. The prediction accuracy of ozone concentration over the next hour is improved compared to other state-or-the-art methods in terms of mean absolute error (MAE), root mean square error (RMSE), and coefficient of determination (R2). To further illustrate the ability of the proposed method in predicting high-level ozone concentration, new evaluation indicators oriented on situations where the ozone concentration exceeds permissible standard are proposed. The results demonstrate its application prospect in hourly ozone pollution prediction and prevention.

- **Keywords:** Air quality management; MDELSTM; Multi-order difference module; Statistical analysis; Ozone concentration prediction; Los Angeles

Jing Xie, Yubin Zhang, Zhanyou He, Pengqian Liu, Yi Qin, Zhaolong Wang, Changhang Xu. *Automated leakage detection method of pipeline networks under complicated backgrounds by combining infrared thermography and Faster R-CNN technique*. Pages 39-52.

Leakage detection is essential to process safety and loss prevention of pipeline networks. As one of the attractive methods for detecting leakages in single pipelines, infrared thermography (IRT) faces new challenges for leakage detection of pipeline networks. Compared with the single pipeline, the pipeline network has a complicated structure with higher topology features and diverse material composition. In addition, the environment of the pipeline network is complex and changeable. These factors increase the complexity of the infrared (IR) thermal images of pipeline networks, which makes the leakage features too weak to be detected via naked-eye observation in an efficient and precise manner. To address this issue, this study develops an automated detection method for pipeline network leakages under complicated background, which is achieved by combining IRT with the Faster Region-based Convolutional Neural Network (Faster R-CNN) technique. First, the pipeline network system in the complicated background is designed for IR thermal image acquisition and data analysis. Then, an automated leakage detection model is built based on Faster R-CNN, which uses a modified VGG16 network for feature extraction for its outstanding performance in the feature extraction of small objects under complicated backgrounds. Finally, the high efficiency and precision of the proposed method for automated detection of pipeline network leakages in complicated backgrounds are verified by extensive experiments. Meanwhile, the generalization ability of the proposed method is verified by conducting experiments under various experimental conditions (different moments all-day, different viewing angles of IR camera, pedestrian disturbing). In general, the proposed method provides a promising way to detect pipeline network leakages in complicated backgrounds.

- **Keywords:** Automated leakage detection; Pipeline networks leakage; Infrared thermography; Faster R-CNN

Maozhong Yin, Luling Yang, Yankui Tang, Yi Liang, Qinghan Wang, Linni Su, Jingmin Liu, Yao Zhuang, Dongdong Li. *Microplastics released from artificial turf applied as hedge walls: Their aging-induced properties and uptake by grass carp, mussels and earthworms*. Pages 53-62.

An emerging source of MPs in China is artificial turf applied as hedge walls (ATHWs), which have been increasingly used mainly in enclosing construction sites as well as beautifying the municipal landscape. However, the specific ecological risks caused by MPs released from ATHWs (ATHW-MPs) are still unknown. In the present study, we investigated the amount and aging-induced properties of green fibers (GMPs) and the backing materials (BMPs), released from the ATHWs; as well as their potential uptake by animals. Grass carp (Ctenopharyngodon idellus), mussels (Mytilus edulis) and earthworms (Eisenia fetida) were used as animal test species. Outdoor exposure for 180 days made ATHWs more prone to embrittlement and disintegration, leading to 4.58 ± 1.96 % weight loss of the grass panels. More and finer particles and fibers were released by an external shear force from the outdoor exposed panels than from panels exposed to artificial UV-light. The aging process altered the surface properties of both GMP and BMP such as zeta potential, surface roughness, specific surface area and chemical groups, which may change their interaction with chemicals and species in the environment. All the studied species tended to ingest more fine particles (<40 μm) of BMPs. As a kind of microfibers, GMP were ingested by some grass carp and mussels but not by earthworms. Ingestion of MPs increased at higher MP-exposure concentrations. Although most of BMPs were partly egested by animal species after 3 d intestinal cleansing; 10 %, 44 % and 22 % of ingested BMPs remained in grass carp, mussels and earthworms, respectively. Aging of ATHW cause more and finer shed MPs, therefore, the

sources and quality of the raw materials and producing process must be strictly controlled. We suggest that industry should develop or pay attention to the materials that are more resistant to aging; assess and inform the life cycle of the ATHWs in the instructions, and remind users to avoid free exposure of the backing material during installation.

- **Keywords:** Microplastics; Artificial turf; Biological ingestion; Ctenopharyngodon idellus; Mytilus edulis; Eisenia fetida

Sultan Büşra Artaş, Emrullah Kocaman, Hasan Hüseyin Bilgiç, Hakan Tutumlu, Hüseyin Yağlı, Recep Yumrutaş. *Why PV panels must be recycled at the end of their economic life span? A case study on recycling together with the global situation.* Pages 63-78.

The use of solar energy as a renewable energy source has been increasing in recent years. Photovoltaic (PV) panel technology is an important alternative to fossil fuels for the future energy needs of the world. PV panels, which have a lifespan of about 25–30 years, have a potential for photovoltaic waste in the coming years due to the increase in their production. There is a remarkable difference between the amount of CO2 emissions generated during the production of a PV panel and the amount of CO2 emissions generated during its recycling. When recycled, the environmental damage of PV panels is significantly reduced. Recycling also helps economically recover materials some of which are rare in nature. In this study, the structures of the components that compose PV panels are emphasized. The estimated waste projection of the PV for the world, Turkiye and, as a case study, Karapinar Solar Power Plant was analyzed until 2050. The harms of PV panels to the environment, people's health and their recycling potential were scrutinised. Furthermore, the carbon dioxide emissions and economic costs of the PV panels produced by recycling and the panels produced without recycling are compared.

- **Keywords:** Solar energy; photovoltaic panel; components of PV panel; recycling; environmental impact

Kaiyao Hu, Wenxuan Li, Hao Mu, Shuang Ren, Hongjuan Zhu, Kexin Zeng, Bo Wang, Jinming Liang, Qi Zhang, Lili Yang, Wei Zhao, Juqiang Xiao. In-situ anaerobic treatment removes the passivation layer of sponge iron to restore the nitrogen and phosphorus removal performance of SBR. Pages 79-94.

Sponge iron (s-Fe0) has a large specific surface area, is cheap and easy to obtain, and has a good reduction capacity. Therefore, its efficacy in enhanced wastewater denitrification and phosphorus removal has been extensively examined. Because of the strong magnetic properties and reactivity of s-Fe0, a passivation layer dominated by iron oxides is formed in liquid phase environments, and this layer inhibits the dissolution of Fe0. In this study, s-Fe0 was used as the carrier filler in an SBR reactor to remove the passivation layer on the surface of s-Fe0 by anaerobic means, and the performance of this reactor was investigated for the removal of chemical oxygen demand (COD), nitrogen, and phosphorus from actual domestic wastewater. The anaerobic treatment of the reactor for 4 days effectively removed the passivation layer on the s-Fe0 surface while the carbon source of the system was maintained with normal feed water. The average removal rates of COD, NH4+-N, and TP in the reactor were 85.67%, 99.8%, and 93.98%, respectively, and the efficient removal of phosphorus in the system was stable for 22–26 days. X-ray diffraction and microbial community analysis showed that, in addition to the formation of FePO4, Fe(PO3), and Fe2P4O12 precipitates were generated in the system to remove phosphorus, and that a synergistic effect aided biological phosphorus removal. Additionally, the presence of abundant microorganisms with corrosion functionality (such as Rhodobacter, Brevundimonas, and Thiobacillus) in the

activated sludge system, on the s-Fe0 carrier surface, and inside the carrier, played an essential role in the corrosion and removal of the s-Fe0 passivation layer. These results demonstrated that s-Fe0 is a promising material for nitrogen and phosphorus removal, and anaerobic treatment can effectively alleviate the passivation of s-Fe0. Thus, the efficient removal of phosphorus from actual domestic wastewater can be sustainably achieved.

- **Keywords:** Sponge iron; Iron reduction; Phosphorus removal; Microbial corrosion

Tao Hai, Masood Ashraf Ali, Mustafa D. Younus, Bhupendra Singh Chauhan, Ahmed Sayed Mohammed Metwally, Mirzat Ullah. *Enhancing efficiency and reducing CO2 emission of a geothermal-driven polygeneration system: Environmental analysis and optimization*. Pages 95-114.

The limitations of the single-flash cycle (SFC) include low efficiency, limited power output, and the inability to produce multiple products simultaneously. Additionally, the SFC requires a large amount of water and can have negative environmental impacts. In this study, to improve performance and produce multiple products, subsystems such as a branched GAX cycle assisted by a thermoelectric generator, a domestic water heater, and a reverse osmosis unit are coupled with the SFC. Then, thermodynamic, environmental, sustainability, and net present value approaches are devoted to analyzing system performance. This study utilizes MATLAB software to achieve a two-objective optimization that uses both CO2 emission rate and exergetic efficiency as objectives. The CO2 emissions rate represents a downward inclination with an increase in temperature in the generator inlet. Net electricity, cooling load, and pure water rate have a downward inclination with an augmentation of the temperature in the generator inlet due to reducing mass flow rate in the branched GAX/TEG cycle. At the optimum point, the payback period of the designed system with increasing selling prices of the products is decreased. The polygeneration gain output ratio in the optimized conditions reduces compared to the base case, whereas the sustainability index increases. Compared to similar works, the designed system produces a higher output.

- **Keywords:** Thermoelectric generator; CO2 emission; Net present value; Branched GAX cycle; Pareto front

Mehdi Jamei, Mumtaz Ali, Bakhtiar Karimi, Masoud Karbasi, Aitazaz A. Farooque, Zaher Mundher Yaseen. *Surface water electrical conductivity and bicarbonate ion determination using a smart hybridization of optimal Boruta package with Elman recurrent neural network*. Pages 115-134.

Water quality (WQ) monitoring in the surface water resources is a crucial concern as it has an impact on human health and ecosystem equilibrium. An accurate simulation of river WQ indicators as a function of available variables with data mining techniques is not much explored by the researchers. In this study, two smart dual-preprocessing hybridized with Elman recurrent neural network (ERNN) were developed for an accurate simulation of two surface WQ indices including electrical conductivity (EC) and bicarbonate (HCO3-) in the Northern zones of Karun River, Iran. Nine input features including sodium adsorption ratio (SAR), magnesium (Mg2+), Ca+2 (calcium) sum of the anions (Sum.A), SO42-(sulphate) Cl-(chloride), pH, discharge (Q), and Na+ (sodium) were employed to simulate the EC and HCO3- in surface water Two Boruta-data filtering strategies including Boruta-XGBoost (BXGB) and Boruta-Extra Tree (BET) were utilized to extract the most important WQ indicators in available features. The best subset regression (BSR) scheme was utilized to optimize the input combinations of available features to predict EC and HCO3-. Three superior scenarios (C1, C2, and C3) were

considered for each target variable to feed the machine learning (ML) models. The dual pre-processing was hybridized with ERNN to compare the results of advanced ML approaches i.e., long short-term memory (LSTM), Kernel ridge repression (KRR), and Elastic net regression (ELNET). Eight hybrid modeling paradigms (BXGB-ERNN, BET-ERNN, BXGB-KRR, BET-KRR, BXGB-ELNET, BET-ELNET, BXGB-LSTM, and BET-LSTM) were evaluated in terms of performance using statistical criterions such as correlation coefficient (R), root mean square error (RMSE), and Kling-Gupta efficiency (KGE). Results revealed that the BET-ERNN-C1 hybrid model outperformed the other models for HCO3- (R = 0.9847, RMSE = 0.0793 mEq/L, and KGE = 0.9782) and EC simulation (R = 0.9543, RMSE = 51.0260 µS/cm, and KGE = 0.9406) in terms of performance efficiency. Results indicated that the BET-ERNN-C1 model resulted in minimum values of IQR for EC (0. 7.455) and HCO3- (0.1819). Overall, the result of modeling showed that the ERNN-C1 model had a superior performance in simulating the WQ indices followed by BXGB-ERNN-C3 and BXGB-KRR approaches. Results of this study suggested that the predictions of WQ indicators using hybrid models can be used to assess the acceptable levels of EC and HCO3- in surface water using appropriate input variables efficiently and reliably.

- **Keywords:** Electrical conductivity; Bicarbonate; Water quality; Elman recurrent neural network; Boruta-Extra tree; Boruta-GXBoost

Yafang Liu, Jiaxin Wang, Baozhong Zhu, Xinjian Zhou, Jialiang Zhou, Fan Li, Yunlan Sun. *Poisoning mechanism of the coexistence K and SO2 on the deNOx of MnO2/TiO2 catalyst at low temperature*. Pages 135-144.

Manganese-based catalysts supported by TiO2 (MnO2/TiO2) show good deNOx performance at low temperature. However, the microscopic impact mechanism of poisonous substances such as K and SO2 on the deNOx of the MnO2/TiO2 catalyst is a grey area. In this work, the poisoning mechanism of K and SO2 coexistence on the deNOx of the MnO2/TiO2 catalyst was explored by using a density functional theory combined with experimental methods. SO2 has low adsorption performance on the MnO2/TiO2 (001) surface, while it can be oxidized to form SO3, and it will react with the catalyst to form sulfates. K poisoning makes NH3 and NO molecules more difficult to be adsorbed on the MnO2/TiO2 (001) surface. However, when SO2 is introduced on the catalyst surface with K poisoning, it can interact with K and change the charge transfer from K to the catalyst surface, alleviating the K poisoning of the catalyst. These results contribute to the understanding of the mechanism of K and SO2 co-poisoning on the deNOx of Mn-based catalysts at a microscopic level, and provide guidance for designing Mn-based catalysts with high anti-poisoning ability.

- **Keywords:** MnO2/TiO2 catalyst; DFT; K; SO2; Co-poisoning

Shu-Hui Liu, Chin-Hui Ko, Chi-Wen Lin. *Improved deoxygenation beads for trickle bed-based microbial fuel cells to increase isopropanol and styrene-containing exhaust gas removal efficiency and power production*. Pages 145-157.

This study is the first to use a trickle-bed microbial fuel cell (TB-MFC) to treat both hydrophilic (isopropyl alcohol) and hydrophobic (styrene) pollutants. During the operation of the TB-MFC, the microorganisms continue to convert pollutants into electrons, improving the removal of hydrophilic and hydrophobic pollutants, and generating electricity. To enhance the growth of electricity-generating bacteria, a novel deoxygenated packing material (DPM) that removes oxygen from the exhaust gas was applied to the TB-MFC. The TB-MFC reached maximum pollutant removal and power generation at a total carbon concentration of 2.20 g/m3, an empty bed residence time of 60 s and a concentration ratio of 1: 1 of isopropanol and styrene. The mean elimination capacity of isopropanol and styrene were 81.5 ± 0.20 g/m3/h and 54.2 ± 0.26 g/m3/h,

respectively, and the maximum voltage outputs and power density were 450 mV and 426 mW/m3. A microbial community analysis revealed that the electricity-generating bacteria were mostly Clostridium, Aeromonas, Acinetobacter and Kosakonia. Most of the isopropanol-degrading bacteria (Xanthobacter, Beijerinckia) and styrene-degrading bacteria (Chryseobacterium, Cloacibacterium) were in the TB-MFC. The findings indicate that TB-MFC is capable of generating electricity and treating both hydrophilic and hydrophobic pollutants simultaneously. The improved DPM can be used in the TB-MFC to reduce the concentration of oxygen in industrial emissions and accelerate the growth of electricity-generating bacteria, with the goal of achieving high pollutant removal and electricity generation.

- **Keywords:** Concentration inhibition; Deoxygenated packing material (DPM); Elimination capacity; Microbial community; Power generation

Mohammad Alauddin, Faisal Khan, Syed Imtiaz, Salim Ahmed, Paul Amyotte. *Integrating process dynamics in data-driven models of chemical processing systems*. Pages 158-168.

Data-driven models require high-fidelity data of sufficient quantity and granularity. This is challenging in a complex chemical processing system due to frequent sensor breakdown, process shutdown, malfunctioning of equipment, random fluctuations, miscalibration, inconsistent sampling frequencies, and data entry errors. Thus many models scoring well on training data flounder on the real-time data of industrial systems. This work presents a process dynamics-guided neural network (PDNN) model to improve model generalization that can maintain higher performance in sparse and low-quality data. This has been enacted by adding an additional layer in the neural network architecture to incorporate process dynamics such as material and energy balance equations, universal laws, standard correlations, and field knowledge. We evaluated the proposed model against a standard neural network on a regression and a classification tasks representing a steady state and transient behavior of processing systems. The proposed model yielded improved outcomes on reduced sample-sized data and in extrapolated regimes implying a higher generalization capability of the PDNN model. The proposed process dynamics-guided neural network can be employed as a robust model for handling generalization issues of data-driven methods in processing systems.

- **Keywords:** Semi-mechanistic; Fault detection; Process monitoring; Fault detection rate; PDNN; ROC Curve

Jie Dai, Abdulkareem Abdulwahab, Haoran Wei, Abdulaziz Alanazi, Mohana Alanazi, Tarek I Alanazi, Ammar Armghan, Makatar Wae-hayee. *Multi-criteria sensitivity study and optimization of an electricity/cooling/hydrogen production scheme combined with SOFC-based sequential heat recovery: Sustainability and economic analyses*. Pages 169-187.

The establishment of new multigeneration processes is comparable and assessable from the sustainability viewpoint. Indeed, the sustainability approach assists the economic analysis leading to appropriate combination methods. Concerning the energetic flow exhausting a solid oxide fuel cell system, this study proposes an innovative trigeneration process with high sustainability index utilizing three stages of sequential heat recovery. The process encompasses a two-stage Rankine cycle boosted by a thermoelectric generator and an ejector refrigeration unit, and a polymer electrolyte membrane electrolyzer. This system is simulated in engineering equation solver software and a comprehensive sensitivity study is accomplished. It is concluded that the most influential parameter in the whole framework is the operational temperature of the stack and in the integrated process is turbine 1 pressure. Afterward, an advanced evolutionary

optimization method is employed using the MATLAB software, and the optimal point is designated from the sustainability and economic standpoints. The optimal state reveals the sustainability index of 2.61 and total unit cost of 35.93 $/GJ, improved by 12.5% and 3.8% against the base case, respectively. Besides, the electric power, cooling, and hydrogen are correspondingly produced at 389.4 kW, 112.4 kW, and 0.45 kg/h, resulting in exergy efficiency and exergoeconomic factor of 57.75% and 52.1%, respectively.

- **Keywords:** Sequential heat recovery; Solid oxide fuel cell; Multi-criteria sensitivity study; Evolutionary optimization method; Sustainability

Dengrong Lai, Zhi Huang, Jiaqian Xie, Xiaohuan Ai, Xiaodong Xin, Junming Hong. *Effects of filling methods on the degradation of ethyl acetate and the microbial community in biofilters*. Pages 188-199.

Two biofilters (BFs) for treating ethyl acetate (EA) were constructed with magnetite, activated carbon, perlite and gravel added via layered filling (BF1) or mixed filling (BF2). This study demonstrated the effect of filling method on the degradation of EA and the microbial community in the BFs. The results indicated that the EA removal efficiency (RE) of BF1 and BF2 reached 86.3 ± 3.0 % and 88.9 ± 2.1 %, respectively, under low inlet load (L-IL; (224 g/(m3·h)). Meanwhile, BF2 exhibited stabler RE than BF1 at high IL. BF1 achieved the highest REs of total phosphorus (TP), total nitrogen (TN) and ammonia nitrogen (NH4+-N) under moderate inlet load (M-IL; 336 g/(m3·h)), with average values of 95.8 ± 3.5 %, 83.4 ± 0.4 %, and 85.7 ± 0.3 %, respectively. The removal of TP, TN and NH4+-N in BF2 was superior than BF1 at L-IL and M-IL condition. Moreover, the genera Burkholderia, Acinetobacter, unclassified_Rhizobiales and unclassified_Burkholderiales were the dominant EA-degrading bacteria in BF1, while the EA-degrading bacteria in BF2 were dominated by unclassified_Chloroflexi, unclassified_Bacteroidetes and unclassified_Anaerolineaceae. Furthermore, the mechanism investigation of the mechanism revealed that the types of filling method affect EA degradation by shifting the abundance and diversity of key microorganisms in biodegradation. This study provides an effective strategy for improving the biodegradation efficiency of volatile organic compounds VOCs.

- **Keywords:** Volatile organic compounds (VOCs); Biofilter; Mixed filling; Layered filling; Ethyl acetate (EA); Microbial community

Antonin Robinet, Khaled Chetehouna, Soleh Junjunan, Axel Cablé, Antoine Oger. *Thermal and spectral analysis of a pool fire in an engine compartment: Experimental study on the influence of ventilation and fuel depth*. Pages 200-213.

Engine fire hazards in vehicles are a threat to the personnel, inducing potential fatal injuries as well as damage to the vehicles themselves and their operational capabilities. Thus, it is important to assess the fire dynamics inside a non-confined engine compartment, here with an engine-cooling fan flow. A n-heptane pool fire was used to conduct a parametric study varying pan diameter, fuel depth and ventilation flow rate in a scale 1 compartment representative of the engine block of an APC (Armored Personnel Carrier). The results showed that an increase of the ventilation flow rate decreases the mean top temperature alongside the hood but increases the mean temperature in the wheel arches. The latter can be explained by the movement of hot gases to the sides of the compartment and was confirmed with a side to center temperature ratio. For the biggest ventilation flow rate, the temperature in the wheel arches of the compartment exceeds the temperature directly above the flame in the steady state of the fire. This temperature evolves linearly along the slope of the hood. A spectral analysis of the flame showed that the oscillation frequency is tied to the pan diameter from standard correlations but is insensitive to the fuel depth or ventilation flow rate investigated range.

- **Keywords:** Pool fire; Parametric study; Confined compartment; Spectral analysis

Xiang Li, Xueqian Wang, Bing Cai, Langlang Wang, Li Yuan, Ping Ning. *Investigation of heavy metal flows in a copper pyrometallurgical process of a typical smelter*. Pages 214-222.

The non-ferrous smelting industry is a major polluter of heavy metals, and investigations on the flow of heavy metals in the metallurgical process are important references and the basis for optimization of the smelting process and control of heavy metal pollution. In this work, using a typical copper smelter as the research object, we examined and analyzed the content and status of the heavy metals lead, arsenic, cadmium, mercury, and chromium in the slag, ash, solid waste, and products of the copper pyrometallurgical process and explored the flow and enrichment of heavy metals in each stage of smelting, converting, and refining. The results showed that lead and arsenic were the most abundant heavy metals in copper concentrate, of which about 66.21% of lead and about 65.02% of arsenic escaped with the flue gas during the pyrometallurgical process and were trapped in the white ash. During the entire copper purification process, about 75.17% of heavy metals were removed in the smelting process, about 21.88% in the converting process, and about 2.92% in the refining process. The final heavy metals discharged into the atmosphere were only lead, arsenic, and mercury, accounting for about 0.03% of the total heavy metal content. It is worth noting that 50% of the mercury in the raw material was discharged into the atmosphere. Since mercury is persistent, easily transportable, highly bio-concentrated, and toxic, mercury pollution requires increased attention.

- **Keywords:** Typical smelter; Copper; Pyrometallurgical process; Solid; Heavy metals; Material flow

H. Tao, J. Zhou, F. Musharavati. *Techno-economic examination and optimization of a combined solar power and heating plant to achieve a clean energy conversion plant*. Pages 223-234.

Renewable energies are one of the best alternatives to fossil fuels, which have disadvantages such as exhaustibility and emission of environmental pollution. An alternative system consisting of a parabolic trough collector (PTC) and a photovoltaic thermal (PVT) is used to produce electric power and heating. By using the Kalina cycle and the organic Rankine cycle (ORC) coupled with the PVT unit, an attempt was made to recover as much as possible heat from the solar energy. Exergy and exergy-economic analyzes were performed on the proposed system, and appropriate criteria for evaluating the system were defined based on energy, exergy, and economic analyses. The exergy analysis results indicate that the highest exergy destruction rate in the ORC sub-system is associated with the PVT unit. The value of electrical cost for three studied cities, Doha, Tehran, and Ankara were calculated. Results present that the highest and lowest net output power were for Doha and Ankara and these cities also have the maximum and minimum electrical cost. In addition, using multi-objective optimization, the optimum states of introduced system in the Pareto diagram are presented and with the help of ideal point concept, the final optimum state is determined.

- **Keywords:** Exergy-economic analysis; Brayton cycle; Photovoltaic thermal; Solar energy

Zahra Taherian, Vahid Shahed Gharahshiran, Yasin Orooji, Hassan Karimi-Maleh, Alireza Khataee. *The study of CO2 reforming of methane over Ce/Sm-promoted NiCaAl catalysts*. Pages 235-242.

In this work, we synthesized Ce and Sm-promoted NiCaAl layered catalysts via co-precipitation and freeze-drying strategies for alleviating some problems, such as coke deposition and agglomeration of active sites, in dry reforming of methane. Employing such promoters leads to rising O2 vacancies on the catalyst's surface, resulting from adsorbing CO2 gas under the reaction. X-ray diffraction (XRD) analysis confirmed the formation of a hydrotalcite network. High-resolution transmission electron microscopy (HR-TEM) and field emission scanning electron microscopy (FE-SEM) images also indicated a wealth of nanocatalysts, well distributed on the surface and within a porous scaffold structure. The temperature-programmed reduction (H2-TPR) proved that cerium (H2 consumption = 1.2 mmol.g-1) could weaken the interactions between nickel and Ca/Al, leading to better reducibility than samarium (H2 consumption = 1.35 mmol.g-1). Moreover, the temperature-programmed deposition (CO2-TPD) showed the Ce-promoted catalyst possesses more basic sites (0.41 mmol.g-1) on its surface than the Sm-enhanced one (0.25 mmol.g-1). Consequently, the Ce-enhanced catalyst with a smaller crystallite size (8.9 nm), higher dispersion of Ni (10.8%), better reducibility, and more basic sites, which caused the highest methane conversion (82%), and H2/CO ratio (0.9) at 700 °C without any coke deposition after 5 h of time on stream.

- **Keywords:** NiCaAl; Hydrotalcite; Methane dry reforming; Cerium; Samarium

Tamiris Rosso Storck, Mariana Islongo Canabarro, Siara Silvestri, Andreli Lopes Piccoli, Jaíne Ames, Vania Lucia Loro, Renato Zanella, Adriele Tassinari, Tadeu Luis Tiecher, Gustavo Brunetto, Elvis Carissimi, Barbara Clasen. *Toxicity evaluation of landfill leachate after treatment by simple distillation using Danio rerio biomarkers*. Pages 243-252.

Landfill leachate is an effluent characterized by a great heterogeneity in its composition, and may contain the most diverse types of organic and inorganic contaminants. Therefore, the leachate needs an efficient treatment before being released into the environment. For this, a lot of treatment processes are being developed and studied, such as simple distillation. To evaluate the efficiency of the treatment, the use of ecotoxicological assays with fish is a useful tool to determine the effects on the aquatic environment of the residual compounds present after the treatment. The aim of this study was to evaluate the efficiency of the simple distillation process in a landfill leachate. For this, in addition to the physical-chemical characterization, the presence of volatile organic compounds (VOC), metals, pharmaceuticals, hormones, and pesticides in the raw (RL) and distilled raw leachate (DRL) was evaluated. Finally, biochemical biomarkers were evaluated in Danio rerio fish exposed to different concentrations of RL and DRL. High concentrations of chemical (COD) and biochemical (BOD) demand for oxygen, nitrogen compounds, sulfates, and chlorides were detected, in addition to fatty acids, long-chain alkanes, alcohols and esters, heavy metals, and six pharmaceuticals. After the distillation process, most of these compounds were reduced by more than 90% and some were removed completely. The biomarkers showed greater changes in the groups exposed to LR and were influenced by the exposure concentration. Thus, the treatment of simple distillation of the leachate proved to be efficient because, in addition to reducing/removing the contaminants, it also reduced the toxicity in D. rerio.

- **Keywords:** Effluent; Metals; Pharmaceuticals; Ecotoxicology; Zebrafish; Biomarkers

Hongyuan Hu, Ziqing Zhang, Binglei Li, Shulin Zhan, Yixiong Huang, Qinyao Lv, Zhenhua Hu, Yi Long. *A numerical simulation of dust pollution law under traditional electric rake operation: A case study of Shuiyindong gold mine.* Pages 253-266.

The Shuiyindong gold mine in Guizhou is used as a case study in this paper to study patterns of dust pollution occurring with traditional electric-rake operation. In particular, the study uses the northern quarry of the twenty-third line in the first middle section of the second mining area and establishes a three-dimensional simulation model of equal size. It uses Computational Fluid Dynamics (CFD) to simulate and analyse the airflow traces and distribution of dust concentration in the relevant roadway during each stage of the electric-rake operation. The simulation results show that the airflow in the working roadway has a spiral movement and produces reverse dirty-wind circulation towards the end. Dust flows out of the working roadway from the 8th second of operation, and dust concentration reaches a peak in the working roadway at the 12th second of operation at an average dust concentration of 37.5 mg/m³. The dust concentration drops rapidly from the 120th second and reaches the maximum dust concentration permitted for operation at the 180th second of operation. The validity of the simulation is tested by comparing the actual measured data at the site with the simulation results. Finally, the simulation results are analysed using violent Python, and the solution is used to divide the roadway into areas according to the human breathing range. The paper analyses the distribution of dust concentration at an average human breathing height, providing an established theoretical basis for dust-control work in mines.

- **Keywords:** Electric-rake work; Dust pollution; Computational fluid dynamics (CFD) Simulation; Violent solution with Python

Rafika Saidi, Moktar Hamdi, Hassib Bouallagui. *Enhanced hydrogen and methane production from date fruit wastes using semi continuous two-stage anaerobic digestion process with increasing organic loading rates*. Pages 267-275.

Biological conversion of date wastes under continuous conditions is a challenge due to their high content of biodegradable organic matter. In this study, hydrogen (H2) and methane (CH4) production in a two-stage process to increase the energy recovery from date pulp wastes (DPW) was investigated. In the first stage, the effect of increasing organic leading rate (OLR) on dark fermentation (DF) performances was evaluated in a semi continuously stirred tank reactors (SCSTR) without nutrients addition. The highest volumetric H2 production rate (VHPR) and specific H2 yield (SHY) of 0.76 L/L.d and 81 LH2/kg volatile solid (VS), respectively were achieved at high OLR of 11.74 gVS/L.d. In the second stage, the DF effluent was used as substrate to feed the SCSTR of anaerobic digestion (AD). The highest volumetric methane production rate (VMPR) of 2.92 L/L.d was achieved with a high OLR (4.25 gVS/L.d) and short hydraulic retention time (HRT, 8 days), producing specific methane yield (SMY) of 530 LCH4/kgVS. Thus, the two-stage process can be an effective strategy for high rate renewable energy recovery (13 kJ/gVSinlet) and organic waste processing.

- **Keywords:** Hydrogen; Methane; Date pulp waste; Two stage; Organic loading rate; SCSTR

Elena M. Rojo, Angel A. Filipigh, Silvia Bolado. *Assisted-enzymatic hydrolysis vs chemical hydrolysis for fractional valorization of microalgae biomass*. Pages 276-285.

Despite the interest in the utilization of photobioreactors as an alternative wastewater treatment, the research about posterior recovery and valorization of nutrients

accumulated in the biomass is still limited. This work compared several hydrolysis methods for the recovery of proteins and carbohydrates from the biomass grown in a photobioreactor treating swine wastewater. Ultrasound-assisted and microwave-assisted enzymatic hydrolysis at mild conditions and chemical methods at different temperatures (40, 60, 120ºC) were applied to the microalgae and bacteria biomass. Alkaline hydrolysis provided the greatest peptide recoveries, increasing with temperature up to a maximum of 81%, but with very small peptide sizes in all temperature range. Acid hydrolysis provided the highest carbohydrate recoveries (60.7% at 120ºC) but degraded proteins, even at mild temperatures. Protein degradation did not vary with temperature in each chemical hydrolysis, obtaining similar peptide sizes in all temperatures, while carbohydrate losses were higher at lower temperatures. Ultrasound-assisted enzymatic extraction recovered 43.6% of the initial proteins as large peptides (up to 135 kDa) with the highest peptide purity (46.7%). Microwave-assistance increased the carbohydrate solubilization of enzymatic hydrolysis, achieving yields of 73% of xylose, but with significant losses.

- **Keywords:** Ultrasounds; Microwaves; Proteins; Peptides; Monosaccharides; Piggery wastewater

Vijaya Lakshmi Bollakayala, Nagabhushan Etakula, Kiran Kumar Vuba, Appala Naidu Uttaravalli, Hrithika Ganta, Srikanta Dinda, Bhanu Radhika Gidla, Likitha Gadde, Gopi Katiki, Srinivas Teja Manda, Sanjana Mutyapu, Narasimha Reddy Seelam. *Enhancement of wood-plastic composite properties in presence of recycled vehicular soot as a carbon source material: Sustainable management approach*. Pages 286-297.

In the study, the wood-plastic composites (WPCs) were prepared using recycled expanded polystyrene (EPS) and sawdust as biomass material. The recycled vehicular soot (RVS) was used as a potential carbon based additive in the composites; and its effect on the properties of the composites was studied. In the process, the soot loading was varied in the range of 0–2.5 wt%. The composites were prepared using the compression moulding method. The effect of recycled soot on the physico-mechanical and thermal properties such as tensile strength, flexural strength, compression strength, impact strength, hardness, screw holding power / screw withdrawal force, water absorption and thermal stability of the in-house prepared WPCs was studied. From the results, it was observed that the mechanical properties of the composites improved in presence of soot and its loading. The soot offered positive results in mechanical properties when it was used up to a loading of 1.0 wt% in the composites. However, the soot loading beyond 1.0 wt% resulted in obtaining the detrimental results in the properties of the composites. The probable reason for decrease in composite properties when the soot was used beyond 1.0 wt% was due to the agglomeration of the soot particles in the composite network. The water absorption values of the composites decreased continuously with the increase of soot loading from 0 to 2.5 wt% due to the hydrophobic nature of soot. The prepared composites were thermally stable up to a temperature of around 240 °C. From the outcome of the study, it can be concluded that the recycled soot can be used as a potential substitute to commercial carbon material in the composites to enhance its properties; and also to prepare cost-effective composites.

- **Keywords:** Wood-plastic composites; Vehicular soot; Compression moulding; Characterization; Strength

Zhenghao Wang, Zhifeng Qin, Liang Chen, Bin Liang, Yingming Zhu, Kejing Wu, Dongmei Luo. *Recovery of low valence vanadium from vanadium slag for the preparation of VOSO4 electrolyte*. Pages 298-309.

Fully oxidation roasting of vanadium slag are industrial methods to recover V(V) from vanadium slag, and discharges residue and wastewater containing highly toxic V(V) and Cr(VI). To avoid this, an environmentally friendly strategy for the direct recovery of low valence vanadium (LVV) from vanadium slag produced by selective oxidation roasting and self-pressure leaching was proposed, and the leaching process of the selective oxidation roasted slag was investigated in this study. It was found LVV recovery to be 68.38% in atmospheric leaching, and the structure of the vanadium slag particles was not completely broken down during the roasting process. In addition, the solubility of the newly formed vanadium compounds was low. When enhanced the leaching process by employing high-temperature self-pressure leaching conditions, 98.34% of the vanadium was recovered as VO2+ ion in solution accounting for 100%. In addition, silicon and titanium were enriched in the leaching residue, realizing the effective separation of vanadium and titanium in the leaching stage. Finally, the VOSO4 electrolyte will be obtained with sufficient purity for use in batteries via solvent extraction. This process provides a novel approach for the comprehensive utilization of vanadium slag that directly recovers VOSO4-containing leaching solution from slag rather than oxidizing V(III) to V(V) then reduces to LVV.

- **Keywords:** Vanadium slag; Recycling; Leaching; Low valence vanadium; Solvent extraction

Sun Liu, Guoqing Shi, Hao Ren, Di Wang. *Effect of diurnal fluctuation of atmospheric pressure on gas migration in goaf of coal mine*. Pages 310-319.

The atmospheric pressure fluctuation will break the pressure balance between the goaf and the working face, and the phenomenon of goaf breathing will occur. The breath causes the regular gas flow out or in between the goaf and the working face, which results in the migration and exchange of the fresh air in the working face and the poisonous and harmful gas in the goaf. Therefore, the risk of disaster in goaf is increased. In this study, based on No.16–17-22050 of Pingdingshan Tian'an No. 9 Coal Mine Co., Ltd, a large number of CFD simulations were carried out by using different fluctuation amplitudes to analyze the influence of diurnal fluctuation of atmospheric pressure on gas migration in goaf. The simulation results show that the goaf is like a semi-closed accumulator. When the atmospheric pressure increases, the increase of inlet flow leads to the accumulation of energy in the goaf, which leads to the farther the spontaneous combustion hazard zone (SCHZ) from the working face and the decrease of methane concentration in the return air corner. When the atmospheric pressure decreases, the decrease of the inlet flow causes the energy release in the goaf, resulting in the closer distance between SCHZ and the working face and the higher methane concentration in the return air corner. The size of SCHZ increases due to atmospheric pressure fluctuation. The above findings provide a theoretical basis for coal spontaneous combustion fire prevention and goaf methane disaster control.

- **Keywords:** Atmospheric pressure; Diurnal fluctuation; CFD; Gas migration

Behnam Akhlaghi, Hassan Mesghali, Majid Ehteshami, Javad Mohammadpour, Fatemeh Salehi, Rouzbeh Abbassi. *Predictive deep learning for pitting corrosion modeling in buried transmission pipelines*. Pages 320-327.

Despite significant efforts and investments in the renewable energy sector, fossil fuels continue to provide the majority of the world's energy supply. Transmission pipelines, which are extensively used in the oil and gas industry, are vulnerable to various failure mechanisms, such as corrosion. Among these, pitting corrosion in offshore pipelines is the most prevalent type of external corrosion. This study explores the potential of deep learning models (Generalization and Generalization-Memorization models) to predict the maximum depth of pitting corrosion in oil and gas pipelines. The models are trained considering various characteristics of the soil where the pipe is buried and different types of the protective coating of the pipes. The application of deep neural networks resulted in a mean squared error of prediction of 0.0055 in training data and 0.0037 in test data. These results demonstrate that deep learning models outperform all empirical and hybrid models applied in previous studies on the same dataset. The proposed model in this study has the potential to predict failure rates of the pipelines due to external corrosion and enhance the safety and reliability of these facilities.

- **Keywords:** Transmission pipelines; Pitting corrosion; Deep learning; Generalization model; Generalization-Memorization model

Demet Canpolat Tosun, Emin Açıkkalp, Basar Caglar, Onder Altuntas, Arif Hepbasli. *Proposal of novel exergy-based sustainability indices and case study for a biomass gasification combine cycle integrated with liquid metal magnetohydrodynamics*. Pages 328-339.

Exergy is considered a way to sustainability. Exergy-based analyses have been recently widely used for performance assessment and comparison purposes of energy systems from production to end-user while different sustainability related indices or indicators including exergetic concepts have been developed in the literature. In this regard, the present study proposed five different indices: (i) Exergetic Fuel Based Environmental Remediation Index (χ), (ii) Exergetic Product Based Environmental Remediation Index (δ), (iii) Exergetic Fuel Based Total Environmental Remediation Index (β), (iv) Exergetic Product Based Total Environmental Remediation Index (α), and (v) Improved Sustainability Index (ISI). These indices were applied to a novel Biomass-integrated Gasification Combine Cycle (BIGCC) integrated with Liquid Metal Magnetohydrodynamics (LMMHD). They allowed to perform a more complete environmental analysis by considering the exergetic cost of environmental remediation of the process. The average exergy efficiency values for the BIGCC, LMMHD and the overall system were determined as 0.491, 0.222 and 0.688 under daily ambient temperatures for a year and different air to fuel ratio (AFR) conditions, respectively. The average values for χ, β, δ, α and ISI were 1.636, 2.389, 1.949, 2.848 and 0.513, respectively.

- **Keywords:** Exergy; Environment; Environmental remediation; Sustainability; Liquid metal magnetohydrodynamic

Sukru Ilke Sezer, Gizem Elidolu, Emre Akyuz, Ozcan Arslan. *An integrated risk assessment modelling for cargo manifold process on tanker ships under FMECA extended Dempster–Shafer theory and rule-based Bayesian network approach*. Pages 340-352.

Risk assessment is one of the top requirements in maritime transportation due to the complexity of ship operations, particularly on tanker vessels. By carrying hazardous liquid cargo, tankers pose significant risks for life, property and the marine environment, which

should be assessed in detail. This paper focuses on the manifold process during tanker cargo operation since it involves various risks that may lead to severe consequences such as human injury, gas poisoning, hull damage, cargo spill or explosion. The process is modelled via Bayesian network, and marine experts evaluate 12 failure modes with respect to Failure Mode, Effect and Criticality Analysis parameters. To fuse the expert judgment, Dempster–Shafer theory is applied with a rule-based approach in the Bayesian model. The highest crisp risk value is found 48.85 for Failure Mode (FM) 1.1 (Improper arrangement of valves and pipelines to be connected). It is followed by FM 1.2 (Improper connection between the line and the manifold) with a crisp risk value of 45.83, and FM 4.1 (Failure in earthing & bonding condition of equipment to be used) with 38.26 crisp risk value. According to results, control actions are presented to reduce the risks during the manifold process. Beside its technical background, the paper provides utmost contributions to maritime safety inspectors, tanker ship crew, tanker ship operators and safety researchers to improve safety process and minimize the operational risks of cargo manifold process.

- **Keywords:** Tanker manifold process; FMECA; Dempster–Shafer theory; Bayesian network; Risk assessment

Huaming Dai, Qingyuan Cui. *La-Ce-hexaaluminate doped by multivalent metal ion as the oxygen carrier for the optimization of hydrogen production*. Pages 353-367.

The efficiency of porous media combustion was greatly improved by combining the high-temperature catalyst of hexaaluminate. In this paper, a double-layer porous media burner filled with cylinders was built with the loading of La0.8Ce0.2MAl11O19 (M = Fe, Co, Cu). The effects of hexaaluminate and cylinders parameters on the products concentration and temperature distribution were studied at different working conditions. Results indicated that the La0.8Ce0.2CuAl11O19 obtained the excellent catalytic performance with the most adsorbed oxygen and oxygen channels, so that the maximum hydrogen mole fraction was achieved. With the increasing of the 13 mm cylinders volume ratio from 0 to 1, the hydrogen and carbon monoxide yield increased by 53.3 % and 50.9 %, respectively. Meanwhile, the increased heat releasing of the higher velocity contributed to improving the combustion temperature and syngas production. These results provided theoretical guidance for the catalytic porous media reactor in energy utilization and environmental protection.

- **Keywords:** Hexaaluminate; Porous cylinder; Hydrogen production; Adsorbed oxygen

Tse-Wei Chen, Thangavelu Sakthi Priya, Shen-Ming Chen, Thangavelu Kokulnathan, Faheem Ahmed, Thamraa Alshahrani. *Synthesis of praseodymium vanadate in deep eutectic solvent medium for electrochemical detection of furaltadone.* Pages 368-375.

The fabrication of electrode material with unique physiochemical properties is significant to enhance electrochemical performance. In this work, we synthesized praseodymium vanadate (PrVO4) through green deep eutectic solvents (DES) by the solvothermal approach and explored it as an electrochemical sensor for furaltadone (FLD) detection. The as-prepared PrVO4 was characterized by using appropriate microscopic and spectrophotometric techniques. The modification of the electrode on PrVO4 showed excellent electrochemical performance due to its high conductivity, active sites, and fast electron transfer ability. The PrVO4-modified electrode displayed a dynamic linear range (0.008–91 μM), trace-level detection limit (0.002 μM), high sensitivity (4.276 μA μM−1 cm−2), and strong selectivity for FLD detection under optimum experimental conditions. The practical applicability of PrVO4 modified electrode was successfully investigated for

the effective determination of FLD in pond water, human urine, and fish samples, revealing its potential application for real samples analysis. This work provide applicable guidelines for the design and development of DES-based electrode materials for the electrochemical sensor application.

- **Keywords:** Rare-earth metal vanadates; Binary metal oxides; Nitrofuran; Antibiotic; Green solvent

Olav R. Hansen, Eirik S. Hansen. *CFD-modelling of large-scale LH2 release and explosion experiments*. Pages 376-390.

As a part of zero emission ambitions within the maritime, aviation and elsewhere, liquid hydrogen (LH2) will increasingly be used as an energy carrier and fuel in the coming years. It is therefore important to understand safety aspects of LH2, including gas dispersion and explosion properties. In the process of building the world's first ferry using LH2 as fuel the Norwegian Public Roads Administration commissioned large-scale LH2 release tests to study dispersion and explosion properties relevant for the design and approval processes. Experiments with LH2 releases both indoor and outdoor were performed. In this article these experiments are described and compared to simulations with the CFD-model FLACS. The aim of the modelling is both to better understand the experiments performed, and to demonstrate that important phenomena and physics related to LH2 safety assessments for approval processes can be simulated and predicted with confidence.

- **Keywords:** Liquid hydrogen; Dispersion; Explosion; Computational fluid dynamics; Experiments; Validation

Nannan Zhu, Xuehui Wang, Mingyi Chen, Que Huang, Chao Ding, Jian Wang. *Study on the combustion behaviors and thermal stability of aging lithium-ion batteries with different states of charge at low pressure*. Pages 391-402.

Currently, there are many application scenarios for lithium-ion batteries (LIBs) in high-temperature environments, such as large-scale energy storage, electric vehicles, aviation and so on. However, the fire and explosion risks of LIBs will pose a serious threat to transportation, industry applications, and environment. In this work, hence, considering the influence of ambient pressure, a series of experiments are performed to study the characteristics of thermal runaway (TR) for commercial LIBs with different states of charge (SOCs). Relative to past research on fresh batteries, aging LIBs whether at 100 % SOC condition or at lower SOCs, did not particularly exhibit significant spark ejection. The simultaneous burning flame was vertically upwards and no petal-shaped flame appeared. And the maximum flame temperature of LIBs during TR are 394 °C, 368 °C, 469 °C and 508 °C from 30 % SOC to 100 % SOC, respectively. The maximum flame temperature and average mass loss rate of LIBs show a correlation with SOC. Given that the combustions of gases and most ejected combustibles are significantly affected by the environmental pressure, the modified energy balance equation of the battery during the entire TR process is established to quantitative the relationship between the cell surface temperature and SOC under different environmental conditions. These results will help to further identify the risk of the TR process of LIBs with different SOCs after high-temperature aging, and provide a scientific basis for the transportation and use of batteries.

- **Keywords:** Lithium-ion batteries; Aging; Low pressure; Thermal runaway; Combustion characteristics; Thermal stability

Yu Cheng, Kangjuan Lv, Siwei Zhu. *How does digital financial inclusion promote green total factor productivity in China? An empirical analysis from the perspectives of innovation and entrepreneurship*. Pages 403-413.

Green total factor productivity (GTFP) is a critical indicator for measuring sustainable development, with profound implication for achieving a win-win situation of economic prosperity and environmental protection. However, little attention has been paid to understand the influence of emerging digital financial inclusion (DFI) on China's GTFP growth. To address this research gap, this study employs the Malmquist-Luenberger index to measure the GTFP of 276 cities in China from 2011 to 2019, and then explores the impact of DFI on GTFP from the perspectives of innovation and entrepreneurship. The results show that the development of DFI significantly increases GTFP, which remains robust after variable replacement and endogenous treatment. At the micro-level, DFI is conductive to GTFP growth by promoting green innovation and entrepreneurial activity. Particularly, this study sheds light on the valid channel of green innovation patents in the relationship between DFI and GTFP whereas the mediating role of green utility models appears trivial. Heterogeneity analysis illustrates that the promotion effect of DFI on GTFP is more significant in the eastern area and non-resource-based cities. Therefore, in order to achieve sustainable development, the Chinese government should incorporate the development of DFI into the formulation of policies related to carbon mitigation.

- **Keywords:** Digital financial inclusion; Green total factor productivity; Green innovation; Entrepreneurial activity; Heterogeneity analysis

Rezgar Hasanzadeh, Parisa Mojaver, Taher Azdast, Shahram Khalilarya, Ata Chitsaz, Marc A. Rosen. *Decision analysis for plastic waste gasification considering energy, exergy, and environmental criteria using TOPSIS and grey relational analysis*. Pages 414-423.

Plastic waste is becoming of increasing interest in gasification research because the gasification of plastic waste not only produces a valuable hydrogen-rich syngas but also can help reduce environmental problems caused by these materials. Most studies in the field of plastic waste gasification have only focused on evaluating effects of process parameters and optimizing the process by considering input variables. The present study explores the comparative performance analysis of a wide range of prevalent plastic waste types utilizing multi-criteria decision-making techniques. This study uses the "technique for order preference by similarity to ideal solution" (TOPSIS) and grey relational analysis (GRA) and presents a thorough sensitivity analysis. Low-density polyethylene results in maximum lower heating value of syngas and has a desirable performance from cold gas and exergy efficiencies viewpoints in air gasification. The findings of TOPSIS and GRA techniques show that low-density polyethylene as plastic waste exhibits the best performance in an air gasification process and the results of the sensitivity analysis confirm this. However, the decision making in steam gasification was challenging where TOPSIS and GRA techniques introduced high-density polyethylene and low-density polyethylene as the best candidates, respectively. Again, the findings of the sensitivity analysis confirmed the result. High-density polyethylene exhibits the best performance in steam gasification according to sensitivity analysis via the TOPSIS technique while low-density polyethylene ranked first according to sensitivity analysis of GRA. The findings can contribute to a better understanding of the selection of plastic waste feedstock for air and steam gasification by considering energy, exergy, and environmental factors.

- **Keywords:** Plastic waste; Gasification; Multi-criteria decision-making analysis; Sensitivity analysis; Grey relational analysis

Mohini Verma, Shubhrasekhar Chakraborty, Shweta Kumari, Aalok Gupta, Dewanshu Kumar, Jawed Iqbal, J. Rajesh Banu, Arulazhagan Pugazhendi, R. Naresh Kumar. *Co-treatment of stabilized landfill leachate and municipal wastewater in a granular activated carbon-sequencing batch reactor (GAC-SBR).* Pages 424-432.

A laboratory-scale granular activated carbon-sequencing batch reactor (GAC-SBR) was used to co-treat stabilized landfill leachate with municipal wastewater. GAC-SBR was studied for the different mixing ratios of leachate and municipal wastewater at different hydraulic retention time (HRT). GAC dose (5, 10, 15 and 20 g/L) was optimized for COD reduction with a contact time of 22 h. GAC-SBR treatment efficiency was assessed on mixed liquor suspended solids (MLSS), mixed liquor volatile suspended solids (MLVSS), turbidity, chemical oxygen demand (COD), ammonia, nitrate, and phosphate removal. Univariate ANOVA was applied to test the statistical significance of treatment at different leachate:wastewater ratios. Results showed that the increase in GAC concentration led to an increase in the removal of COD and ammonia from stabilized landfill leachate. Adsorption efficiency decreased or remained constant after 15 g/L GAC. GAC-SBR was efficient in removing COD (83%) and nutrients (80–90%) from stabilized landfill leachate at 10 d HRT. Univariate analysis of variance (ANOVA) highlighted that there was a statistically significant difference in the treatments for the mixing ratio tested. GAC-SBR results showed that treatment efficiency was dependent on landfill leachate concentration and hydraulic retention time (HRT). Coupled treatment tested exhibited a high potential for co-treatment of leachate and municipal wastewater. However, the effluent after treatment could not achieve a complete or very high level of COD, nutrients and turbidity removal which necessitates the incorporation of physico-chemical processes such as coagulation, electrocoagulation, membrane filtration etc. as post-treatment options. Further studies in this direction along with exploring the longevity of GAC in SBR would provide useful information for effective landfill leachate treatment.

- **Keywords:** GAC-SBR; Co-treatment; Landfill leachate; HRT; COD; Nutrients

Mehdi Mennani, Meriem Kasbaji, Anass AIT Benhamou, Abdelghani Boussetta, Abderrahim El Haib, El-Houssaine Ablouh, Nabil Grimi, Amine Moubarik. *Unlocking the polyfunctionality of cactus waste seed lignin in sustained catalysts: Optimizing the catalytic activity of a novel maleated lignin catalyst (MLC).* Pages 433-447.

Lignin's polyfunctionality is evolving into alternative bio-based catalysts from under-used agro-industrial waste. To promote safe and eco-conscious disposal of these residues, maleated lignin catalyst (MLC) was prepared via simple and efficacious process, and used as a sustainable heterogeneous catalyst for the O-acetylation of SA (salicylic acid). Response surface methodology (RSM) built on Box-Behnken design of experiment (BBD) has reliably established the influence of reaction parameters on the catalytic properties of MLC. The characterization findings reveal stable yet efficient functional reactive sites on MLC, with an acid density of 4.92 mmol.g−1 and BET surface of 1.37 m2/g. With only 4% MLC, high activity was achieved (95.14%) with short reaction time and low temperature (30 min, 60 °C), and an Ea of 56.11 kj.mol−1. Upon reusability, the MLC was characterized by FTIR, XRD, TGA, SEM, BET, etc., and 57% of its catalytic activity was retained after 5 cycles, with high stability and no meaningful mass loss. The BBD model was statistically significant and exhibited good agreement between the predicted and actual yield. The adopted coupling of experimental and theoretical approaches for the first time in lignin-based catalysts can promote beneficial rational design and implementation of lignin catalysts in green chemical synthesis.

- **Keywords:** Lignin; Agro-industrial waste; Maleated lignin; Reusability; Acetylation; Box-Behnken design

Depeng Kong, Hengle Zhao, Ping Ping, Yue Zhang, Gongquan Wang. *Effect of low temperature on thermal runaway and fire behaviors of 18650 lithium-ion battery: A comprehensive experimental study*. Pages 448-459.

To investigate the effect of operating temperature on the thermal runaway (TR) and combustion behavior of lithium-ion batteries(LIBs), a series of LIB thermal abuse experiments were performed after cycling at different temperatures and cycle rates. Local heating of the electrothermal film was used to simulate the abuse process triggered by the TR of adjacent LIB in the module. Combustion behavior, cell surface and flame temperatures, thermal radiation and mass loss were measured. For the cell cycling at 0 °C, the amount of gas in the exhaust phase was obviously reduced, and the intensity of flame combustion was reduced. For the battery after cycling at − 10 °C, deflagration occurred within 2 s after the safety valve cracked. The experimental results show that the onset temperature of TR of LIB decreased significantly with the operating temperature decreasing from 25 °C to − 10 °C. Low-temperature cycling causes safety valve cracking and TR to occur earlier. This work presents in detail the characteristics and mechanism of TR behavior changes of LIBs at low temperatures, which provides guidance for process safety assurance and fire protection design for the practical engineering applications of battery at low temperatures.

- **Keywords:** Lithium-ion battery; Thermal runaway; Combustion behavior; Low temperature; Lithium deposition

Xinqi Zhang, Jihao Shi, Ming Yang, Xinyan Huang, Asif Sohail Usmani, Guoming Chen, Jianmin Fu, Jiawei Huang, Junjie Li. *Real-time pipeline leak detection and localization using an attention-based LSTM approach*. Pages 460-472.

Long short-term memory (LSTM) has been widely applied to real-time automated natural gas leak detection and localization. However, LSTM approach could not provide the interpretation that this leak position is localized instead of other positions. This study proposes a leakage detection and localization approach by integrating the attention mechanism (AM) with the LSTM network. In this hybrid network, a fully-connected neural network behaving as AM is first applied to assign initial weights to time-series data. LSTM is then used to discover the complex correlation between the weighted data and leakage positions. A labor-scale pipeline leakage experiment of an urban natural gas distribution network is conducted to construct the benchmark dataset. A comparison between the proposed approach and the state-of-the-arts is also performed. The results demonstrate our proposed approach exhibits higher accuracy with AUC = 0.99. Our proposed approach assigns a higher attention weight to the sensor close to the leakage position, indicating the variation of data from the sensor has a significant influence on leakage localization. It corresponds that the closer to the leakage position, the larger variation of monitoring pressure after leakage, which enhances the detection results' trustiness. This study provides a transparent and robust alternative for real-time automatic pipeline leak detection and localization, which contributes to constructing a digital twin of emergency management of urban pipeline leakage.

- **Keywords:** Pipeline fault diagnosis; Leakage localization; Attention mechanism; Long short-term memory

Ben Ji, Bingyou Jiang, Liang Yuan, Changfei Yu, Gang Zhou, Yang Zhao, Shiju Wang, Xiaohan Wang. *Experimental and molecular dynamics simulation study on the influence of SDS and JFC composite ratios on bituminous coal wettability*. Pages 473-484.

Dust control has always been a difficult problem in the process of safe mining. Using composite surfactants becomes a simple and effective dust suppression method. However, the micro mechanism of the effect of composite ratio on coal wettability was still unclear. In this study, the experimental combined with molecular dynamics (MD) simulations were used to research the effect of different composite ratios of SDS (Sodium dodecyl sulfate)/JFC (Fatty alcohol polyoxyethylene ether) surfactant on bituminous coal wettability. The experiment results showed that the mixed JFC and SDS solution had good wettability on bituminous coal. The contact angle and surface tension decreased as the proportion of JFC increased in the compound solution. Zeta potential experiment results indicated that adding JFC improved the aggregation ability between coal dust and promoted the settlement of coal dust in the mixed surfactant. The best synergistic wetting effect was achieved at a molar ratio of 1:3 (SDS/JFC). The simulation results showed that the thickest coal/water adsorption layer was formed at a 1:3 (SDS/JFC) mixing ratio. At this ratio, the diffusion coefficients of water molecules increased significantly, which promote the probability of coal collision with water molecules. Finally, the mechanism of the optimal synergistic ratio promoting coal wetting was explained by analyzing the distribution configuration of surfactant molecules. The whole work is of great significance to coal dust prevention and provides a new idea for exploring the synergistic composite ratio of wetting agents.

- **Keywords:** Coal dust; Surfactant; Bituminous coal; Molecular dynamics simulation; Wettability

Weiwei Wang, Yeguo Sun, Hasan Sh. Majdi, Ahmed Deifalla, Theyab R. Alsenani, Zhanping Zhao, Zhanguo Su, Wu Zhang, Mostafa A.H. Abdelmohimen. *Multi-aspect investigation and multi-criteria optimization of a novel solar-geothermal-based polygeneration system using flat plate and concentrated photovoltaic thermal solar collectors*. Pages 485-509.

This study investigates different aspects of an innovative multi-heat recovery-based solar-geothermal polygeneration system, acclaiming the exergetic, exergoeconomic, and energetic concepts. Principally, using two renewable energy sources, the whole framework of the system encompasses Concentrated PhotoVoltaic Thermal (CPVT) solar collectors, Flat Plate Solar Collectors (FPSCs), geothermal wells, an Ejector Refrigeration Cycle (ERC) Organic Rankine Cycle (ORC) integrated with a Solid Oxide Electrolyzer Cell (SOEC), heating production units, an air dryer, and an Organic Rankine Cycle (ORC) unit. Afterward, the sensitivity analysis utilized for the parametric study makes a multi-aspects optimization in diverse scenarios in which NSGA-II, as well as, fuzzy TOPSIS and fuzzy VIKOR decision makings, are handled to designate the optimal solution. The suggested system has professionally been devised thanks to the characteristic of maximum use of energy of the streams circulated. Hence, crucial variables evaluated are more influenced by the variation in the geothermal heater pinch point temperature gradient. Also, in the optimization scenario based on unit cost of products / exergy efficiency, the TOPSIS selects the optimal objectives of 4.29%/1.13 $/GJ, while the VIKOR selects 4.06%/1.07 $/GJ, respectively.

- **Keywords:** Solar-geothermal; Multi-heat recovery; Concentrated photovoltaic solar collectors; Fuzzy TOPSIS; Fuzzy VIKOR; Multi-criteria optimization

Suman Mor, Khaiwal Ravindra. *Municipal solid waste landfills in lower- and middle-income countries: Environmental impacts, challenges and sustainable management practices*. Pages 510-530.

Municipal Solid Waste (MSW) is collected, transported, and disposed of in an unorganized and disordered manner in lower- and middle-income countries. Improper waste disposal in landfills can have severe environmental consequences in terms of groundwater, soil and air contamination, resulting in numerous health hazards. In India, Landfills require 1240 ha of land per year and only 21% of MSW is adequately managed. The remaining MSW is not reprocessed or recovered through treatment technologies and is generally disposed of in an un-hygienic landfill. Urban or rural solid waste is usually dumped in low-lying areas, which adds to the greenhouse gas emissions, obnoxious odor production and causes fire hazards that adversely affect the local ecosystem. Landfills contribute to CH4 production and about 29% of all GHGs emissions, which is more than 15% of the average global contribution. It is also noticed that by 2030 and 2050, global GHGs emissions will rise to 64% and 76% due to uncontrolled waste disposal systems. The study highlights effective solid waste management practices and discusses ways to manage it sustainably through resource recovery. As a result, the study concentrated on using waste-to-energy technologies that still require significant support for execution. The study concluded that waste-to-energy technologies need adequate financial and government support. Further, extreme resource recovery from the waste must be linked with a secure waste disposal system via engineered landfill construction and waste-to-energy plants' operation. Solid waste management also needs local corporations to effectively manage the waste services following national-specific policies and standards, including community awareness and participation, system responsibilities and use of emerging technologies. This will aid in reducing the adverse effects of MSW disposal and achieve the UN's sustainable development goals.

- **Keywords:** Municipal solid waste landfills; Landfill pollution; Environmental and health impacts; Waste management practices; Waste-to-energy

Tan Tingjiang, Guo Changfang, Zhang Guohua, Jiao Wenhua. *Research and application of downhole drilling depth based on computer vision technique.* Pages 531-547.

Gas drainage and water detection and release by drilling are essential to prevent gas and water disasters in China. The accurate drilling depth substantially affects gas drainage, water exploration, and safety problems. Consequently, it is essential to precisely monitor drilling depth by counting drill pipe to assure drilling efficacy. Based on increasingly sophisticated subterranean video surveillance technology, this paper leverages computer vision technology to implement precise drill pipe counting and calculates the corresponding drilling depth determined by the number of drill pipes. First, the operation of the drilling rig was examined, and the movement trajectory of the impact power head on the drilling rig feeding mechanism was estimated to quantify the number of drilling pipes. The optimized Retinex mine image enhancement algorithm is used to preprocess the initial underground image with issues including an unreliable light source, considerable light and shadow fluctuation, and blurred lens. Furthermore, the challenges of fixed scale and easy loss of target tracking in the Kernel Correlation Filter Algorithm are addressed by employing an adaptive scale algorithm and a re-detection approach to boost target location data accuracy. Eventually, the amount of drill pipes is calculated by the effective peak count of the displacement, the precise drilling depth is achieved, and the result is consistent with the actual drilling construction condition by evaluating the on-site drilling video. This study adopted computer vision tracking technology to tackle the challenge of calculating drilling depth and building progress accurately, ensuring the safe and efficient output of the mine.

- **Keywords:** Drilling depth; Retinex mine image enhancement algorithm; Adaptive scale algorithm; Re-detection strategy; Improved kernel correlation filtering algorithm; Effective wave peak count

Xin Zhang, Junjie Liu, Chaojun Liu. *A novel slip-velocity model to simulate the filtration performance of nanofiber media*. Pages 548-560.

Aerosols such as PM2.5 and PM10 can have an immense impact on human health. With the outbreak of SARS-CoV-2, it is urgent to filter aerosols by media filtration technology. Electrospun nanofibers are a promising material for achieving high efficiency, low resistance, light weight, and environmentally friendly air filtration. But research on filtration theory and computer simulation of nanofiber media is still lacking. The traditional method involving computational fluid dynamics (CFD) and Maxwell's first-order slip boundary overestimates the slip velocity on the fiber surface. In this study, a new modified slip boundary was proposed, which introduced a slip velocity coefficient on the basis of the no-slip boundary to address the slip wall. Our simulation results were compared with the experimental pressure drop and particle capture efficiency of real polyacrylonitrile (PAN) nanofiber media. The computational accuracy on pressure drop of the modified slip boundary improved 24.6% and 11.2% compared with that of the no-slip boundary and Maxwell's first-order slip boundary, respectively. It was found that the particle capture efficiency near the most-penetrating particle size (MPPS) was significantly increased when slip effect occurred. This may be explained by the slip velocity on the fiber surface, which would make particles more accessible to the fiber surface and captured by interception.

- **Keywords:** CFD; Nanofiber; Filter media; Air filtration; Slip effect; Transition regime

Bin Su, Zhenmin Luo, Jun Deng, Tao Wang, Litao Liu, Shangyong Zhou, Kunlun Lu, Jiang Zhang, Lu Liu. *Comparative study on methane/air deflagration with hydrogen and ethane additions: Investigation from macro and micro perspectives*. Pages 561-573.

Natural gas usually contains a small amount of hydrogen and ethane in addition to methane, which would pose a threat to the safety of natural gas production and utilization by affecting its explosion risk. In order to reveal the effect mechanism of hydrogen and ethane on methane deflagration, the deflagration behaviors of methane-hydrogen/ethane-air mixtures([CH4]=7.0, 9.5, 11.0 vol. %; [H2]=0–2.0 vol. %; [C2H6]=0–2.0 vol. %) at normal temperature and pressure are compared and analyzed from macro and micro perspectives. The results indicate that the deflagration pressure and the spectral intensity of free radicals (H* and OH*) show different change trends depending on equivalent state of the system with adding hydrogen or ethane to methane/air mixtures. There is a parabolic relationship between the average rising rates of deflagration pressure (VP) and spectral intensity (VI) and they are positively correlated. The contribution of H* to deflagration pressure gradually decreases while the promotion of OH* to it increases with the volume fraction of methane changing from 7.0 % to 11.0 %. Besides, the top 10 most significant elementary reactions were obtained in the methane deflagration process with adding hydrogen and ethane. Hydrogen promotes methane deflagration by reacting with OH and O, while ethane contributes to it by reacting with OH and CH3.

- **Keywords:** Deflagration pressure; Key free radical; Average rising rate; Laminar burning velocity; Chain reaction; Sensitivity analysis

Zhengshe Kang, Xinming Qian, Yuanzhi Li, Longfei Hou, Zhengrun Huang, Weike Duanmu, Mengqi Yuan. *Feature extraction of natural gas leakage for an intelligent warning model: A data-driven analysis and modeling*. Pages 574-584.

Online monitoring of natural gas in urban underground space has proven to be an effective method for resolving minor leakage and explosion accidents in urban low-pressure natural gas pipelines. However, the harsh environment of urban underground space is often accompanied by the generation of biogas, whose components are more similar to those of natural gas, causing great disturbance to early warning of natural gas leakage. This study correlates the biogas generation principle and its transport law with human activities and environmental changes, analyzes and extracts the characteristics of the natural-gas-biogas CH4 concentration using big data analysis technology, and establishes a natural-gas-biogas sample database. The imbalance between positive and negative samples in the database is addressed by two oversampling techniques. The models trained by two different machine learning algorithms were then evaluated. The results of the study are summarized as follows: (1) There are daily and annual cycles in the CH4 concentration in biogas. The daily trend of biogas in the same manhole is similar, and the biogas in different manholes shows various changes periodically with human activities. Biogas early warnings often occur during the high temperature season (April-September). (2) Features such as period, temperature of alarm, and average concentration over 24 h are positive for improving model accuracy. (3) The combined model of XGBoost and the borderlineSMOTE algorithm has an f-score of 72.7 %, an accuracy of 71.2 %, and a recall of 73.4 %. Compared with the traditional manual classification method, the model proposed in this study can identify natural gas and biogas in a more real-time and accurate manner, reduce the workload of on-site confirmation, and effectively shorten the emergency response time.

- **Keywords:** Underground pipeline; Natural gas leakage detection; Feature extraction; Extreme Gradient Boosting; Intelligence classification model

Yijie Tong, Ruijin Wang, Shifeng Wang, Huijiao Wang, Lizhong Huang, Chun Shao, Xiao Jin, Bing Xue, Zefei Zhu. *Comparison and evaluation of energetic and exergetic performance of an evacuated tube solar collector using various nanofluid*. Pages 585-594.

There is a growing interest in renewable energy sources cause the worsening impact of fossil fuel development and abuse on the ecological environment. Solar collectors are major facilities that utilize solar energy, many studies and techniques have been employed to increase the efficiency of the collectors. This paper aims to evaluate the thermal performance of an evacuated tube solar collector(ETSC) in the solar thermal system by using Al2O3, CuO, Fe3O4 and Multi-walled carbon nanotube(MWCNT) nanofluid as working fluids. An evaluation approach for the energy, exergy and entropy of ETSC were proposed. Furthermore, the energy gained and stored by nanofluid in the solar collector was also been studied. The ETSC shown highest energy and exergy efficiency when the 0.01 vol%-MWCNT nanofluid was used which was 33.1% higher than that of water, and it was the same situation of exergy efficiency while the highest was 3.17 under the optimum situation. In addition, the energy gained by 0.01 vol%-MWCNT nanofluid showed the highest potential of energy absorption than other nanofluid, the maximum exergy destruction and entropy generation were achieved when water was used as working fluid of solar collector while the lowest were observed when MWCNT nanofluid with 0.01 vol% was used. Compared to normal working fluid in the ETSC, the use of nanofluid with high thermal conductivity can save more fossil fuels and coals which have a positive effect on protecting the environment.

- **Keywords:** Energy storage; Solar collector; Entropy; Exergy

Shilpa Mishra, Baranidharan Sundaram. *Fate, transport, and toxicity of nanoparticles: An emerging pollutant on biotic factors*. Pages 595-607.

Most aspects of various nanoparticles are now developing and expanding without having any standard laws or specified guidelines. This could lead to unfavorable environmental changes and have an impact on the employees in both interior and exterior working environments. Asbestos, silica, carbon nanotubes, graphene, fullerene, metal oxides, and metals like iron and titanium are all-natural inorganic minerals that can have serious biotic and environmental repercussions. The mobility, sensitivity, environmental consequences, and stability of such nanoparticles must all be considered when assessing their potential. With the growing usage of nanoparticles for industrial and commercial reasons, the question is whether the significant advantages of nanoparticles outweigh the financial expenses, environmental implications, and unknown hazards associated with their use. There are no defined standards for determining nanoparticle effects, and there have been few investigations on the environmental and hazardous repercussions of nanoparticles in explicit as well as implicit exposure. A thorough examination is needed to determine the specific, significant risk associated with the use of nanoparticles. To provide a thorough analysis of the health hazards associated with exposure to such nanoparticles on the environment and biotic factors, this review will present a glimpse of research into the toxicity of various nanoparticles. The detrimental effects of nanoparticles on humans, plants, animals, and the environment are highlighted in this review article along with various sources, exposure routes, and transport of nanoparticles. The information gleaned from these studies may help to lessen the environmental risks associated with the use of nanoparticles.

- **Keywords:** Nanotoxicology; Nanoparticles; Toxicity; Environmental impact; Emerging contaminants

Sabryna I.G. Costa, Fabricio L. Ferreira, Silvio E. Weschenfelder, João Vítor R. Fuck, Maria de Fátima R. da Cunha, Belisa A. Marinho, Luciana P. Mazur, Adriano da Silva, Selene M.A.Guelli.U. de Souza, Antônio Augusto U. de Souza. *Towards the removal of soluble organic compounds present in oilfield produced water by advanced oxidation processes: Critical review and future directions*. Pages 608-626.

Even with the development of alternative fuels and energy sources, the world is still highly dependent to the petroleum production and extraction. Align to this, the treatment of oilfield produced water (OPW) is a global challenge, since for each barrel of extracted oil it is produced 3 barrels of OPW in average. OPW contains numerous organic compounds, including naphthenic acids (NAs), which are considered recalcitrant compounds and are not efficiently removed by conventional OPW treatment. Advanced oxidation processes (AOPs) produce highly reactive hydroxyl radicals (•OH) and are considered a promising alternative for the degradation of resistant organic compounds. This review focuses on the treatment of OPW and degradation of pollutants present in its composition through different AOPs (ozonation, photocatalysis, photochemical oxidation and Fenton-based processes). The factors affecting the processes and strategies to improve AOPs efficiency for OPW treatment are discussed. The background information regarding each process, their main operational parameters and recent publications were addressed aiming to present viable technologies for the complete treatment of OPW. The main finds indicate that individual processes may present some limitations, and much of the emerging research in this field is directed towards the use of combined processes.

- **Keywords:** Petrochemical wastewater; Ozonation; Photocatalysis; Photochemical oxidation; Fenton-based Processes; Wastewater treatment

Shunda Lin, Yang Lu, Lin Zheng, Ling Long, Xuguang Jiang, Jianhua Yan. *Immobilization potential of Cr through Ultrasonic-assisted water washing in MSWI fly ash and evaluation of carbon capture and product reuse in its washing liquid*. Pages 627-636.

This study, a method was proposed under room temperature, atmospheric pressure, additive-free, and ultrasound was used as a strengthening method to promote the original gehlenite in municipal solid waste incineration fly ash (MSWI FA) to fix soluble chromium (Cr). At the same time, CO2 was captured, and calcium salts were recovered by using the washing solution's alkaline and high calcium ion properties. Firstly, the reaction time (t), ultrasonic power (w), magnetic stirring rate (rpm), and liquid-solid ratio (L/S) of ultrasonic-assisted water washing were studied by single factor experiment. The results shown that the ultrasonic power had the most significant effect on the fixation effect of Cr, and the optimal parameters are 50 min, 800w, 500 rpm, and 8 L / kg, respectively. The fixation rate of Cr was more than 99.64%. Subsequent carbonation experiments on the washing waste liquid showed that under the flow rate of 200 ml/min of carbon dioxide gas flow, the calcium ions in the solution can be recovered in the form of calcium salts. This study provides an effective MSWI FA treatment process, which can realize the resource utilization of MSWI FA and has the potential to adsorb CO2 and recover calcium salts efficiently.

- **Keywords:** Ultrasound; MSWI FA; Cr; Resource utilization; CO2 adsorption

Davod Naghavi dizaji, Mohsen Ghafari, Naser Vosoughi. *Investigation of nuclear reactor* core thermal-hydraulic characteristics after partial loss of flow accident. Pages 637-662.

In normal operation conditions of nuclear power plants, the distribution of primary coolant between fuel channels would be considered almost uniform. When different number of Reactor Circulation Pumps (RCPs) are switched off, known as an abnormal condition, this uniform distribution is disturbed and different conditions occur for each channel depending on its position in the core. In this research, the normal and abnormal condition (with one or two tripped RCPs) for a VVER-1000/446 is investigated. For evaluation of the core neutronic calculations and thermal power distribution, USNRC's PARCS system code is employed. Then a thermal-hydraulics module was developed for performing the T/H calculation of the core zone. The input velocity of each channel in abnormal condition was calculated based on developed CFD model in downcomer and lower plenum of Reactor Pressure Vessel (RPV) by ANSYS-CFX. The results show that, in normal operation, the hot channel is related to the central fuel assembly of the reactor core with the highest relative power equal to 1.29 and total power of 23.74 MW. In this case, the minimum inlet velocity, the maximum coolant outlet velocity, and the maximum fuel temperature are 5.6 (m/s), 330.96 (°C), and 1345.8 (°C), respectively. In the cases of operation with one and two tripped RCPs, the hot channel is related to the fuel assemblies with the lowest inlet velocities. The lowest velocities are 0.32 m/s, 0.24 m/s, and 0.22 m/s respectively for the condition with one tripped pump, two tripped pumps placed oppositely, and two tripped pumps placed contiguously. The hot channel numbers in these cases are 158, 102, and 90, respectively. In these channel, the condition of outlet flow would be superheated, but the fuel temperature (1006.3, 1050.9, and 987.9) do not reach the maximum allowable margin. The study confirms the necessity of the coolant distribution consideration in OLCs as well as events that may disturb the symmetry of the coolant flow. It also showed that the lateral fuel assemblies are more at risk in this situation because of a significant reduction in coolant flow. Likewise, the investigations proved the safe continuation of the operation in PLOFA conditions with the preventive algorithm of the emergency protection system and without any need for immediate mitigation actions or operator intervention.

- **Keywords:** Nuclear safety; Thermal-hydraulics analysis; Operational Limits and Conditions; Tripped RCPs; PARCS; ANSYS-CFX

Jiaxin Zhang, Yiyang Dai, Zemin Feng, Lichun Dong. *An enhanced temporal algorithm- coupled optimized adaptive sparse principal component analysis methodology for fault diagnosis of chemical processes*. Pages 663-680.

Principal component analysis (PCA) is a classic fault diagnosis method widely used in chemical process data modeling. However, the limitation of PCA to handle dynamic and time-variant data has been progressively exposed with the ever-increasing development of artificial intelligence technologies and applications of automation systems in the chemical industry. In this paper, an enhanced temporal algorithm-coupled optimized adaptive sparse PCA (ETA-OASPCA) methodology is proposed with the aim to improve the conventional PCA method by introducing temporal state computation and dynamic adaptive sparsity. The ETA is constructed to extract the state transitions of the time-variant process data by introducing the "Transition" and "Hold", acquire the region of interest by employing a Maximum Fuzzy c-means (MFCM) method, and then use the region time prediction automaton to label the possible abnormal states. The introduction of dynamic adaptive sparsity in PCA, achieved by presenting an iterative interior point optimization method to update the dynamic sparse penalty term, can impose sparsity constraints on dynamic data calculations, thus enhancing the interpretability of the PCA model. The effectiveness of the proposed method was validated through its application in the Eastman Tennessee process, showing that an average fault detection rate, false alarm rate, and latency of 99.4%, 0.37%, and 4.11 mins can be achieved, respectively.

- **Keywords:** Enhanced temporal algorithm; Principal component analysis; Adaptive sparsity model; Fault diagnosis; Multivariate statistical method; Time series analysis

Şehmus Altun, Müjdat Fırat, Yasin Varol, Mutlu Okcu. *Comparison of direct and port injection of methanol in a RCCI engine using diesel and biodiesel as high reactivity fuels*. Pages 681-693.

In this work, methanol dual-direct injection (DI2 mode) was compared with the port injection of methanol (RCCI mode) when biodiesel and diesel fuel were employed as HRFs (High Reactivity Fuels). This study presents an innovative dual-direct injection strategy as an alternative method to the commonly utilized port injection strategy in RCCI engines, and evaluates its impact on both engine performance and pollutant emissions. The engine was operated at a constant speed of 2400 rpm by a single-cylinder diesel research engine, and BMEP of 1.57, 3.15, and 4.72 bar (20 %, 40 %, and 60 % of max torque) with methanol was injected using both the DI2 and RCCI modes while diesel fuel and biodiesel were injected directly. In reactivity-controlled compression ignition (RCCI) mode, NOx emissions were reduced by 60 % and 62 % for diesel fuel and biodiesel, respectively, while the reduction accounted as 92 % and 80 % in smoke opacity. However, CO and unburned HC emissions were measured as higher for advanced modes than conventional mode using diesel fuel and biodiesel. According to experimental results obtained for DI2, unburned HC and CO emissions were reduced (up to 63 % and 22 %) when compared with RCCI mode. In addition, for DI2, NOx emissions were slightly higher than in RCCI mode, mainly due to the high injection pressure (50 bar) of DI2 mode. In comparison to conventional diesel injection (CDI), cylinder pressure and heat release rate (HRR) decreased as the premixed ratio (Rp) increased at 20 % load, while cylinder pressure and HRR increased with load and Rp increased. In both diesel and biodiesel experiments, ignition delay increased as Rp increased. The ignition delay was found to be longer in RCCI mode than in DI2 mode. It was concluded that DI2 was a

beneficial way to control inefficient combustion during RCCI operation fuelled by diesel fuel and biodiesel.

- **Keywords:** RCCI; Methanol; Dual direct injection (DI2); Combustion and emissions; Biodiesel

V. Shenbaga Muthuraman, Nanthagopal Kasianantham. *Valorization opportunities and adaptability assessment of algae based biofuels for futuristic sustainability-A review*. Pages 694-721.

The development of third-generation biofuels of algae-based biomass has significant benefits than the first- and second-generation biofuels due to their accessibility and versatility. These algae-based biofuels are notably one of the best sustainable energy resources for automotive and aviation industries which receives wider attention in global fuel markets in recent times. Therefore, a critical review assessment has been carried out on production techniques of third generation algae-based biofuels and their applications in Spark Ignition (SI) engines in detail. Several methodologies for development of bio-alcohols, biohydrogen and biomethane are outlined. This article also examined on various bioreactors developed for algal biofuels production to address the issues on biofuel extraction, utilizing diverse mediums and wastewater treatment strategies. In addition, the suitability of algal biofuel for SI engines and the features of SI engine output while using bio-alcohols and biogases have been investigated. A techno-economic study has been done to determine the commercial state of algae biofuel on the fuel market. The critical assessment clearly reveals that raceway pond, Algae Turf Scrubber and biofilm, water medium are occupy the crucial roles in algae cultivation. Furthermore, the economic aspects of pre-treatment process and toxic removal during ethanol and butanol productions are the major obstacles. Dark fermentation is the primary choice for biogas and biohydrogen production than photo fermentation process. Thus, this study reveals that wastewater-treated biomass and algal biofuel with hybrid engine combinations offer promising future prospects for biofuel development.

- **Keywords:** Biofuels; Algae; Biomass; Spark ignition engine; Third generation

Mengbo Zhu, Geng Xie, Lang Liu, Ruofan Wang, Shishan Ruan, Pan Yang, Zhiyu Fang. *Strengthening mechanism of granulated blast-furnace slag on the uniaxial compressive strength of modified magnesium slag-based cemented backfilling material*. Pages 722-733.

The hydrating active mineral in the modified magnesium slag-based (MMS-based) backfilling material is mainly β-phase dicalcium silicate characterized with slow speed of hydration and low early strength. This disadvantage restricts the application of modified magnesium slag (MMS) as cementitious material in backfilling mining to some extent. In this work, the strengthening mechanism of granulated blast-furnace slag (GBFS) on the uniaxial compressive strength (UCS) of MMS-based cemented backfilling material has been investigated systematically. The hydration heat tests reveal that the duration of induction and acceleration periods are gradually shortened and the appearance time of the second exothermic peaks are obviously advanced as the proportion of GBFS increases. The total normalized hydration heat releases of MMS-based pastes containing 0, 1%, 2%, 3% and 4% (solid-mass proportion) GBFS at 120 h are 15.76, 16.02, 18.40, 22.31, and 25.54 J/g, respectively. Compared with the blank control group, the hydration heat release of MMS-based paste at 120 h increased by 62% with addition of 4% (solid-mass proportion) GBFS. In addition, the TG-DTG tests shown that the final mass-losses of MMS-based cemented backfilling materials tend to increase with the increase of the amount of GBFS. The 3- and 7-days UCSs of MMS-based backfilling mortars tend to increase dramatically with the increase of proportion of GBFS. A small amount of GBFS (1 wt%) can significantly improve the 28- and 56-days UCSs of the MMS-based mortars.

Compared with the blank control group, the UCSs of MMS-based mortars cured 3, 7, 28, and 56 days increased by 74.2%, 94.6%, 38.0%, and 24.1% respectively with addition of 5% (solid-mass proportion) GBFS. The SEM, XRD, FTIR, and TG-DTG tests show that the MMS-based mortars containing GBFS generated more hydration products, yielded more compact microstructures, and consumed CH more quickly compared with that of blank control group. Compared with fly ash (FA), GBFS dissolves faster in alkaline media (leaching reactive Al and Si early), and releases much more hydration heat and Ca2+ ions during the process of pozzolanic reaction. The above three factors strengthen the UCS of MMS-based mortar. The results of this study can provide theoretical guidance for the raw material ratio design and field application of MMS-based cemented backfilling paste.

- **Keywords:** Magnesium slag; Granulated blast-furnace slag; Cemented paste backfill; Compressive strength; Hydration

Jianfei Ding, Xingqing Yan, Yichang Jiang, Chen Song, Fei Xiao, Jie Zou, Qi Zhang, Jianliang Yu. *Effect of combination of explosion venting and chemical barrier on starch explosion suppression in a large scale connected vessels*. Pages 734-744.

The explosion of starch poses a potential threat to the process safety of food and energy enterprises in product processing and storage. To control explosion, a 5 m3 columnar tank with a 10 m long connecting pipe at one end and a 700 mm diameter explosion vent at the other end was built as an experimental device. Combined controlled explosion experiments were conducted using a rupture disc with a static activation pressure of 10 kPa and a chemical barrier containing ABC powder with nitrogen as the driving gas to investigate the pressure and flame change characteristics inside the vessel and piping. The experimental results show that the maximum explosion pressure in the connected vessel without explosion venting is 41.21kPa and the maximum pressure rise rate is 5.20 bar/s. Explosion venting reduces the maximum explosion pressure and pressure rise rate in the vessel by 52.31 % and 21.92 %, respectively, and reduces the flame propagation speed in the pipeline, so that the chemical barrier device can effectively isolate the flame when the installation distance is more than 6 m. The N2 and ABC dry powder two-phase explosion suppressant produced an effective inhibition effect through the physical effects of oxygen insulation, heat absorption, and thermal transmission weakening, as well as the chemical effect of eliminating explosive radicals. The explosion venting provides an initial defense by releasing any remaining pressure and heat of the explosion, while the chemical barrier provides a secondary layer of protection by extinguishing the flame and suppressing the explosion in the pipe to prevent further damage. This combination can greatly reduce the risk of equipment damage, injuries, and fatalities caused by explosions in industrial settings.

- **Keywords:** Safety production; Explosion venting; Chemical barrier; Combined effect; Fire extinguishing and explosion suppression

Zhi Wang, Bo Yin, Qingjie Zhao, Jian Wang, Weiguang An, Haoran Zhai. *External heating-induced thermal runaway and gas venting characteristics of polymer lithium-ion cells with LiNixCoyMnzO2 cathode*. Pages 745-755.

Thermal runaway is an important issue in the process of storage and application of lithium-ion cells. Herein, to better grasp gas venting characteristics and assess its risk, several sets of thermal runaway experiments and hazard analysis were conducted on polymer lithium-ion cells under external heating. Results demonstrate that 50–100% SOC cells exhibit fierce venting accompanied by higher surface temperature, temperature rate, voltage dropping, and mass loss compared to 25% SOC cells. The gas centerline

temperature distribution covered with venting oscillation conforms to piecewise exponential expressions of height and heat release rate. The venting rate and internal pressure were deduced by temperature and mass loss, which increase monotonously with SOC increasing. The maximum heat release rate increases from 1.45 kW to 5.54 kW for 50–100% SOC cells, while it rapidly rises to 73.3 kW for 100% SOC cells under a secondary ignition. The heat release rate predicted by mass loss or flame surface area coincides well with experimental results. Besides, the asphyxiant harm of the gas emission was also evaluated by the fractional effective dose method. The findings give guidance for process safety evaluation, fire prevention and rescue in a real practical engineering utilization of cells.

- **Keywords:** Lithium-ion cell safety; External heating; Thermal runaway; Venting behavior; Thermotoxic property

Chen Wei, Yuanhang Chen. *A study of the fixed choke and constant outflow method for riser gas handling*. Pages 756-769.

Riser gas events appear during offshore drilling operations when there is a presence of gas in a marine riser above the subsea BOP, which has been recognized as a hazardous situation. The selection of pressure control methods during such events significantly impacts the safety and efficiency of riser gas handling (RGH). This paper performed a numerical simulation study on the fixed choke and constant outflow method as one of the most discussed and positively perceived pressure control methods for RGH currently in the industry. The processes of RGH with the proposed fixed choke and constant outflow method were simulated with a comprehensive riser gas influx simulator. The multiphase flow dynamics in a riser were simulated by a drift-flux model with the inclusion of various sub-models and coupled with a multiphase choke flow model. Measurement data (including distributed fiber optic sensing data) from a set of full-scale experiments conducted at the Petroleum Engineering Research, Training, & Testing (PERTT) Laboratory at Louisiana State University (LSU) was used for the calibration and validation of the developed simulator. The performance of the proposed method is evaluated based on the maximum gas and liquid outflow rates and the peak choke upstream pressure during RGH. A series of sensitivity analyses and a contingency case study was conducted to evaluate the applicability and the extendibility of the fixed choke and constant outflow method. The proposed pressure control method shows great potential in enhancing the safety of RGH for a wide range of riser lengths and gas influx sizes with the available managed pressure drilling (MPD) and riser gas handling equipment. The sensitivity analyses revealed that the selection of the initial circulation rates and choke positions has a significant impact on the safety and time efficiency of the RGH operations and should be carefully determined based on the influx and riser system status. This study deepens the understanding of gas influx movement and pressure behaviors in a marine riser during riser gas events. The numerical simulations in this study help to improve the design of riser gas handling strategies.

- **Keywords:** Riser gas event; Fixed choke and constant outflow method; Drift flux model; Managed pressure drilling

Rui-Li Yu, Qian-Fan Li, Tong Zhang, Zhen-Le Li, Liang-Zhi Xia. Zn. *O Co-adsorption based on MOF-5 for efficient capture of radioactive iodine*. Pages 770-777.

The harmful effects of iodine in nuclear waste gas on humans and the environment, as well as the high kinetic energy of iodine molecules caused by the high-temperature environment, make it very important to develop and produce adsorbents with many active sites. The performance and mechanism of iodine capture by MOF-5 were investigated by experiments and molecular simulations for environmental protection. It was found that the synthesized MOF-5 can remove iodine from the gas phase and

cyclohexane solution, with a high iodine capture capacity (0.63 g g-1) at 75 ℃. The cycling test illustrated the better recoverability and stability of MOF-5. The iodine capture capacity of MOF-5 in the liquid phase was 155 mg g-1, which is not the same as that of iodine in the gas phase. The multi-scale mechanistic analysis revealed that the adsorption process of MOF-5 on iodine was dominated by chemisorption, and the efficient capture of iodine was achieved by the co-adsorption of the central metal Zn atom and the tetrahedral apex O atom of MOF-5. This study provides insight into the iodine trapping process and adsorption mechanism, which is instructive for environmental protection engineering.

- **Keywords:** Nuclear power waste gas; Iodine capture; MOF-5; Adsorption mechanism; First-principles

Reza Abbasinejad, Farzad Hourfar, Dariusz Kacprzak, Ali Almansoori, Ali Elkamel. *SIL calculation in gas processing plants based on systematic faults and level of maturity*. Pages 778-795.

Since Safety Instrumented Systems (SIS) are of great importance in terms of safety and protection in industrial plants, many efforts have been made for appropriate use of these systems. As it is vital not to sacrifice hazards, potential dangers, and people's safety and health, for economic and financial reasons, device selection and configuration in SISs should be pursued with sufficient care to achieve a certain Safety Integrity Level (SIL). Today, many SIL calculation methods use pure random failures, while systematic failure mechanisms are still active in every plant and may cause serious damages and injuries. Meanwhile, the available standards have not explicitly suggested "specific requirements relating to 100% avoidance of systematic faults and errors, which generally lead to systematic failures". In this paper, the failures which led to shutdown in four units of a gas refinery, including a total number of 352 safety instrumented functions (SIFs), during 10 years of operation are investigated. Based on the obtained practical results, systematic error contribution to the studied SIFs failures is determined. Moreover, amateur decision making profound impacts on dangerous failures have been analyzed. The developed closed-form formula for calculation of systematic error's weight in various levels (e.g., management level, engineering phase, etc.) has been verified, using different case-studies of an in-service gas plant. Furthermore, a practical guideline is proposed to improve the decreased actual SIL value, while taking into account the impacts of systematic failures.

- **Keywords:** Safety integrity level (SIL); Probability of failure on demand (PFD); Probability of failure per hour (PFH); Systematic failures; Plant maturity level

Mengru Fu, Xuan Zhao, Shanqi Zhou, Peng Liu, Zhihua Qiao, Yanna Han, Kailin Gong, Cheng Peng, Wei Zhang, Jinhong Wu. *Repeated exposure causes different bioaccumulation and biotoxicity of decabromodiphenyl ethane in earthworms compared to one step exposure*. Pages 796-804.

Current studies on the toxicity of chemicals have focused on one step exposure, but the pollutant accumulation in the soil is gradual. A comparison of one step exposure and repeated exposure is needed to fully evaluate the actual toxicity of chemicals. In this study, we compared the bioaccumulation of decabromodiphenyl ethane (DBDPE) and biomarkers responses of Eisenia fetida in the one step exposure (spiked soil with 100 mg kg−1 DBDPE) and repeated exposure (DBDPE concentrations in the soil gradually adding from 25 to 50, 75 and 100 mg kg−1). Results show that repeated exposure decreased the bioaccumulation of DBDPE by 56.13%, but resulted in more severe damage to the epidermis and intestines surface. Two treatments both increased ROS levels and coelomocytes' apoptosis rates, while only repeated exposure showed a recovery of these two biomarkers. After 28 days, TRIAP1, CAM, ATP-6 and NADH1 were

differently regulated between the two treatments. In repeated exposure, habituation of earthworms to DBDPE caused biomarker responses closer to CK, while severe tissue damage suggested that the cumulative toxicity of DBDPE could not be eliminated through progressive environmental leakage. This study demonstrates that exposure patterns could affect the bioavailability and biotoxicity of pollutants in the terrestrial system.

- **Keywords:** Repeated exposure; Decabromodiphenyl ethane; Earthworm; Toxicity

Sumit Kumar, Ehsan Arzaghi, Til Baalisampang, Vikram Garaniya, Rouzbeh Abbassi. *Insights into decision-making for offshore green hydrogen infrastructure developments*. Pages 805-817.

Green hydrogen is a key element that has the potential to play a critical role in the global pursuit of a resilient and sustainable future. However, like other energy production methods, hydrogen comes with challenges, including high costs and safety concerns across its entire value chain. To overcome these, low-cost productions are required along with a promised market. Offshore renewables have an enormous potential to facilitate green hydrogen production on a large scale. Their plummeting cost, technological advances, and rising cost of carbon pave a pathway where green hydrogen can be cost-competitive against fossil-fuel-based hydrogen. Offshore industries, including oil and gas, aquaculture, and shipping, are looking for cleaner energy solutions to decarbonize their systems/operations and can serve as a substantial market. Offshore industrial nexus, moreover, can assist the production, storage, and transmission of green hydrogen through infrastructure sharing and logistical support. The development of offshore green hydrogen production facilities is in its infancy and requires a deeper insight into the key elements that govern decision-making during their life-cycle. This includes the parameters that reflect the performance of hydrogen technology with technical, socio-political, financial, and environmental considerations. Therefore, this study provides critical insight into the influential factors discovered through a comprehensive analysis that governs the development of an offshore green hydrogen system. Insights are also fed into the requirements for modelling and analysis of these factors, considering the synergy of hydrogen production with the offshore industries, coastal hydrogen hub and onshore energy demand. The results of this critical review will assist the researchers and developers in establishing and executing an effective framework for offshore site selection in largely uncertain and hazardous ocean environments. Overall, the study will facilitate the stakeholders and researchers in developing decision-making tools to ensure sustainable and safe offshore green hydrogen facilities.

- **Keywords:** Green hydrogen; Offshore industries; Infrastructure planning; Environmental impact; Safety; Sustainability

B. Tribouilloy, G. Binotto, F. Flécheux, A. Vignes, G. Marlair. *Assessing genuine flammability hazard of halogenated species for their safe processing and use: Case studies*. Pages 818-827.

It is recognized that the combustion of halogenated substances (gas and liquids) may present specific features compared to traditional hydrocarbons. As a matter of facts, the standardized flammability characterization methods referenced by the various regulations (transport, labeling, etc.) do not necessarily take the specific features of these substances into account. Subsequently, this may lead to an underestimation of the risk associated with their use (physical hazard such as explosion). Through two case studies of interest, one concerning a fluorinated liquid, the other focusing on a fluorinated gas, this work reveals technical difficulties that may arise in appraising actual flammability hazards of halogenated hydrocarbons, due to their combustion specific behavior, when applying existing flammability methods without appropriate expert judgement. In the case of the liquid ethoxy-nonafluorobutane (Novec 7200™) this work highlights that this substance can be erroneously considered non-flammable due a clear pitfall of flash point

methods, whilst its genuine flammability can be revealed otherwise. Regarding gaseous halogenated species, we show that operating conditions shall be carefully selected to reveal the genuine flammability behavior of such substances. Indeed, this is not necessarily correctly identified in all possible flammability hazard rating standard methods. In this study, the application of European standards allows to confirm that R1234ze(E) is flammable at temperatures below 30 °C, at atmospheric pressure and at a humidity of 50%RH.

- **Keywords:** Halogenated substances; Flammability; Experimental methods; Regulation

Yikun Hu, Lu Li, Biqing Li, Lai Peng, Yifeng Xu, Xu Zhou, Renhui Li, Kang Song. Spatial variations and ecological risks assessment of pharmaceuticals and personal care products (PPCPs) in typical lakes of Wuhan, China. Pages 828-837.

Lakes are terminal sink of PPCPs, since PPCPs were transported to aquatic system from wastewater treatment plant effluent. Meanwhile, the ecological risks caused by PPCPs to the lakes have aroused wide concern. This study investigated the presence and distribution of PPCPs in 19 typical lakes in Wuhan city; the short term and long-term ecological risk were assessed. The concentration of ten typical PPCPs and the correlation between PPCPs and water quality parameters were analyzed. Ten PPCPs were widely detected, showing that these PPCPs were abundant in the research region. The total PPCPs concentrations varied from 0.44 to 2.1 * 102 ng/L in water sample and ≤ 5.3 ng/g in sediments. According to the results, two nonsteroidal anti-inflammatory drugs (ibuprofen, naproxen) were predominated compared to other PPCPs tested in the lakes of Wuhan city. The Pearson correlation analysis revealed a substantial positive correlation ($p < 0.01$) between NH4+-N and ibuprofen concentration, indicating that ibuprofen could be produced from the same sources of NH4+-N. Some PPCPs has shown positive correlation ($p < 0.01$) with suspended particles in concentrations. A negative correlation in water-sediment distribution for PPCPs was also observed. The potential ecological risks of PPCPs to the lakes were further evaluated. Results implied that ofloxacin posed the highest potential short-term risk of all the ten PPCPs. Sulfadiazine, sulfamethoxazole and roxithromycin posed a potential long-term risk in Niushan lake. This study investigated PPCPs distribution on a large spatial scale in Wuhan lakes in the post-epidemic era and revealed the importance of ofloxacin control in Wuhan. The findings of this work suggests that the long-term management for lake ecosystems is crucial.

- **Keywords:** Pharmaceuticals and Personal Care Products; Lake; Occurrence; Spatial distribution; Risk assessment

Chunxiang Zhao, Xing Li, Xiaohan Wang, Min Li, Huahua Xiao. *An experimental study of the characteristics of blended hydrogen-methane non-premixed jet flames*. Pages 838-847.

The addition of hydrogen to natural gas promotes the reactivity of fuel and thus increases the jet fire risk from pipeline leakage during the transport process of blended hydrogen-natural gas. Aiming to evaluating the potential jet fire risk, this paper experimentally studied the characteristics of H2/CH4 jet flames at varied heat release rates (HRRs) with H2 volume fraction (fv) ranging from 0% to 90% by two circular nozzles (diameters: 3 and 5 mm). The results show that with the increase of H2 volume fraction, two competing effects on flame height were observed, that is, the increase in mixture molecular diffusivity, radicals pool, and air entrainment decreases the flame height, while the increase in flame temperature and jet velocity of fuel flow with a small flow Reynold number increases the flame height. Comparisons of different previous correlations of flame height with current experiments were conducted to obtain the

applicable flame height model for H2/CH4 flames. The ratio of flame width to flame height for two nozzle diameters increases with dimensionless HRR when HRR is small, and then becomes nearly constant (~ 0.145). The flame width normalized by nozzle diameter has a power dependence on dimensionless HRR, i.e., 0.48 and 0.59 power for the 3 and 5 mm nozzle, respectively. Further theoretical analysis suggested the dimensionless correlations of lift-off height of H2/CH4 flames with fv ≤ 50%.

- **Keywords:** Hydrogen safety; Jet flame; Flame height; Flame width; Lift-off height

Mesut Yılmazoğlu, Nergiz Kanmaz, Jülide Hızal. *Highly efficient sulfonated poly (ether ether ketone) (sPEEK) adsorbent for removal of uranium (VI) from aqueous solution.* Pages 848-855.

Sulfonated polyether ether ketone (sPEEK) polymer matrix was used as adsorbent for uranyl adsorption for first time. sPEEK showed high affinity against uranyl cations and the maximum adsorption capacity was found as 0.82 mmol/g. The maximum adsorption was achieved at pH 6. The adsorption kinetic was described by pseudo-second order model. Pore diffusion was involved in adsorption but not rate controlling step. The adsorption reaction is endothermic, and the activation energy is 85.8 kJ/mol. The desorption kinetics into 2 M HNO3, 0.1 M Na2CO3, 0.05 M EDTA and 5 % citric acid solutions were searched, and 99 % desorption was achieved when 0.05 M EDTA and 2 M HNO3 were used as leaching solution. The recovery efficiency decreased from 98 % to 88 % in 0.05 M EDTA solution and from 96 % to 86 % in 2 M HNO3 solution at the end of the fifth cycle. Uranium removal and recovery from liquid waste generated by mining and nuclear plants is of great importance. This study presents an opportunity for highly efficient removal using a low-cost and easily handled sorbent, as well as high recovery of uranyl ions with the aid of a common eluent, allowing for five cycles.

- **Keywords:** Uranium; Sulfonated poly (ether ether ketone); Adsorption; Desorption kinetic; Reusability

Weike Yao, Danmei Cai, Fuli Huang, Taha Ahmed Mohamed, Peiju Li, Xingyu Qiao, Junqiu Wu. *Promoting lignin exploitability in compost: A cooperative microbial depolymerization mechanism*. Pages 856-868.

Lignin, as the second largest biomass resource in the biomass plant, has the potential to be converted into other organic matter. Microbial mediated biocatalytic process in compost can depolymerize and utilize lignin environmentally. However, the source of lignin is complex and difficult to depolymerize, which limits the composting efficiency and reduces the humus quality. The purpose of the study was to find a breakthrough point by analyzing the difficulties of lignin depolymerization and reveal the potential contribution of lignin depolymerization to humus formation during composting. In this paper, the composition characteristics of lignin and the microbial action of lignin depolymerization were reviewed, including the microorganisms involved in lignin depolymerization, lignin depolymerases and microbial pathways, the potential pathway of lignin to form humus, and the environmental factors affecting lignin depolymerization during composting. Although the depolymerization ability of fungi on lignin has been studied for decades, the strict growth conditions of fungi limit their function during composting. Bacteria not only have good tolerance to environmental changes but also play an important role in the depolymerization of lignin. The results showed that the lignin depolymerization during composting was completed under the synergistic action of fungi and bacteria. Fungi deoxidized lignin β-O-4 and other bonding bonds by secreting depolymerases at low temperature, so as to depolymerize large molecules of lignin into oligomers and monomers, while bacteria degraded small molecules of lignin into nutrients that could be used by microorganisms at low temperature. At high temperature, bacteria can promote lignin depolymerization by secreting high temperature resistant depolymerases.

Therefore, the study provides a theoretical basis for microbial cooperative depolymerization of lignin and formation of humus during composting. At the same time, it is necessary to add microbial agents and control the environment in different stages of compost to efficiently depolymerize lignin.

- **Keywords:** Composting; Lignin depolymerization; Humus formation; Lignin monomer; Lignin depolymerase

Bo Lv, Xiaowei Deng, Feishuo Jiao, Bobing Dong, Chaojun Fang, Baolin Xing. *Removal of Pb2+ in aqueous solutions using Na-type zeolite synthesized from coal gasification slag in a fluidized bed: hydrodynamic and adsorption*. Pages 869-881.

As the heavy metal ion in aqueous solutions, Pb2+ has certain harm to the surrounding natural and ecological environment. To eliminate the pollution of Pb2+ in aqueous solution, Na-type zeolite was prepared from the coal gasification slag by alkaline activation technology, and then the hydrodynamic of fluidized bed with Na-type zeolite granules was studied to achieve fluidization stability. Finally, the adsorption process and mechanism of Pb2+ in aqueous solutions using Na-type zeolite were studied by multiple adsorption experiments in stable fluidized bed. The results showed that: The removal process of Pb2+ using Na-type zeolite is a single-layer adsorption dominated by chemical adsorption, companying with surface electrostatic interaction and ionic exchange processes in the interlayer. Fluidized adsorption process of Pb2+ by Na-type zeolite is mainly affected by rising-water velocity, original concentration of Pb2+, and bed material quantity in fluidized bed. The order of influence significance was as below: Original concentration (co) > Bed material quantity (mo) > Rising-water velocity (vt). Under optimal operating conditions (co=200 mg/L, vt=0.053 m/s, mo =72 g), the fluidized bed have higher adsorption saturation (qs=0.649 g/g) than that of fixed bed (qs=0.501 g/g), promoting the adsorption process of Pb2+ by Na-type zeolite. This research provided a new method for the efficient removal of Pb2+ from aqueous solution.

- **Keywords:** Na-type zeolite; Chemical adsorption; Operating conditions; Fluidization characteristic; Active adsorption process

Jiange Chen, Zhongheng Nie, Fengyu Zhao, Haipeng Jiang, Li Zhu. *Improving the stability of electrostatic induction dust concentration detection using kalman filtering algorithm aided by machine learning*. Pages 882-890.

The suspended dust produced in the production of process industry may cause damage to occupational health and even trigger explosion accidents. To accurately detect the dust concentration, and to reduce the noises and standard deviation volatility of the inductive signal of characterized dust concentration generated when applying the electrostatic induction method, the study designs the Kalman filter based on a machine learning algorithm and realizes secondary processing of the standard deviation of inductive signal. Firstly, this study designs the dust concentration detection device using the electrostatic induction method, realizing an effective extraction and amplification of the dust inductive signal, confirming a positive correlation between the volatility of the inductive signal and dust concentration. A data processing procedure for the inductive signal is also designed. To eliminate the standard deviation volatility of inductive signal, the Kalman filter aided by machine learning is selected to process mathematical models. By comparing the conventional sliding filter algorithm, median filter algorithm and Kalman filtering aided by machine learning, it is confirmed that Kalman filtering aided by machine learning has a better effect on reducing the standard deviation of inductive signal. The standard deviation can be quickly converged to the target value through short-term iteration,

effectively eliminating the fluctuation of the standard deviation value of the inductive signal, and improving the stability of the standard deviation value of the inductive signal.

- **Keywords:** Electrostatic induction method; Dust concentration; Kalman filtering algorithm; Machine learning; Standard deviation

Meriem Banou, Yubiao Niu, Fatima Ammari, Tom Dunlop, Richard E. Palmer, Chedly Tizaoui. *Fabrication of graphene nanoplatelets/MgAl-layered double hydroxide nanocomposites as efficient support for gold nanoparticles and their catalytic performance in 4-nitrophenol reduction*. Pages 891-900.

The catalytic reduction of 4-nitrophenol is of considerable importance to a multitude of applications and industries. The present work introduces a new catalyst (AuNP/GNP/MgAl-LDH) containing gold nanoparticles (AuNP) supported on graphene nanoplatelets (GNP) intercalated in Mg Al layered double hydroxides (MgAl-LDH) for the reduction of 4-nitrophenol to 4-aminophenol using NaBH4 as a reducing agent. The catalyst was characterised by FTIR, XRD, STEM, TEM, and BET specific surface area. The XRD analysis showed the presence of crystalline phases of gold on the supports, while TEM demonstrated that MgAl-LDH provided uniform binding sites for AuNPs and prevented agglomeration. Similar reaction rate constant was determined for the disappearance of 4-nitrophenol and for the appearance of 4-aminophenol. The reaction rate constant was the highest for AuNP/GNP/MgAl-LDH, followed by AuNP/MgAl-LDH and AuNP/GNP. AuNP/GNP/MgAl-LDH was found stable after five repeated cycles.

- **Keywords:** Hydrotalcite; Gold nanoparticles; Graphene; Nitrophenol; Reduction

Juexiu Li, Tonglu Lu, Changsen Zhang, Fangcheng Su, Bo Shen, Lizhong Liu, Panpan Liu. *Effects of impure ions in precursors on the formation of active oxygen in MnO2 for promoting VOCs oxidation*. Pages 901-911.

Impure ions in the precursor can cause the structural transition of prepared MnO2 catalysts and influence their activity in toluene catalytic oxidation. Here, the effects of K+ and SO42- on the catalytic activity of MnO2 are examined. Removing absorbed SO42- by repeating water washing facilitates the exposure of active sites on the surface of MnO2. The temperature for toluene conversion reaches 90% (T90) of catalysts decreases from 247 ºC to 238 ºC. While the loss of K+ during the water washing leads to the inferior performance of MnO2. Re-impregnating of K+ can stimulate the generation of active oxygen species on the surface of catalysts (K/MnO2), which showed elevated catalytic activity in toluene conversion (T90, 229 ºC). In addition, K/MnO2 performs good stability for toluene combustion in long-term operation. Density Function Theory calculations reveal that the formation energy of oxygen vacancy and the adsorption energy of toluene on the surface of catalyst decrease from 6.996 eV and − 0.079 to 5.482 eV and − 0.468 eV as the introduction of K+, respectively. Our results provide a complete understanding of the effects of impurity ions on the performance of manganese oxide for catalytic oxidation of toluene.

- **Keywords:** Catalytic oxidation; MnO2; Potassium; Sulfate; Active oxygen generation

Weiwei Lu, Chao Xu, Fei Liu, Meirong Su, Shuiping Cheng, Yang Zhang. *Antibiotic removal efficiency by microalgae: A systematic analysis combined with meta-analysis*. Pages 912-920.

The removal of antibiotics from the environment have become a critical issue due to their toxicity and persistence. Among various approaches, microalgae-based technology has

emerged as a promising, cost-effective, and eco-friendly option. Unfortunately, a systematic and quantitative analysis of the antibiotic removal efficiency by microalgae is still lacking. Therefore, this study conducted a meta-analysis including 27 peer-reviewed publications to address this gap. The study analyzed the overall antibiotic removal efficiency and influencing factors (antibiotic type, microalgae genus, temperature, hydraulic retention time (HRT), and light intensity), and identified appropriate microalgae for specific antibiotic removal, using the effect size of response ratio. Results showed that microalgae had a significant positive effect on the removal of antibiotics, and antibiotic type, microalgae genus, HRT, and light intensity significantly impacted the overall antibiotic removal efficiency. Haematococcus exhibited better removal efficacy than the commonly used Chlorella and Scenedesmus. For specific antibiotic removal, Chlamydomonas and Chlorella were recommended for macrolide antibiotic, Chlorella for beta-lactam antibiotic, and Haematococcus for sulfa antibiotic. This study offers valuable insights for future research and can help locate the most appropriate microalgae for removing specific antibiotics.

- **Keywords:** Antibiotic removal; Microalgae genus; Response ratio, Meta-analysis

Junhui Gong, Jingyi Liu, Bo Liu, Dongxu Ouyang. *Impact of annealed-Ti3C2Tz-MXene-based anode on thermal runaway propagation in lithium-ion batteries: A comparative and numerical study*. Pages 921-932.

Extensive utilization of lithium-ion batteries due to their high energy density and portable features necessitates urgent solutions to potential safety issues associated with thermal runaway (TR). In this work, a 3D mathematical model based on COMSOL Multiphysics coupling side reactions and complex heat transfer in a 3 × 3 battery pack was developed to investigate TR propagation process and the effect of a new anode material, annealed Ti3C2Tz MXene. Reliability of the model was first verified by simulating experimental temperature evaluation of a traditional graphite-anode-based battery. Then a series of simulation scenarios using annealed-Ti3C2Tz-MXene-based anodes were studied to reveal the impact of modified anode on TR propagation. Up to 22 TR propagation scenarios with varying spacings (0–2 mm) among batteries, heating powers (100–400 W), and SOCs (state of charge, 25%−100%) were examined. The results showed that TR of modified cell was delayed, implying better performance in preventing TR. The modified battery not only reduced the maximum temperature and temperature rising rate of TR, but also significantly inhibited TR propagation in pack. This study provides a theoretical basis for annealed Ti3C2Tz MXene as a new anode material and suggests an alternative way for designing safer and higher energy density LIBs.

- **Keywords:** Lithium-ion batteries; Annealed Ti3C2Tz MXene anode; Thermal runaway propagation; COMSOL Multiphysics; Side reactions

Yonghao Wang, Youmei Liu, Jian Shi, Mingyang Li, Yongjing Wang, Jing Zhang. *Treatment and recycling of arsenic slag by hydrothermal reduction of As2S3 to As(0)*. Pages 933-940.

Arsenic existed concomitantly with minerals containing precious or non-ferrous metals, in which arsenic-containing wastewater (ACW) is inevitably generated during the process of smelting. In the treatment of ACW, the precipitation method using sulphide is widely used, but the resulting arsenic sulphide slag poses a risk of secondary pollution. In this work, a reduction strategy was developed to transform arsenic sulphide slag into elementary arsenic under hydrothermal conditions by using sodium formate as the reductant, with the aim to treat the slag and recycle As. The experimental results show that As(0) can be obtained by one-step hydrothermal reduction by sodium formate at temperature of 200 ℃ and pH 4, and the purity of elementary arsenic produced under the

optimum conditions is higher than 90%. Mechanism analyses reveal that the reduction process of As2S3 to As(0) experiences two steps, where amorphous As2S3 primary particles first transform and crystallize into partially reductive AsS in a bulk size, and then AsS is further reduced into As(0) through a collapse process to form small particles. This work provides a recycling strategy for the efficient conversion of arsenic sulphide slag to As(0) for potential applications.

- **Keywords:** Arsenic sulphide slag; Recycle; Hydrothermal method; Reduction reaction

Ming Yang, Hao Sun, Sunyue Geng. *On the quantitative resilience assessment of complex engineered systems*. Pages 941-950.

Recent years have seen the increasing complexity of engineered systems. Complexity and uncertainty also exist in engineered systems' interactions with human operators, managers, and the organization. Resilience, focusing on a system's ability to anticipate, absorb, adapt to, and recover from disruptive situations, can provide an umbrella concept that covers reliability and risk-based thinking to ensure these complex systems' safety. This paper discusses the quantitative aspects of the notion of resilience. Like the quantitative risk assessment framework, a generic framework should be developed for quantitative resilience assessment. This paper proposes a framework based on a triplet resilience definition consisting of disruption, functionality, and performance. Uncertainty treatment is also considered. The proposed framework aims to answer the question of "resilience of what to what" and how it can be quantitively assessed.

- **Keywords:** Safety; Resilience; Quantitative assessment; Complex system; Uncertainty

Domenica Mosca Angelucci, M. Concetta Tomei. *Feasibility of tubing two-phase bioreactors for biological treatment of high toxicity landfill leachate*. Pages 951-959.

This study describes the performance of a two-phase tubing bioreactor operated with an extractive polymeric membrane able to selectively transfer and biologically remove the toxic fraction of an industrial/hazardous waste landfill leachate. An additional feature of this bioreactor is the separation of the biomass from the polluted stream with consequent marked reduction of the inhibitory/toxic effect exerted by leachate constituents. Process performance has been optimized for decreasing HRTs, from 5.5 to 1.9 h, and step-increased OLRs, from 300 to 900 gCOD/L d with excellent removal efficiencies (88–99%). Removal rates of toxic chemicals, represented by phenolic compounds, as well as mass transfer and biomass activity, were not negatively affected by severe loading conditions. On the contrary, the trend of oxygen consumption rate suggested increased activity of the microorganisms with raised loads. Furthermore, biodegradation efficiency of 90% has been observed by evaluating the final mass balance after washing the polymer, which retained only 1.5% of totally fed phenolics. This work provided reliable results to conclude that the tested tubing bioreactor is an effective and stable treatment technology ready for commercial application, with evident operating advantages and the possibility to recover concurrently other valuable leachate constituents as VFAs and ammonia.

- **Keywords:** Biodegradation of toxic fraction; Industrial/hazardous waste landfill leachate; Polymeric tubing; Resource recovery; Two-phase tubing bioreactor

Muhammed Atamanalp, Muammer Kırıcı, Mine Köktürk, Mahinur Kırıcı, Esat Mahmut Kocaman, Arzu Ucar, Veysel Parlak, Sinan Özcan, Telat Yanık, Gonca Alak. *Polyethylene exposure in rainbow trout; suppresses growth and may act as a promoting agent in tissue-based oxidative response, DNA damage and apoptosis*. Pages 960-970.

The toxic effects of microplastic (MP) pollution, which is a growing threat to the aquatic ecosystem, are constantly recorded by scientific reports at the organism and cellular levels. Despite this, the action mechanism of MP toxicity remains ambiguous. This research was designed to investigate the interactions with multiple biomarkers in the tissues of Oncorhynchus mykiss exposed to polyethylene microplastics (MPs-PE) under controlled conditions. In this context, fish were fed with MP-PE added feeding at different levels [MP-PE-I (10%) and MP-PE-II (20%)]. It was aimed to elucidate the MP abundance in gills, gastrointestinal system, on growth and hematological indexes in fish, as well as possible oxidative, DNA damage in target tissues (brain, gill, liver and muscle) and a number of biochemical events underlying apoptosis. MPs-PE tested at different concentrations led to changes in growth parameters and hematologic indices in fish. In all tissues targeted for the follow-up of oxidative stress, inhibitions in GSH levels and antioxidant enzyme activities were determined, while MDA, ROS, DNA damage and apoptosis significantly changed the expression profile upwards. MPs-PE significantly inhibited neurotransmission in rainbow trout. In conclusion, the outcomes of this study revealed that MPs-PE induced dose-dependent ROS-mediated apoptotic responses/ DNA damage in rainbow trout. The data are also a first record for rainbow trout and will help unravel different mechanisms with the potential to model for other MPs-PE-based toxicity studies.

- **Keywords:** Polyethylene; Rainbow Trout; Growth; Promoting Agent; Oxidative Response; DNA Damage; Apoptosis

Santosh Kumar Singh, Arun Kumar Tiwari, H.K. Paliwal. *Performance augmentation strategy of Parabolic trough collector by employing MXene-based solar absorbing coating.* Pages 971-982.

The investigation intends to study the performance of Direct Absorption Parabolic Trough Collector for low-temperature practices. From the ages, the pathway for strengthening the efficiency of solar collector is been obstructed by state-of-the-art parabolic trough collectors undergoing severe re-radiation losses. Based on this, a novel strategy to coat the absorber tube and its performance (Energy, Environment, and Economy) is investigated. In this regard MXene particles with Black paint are used on the inner layer of coating followed by dip coating of MgF2 and SiO2 particles; furthermore, MXene/ water is used as heat transfer fluid. The highest thermal efficiency is reported to be 58.5% followed by 53% and 48% in coated and normal absorber tubes. The size reduction of the collector also drops in coated by 38.64%, 3,2.7%, and, 25.18% in coated and normal absorber tubes this lays a foundation for the calculation of embodied energy, and further emissions were studied and maximum drop per kg reported in MX/ BP with SiO2 coated absorber tube. Our retrofitted PTCs have a payback period of 2.324 and 2.322 for MgF2 and SiO2 outer layer coatings, respectively.

- **Keywords:** MXene; Solar selective coating; Emissivity; Embodied energy; Emissions

Kang Zhao, Yanming Lai, Zhiwei He, Wanrong Liu, Ruifeng Zhao, Yujing Wang, Xiangqin Tian, Jinglei Nie. *Study on energy dissipation and acoustic emission characteristics of fiber tailings cemented backfill with different ash-sand ratios*. Pages 983-996.

In this paper, acoustic emission (AE) monitoring technique was used to study the mechanical lifting mechanism of polyacrylonitrile (PAN) fibers on the CPB material under uniaxial compression and the specific energy characteristics and AE response characteristics and damage precursors during the damage of fiber tailings cemented backfill specimens with different ash-sand ratios. In this experiment, cemented paste backfill (CPB) and polyacrylonitrile fiber tailings cemented backfill (P-FTCB) specimens with 68% concentration and 1:6, 1:8, 1:10 and 1:12 ash-sand ratios were fabricated using PAN fibers. The study shows that the fracture arresting effect and bridging effect of PAN fibers inhibited the expansion of fracture development inside the CPB, thus enhancing the compressive strength and post-peak damage toughness of the CPB, while the fracture arresting effect and bridging effect of fibers depended on the fiber pull-out process, and the fiber pull-out process is divided into three stages: micro-slip stage, slip stage and detachment stage; the higher the ratio of ash-sand in P-FTCB specimens, the stronger the cementing force, the higher the energy required for material destruction, the greater the elastic strain energy that can be stored, and the greater the energy dissipated per unit volume; CPB specimens without fiber incorporation show a decreasing trend in AE parameters before damage; while P-FTCB specimens show a surge in AE parameters after the specimens reached their stress peaks under the effect of fiber fracture arrest; in addition, there is a significant relationship between the ratio of ash-sand of the filling material and its AE parameters: the AE energy parameters of CPB specimens and P-FTCB specimens increas as the ratio of ash-sand decreased. The results of the study can provide a reference basis for the use of P-FTCB materials in mines, and provide theoretical support for promoting the recycling of mine solid waste.

- **Keywords:** Fiber tailings cemented backfill; Comprehensive utilization of solid waste; Fiber action mechanism; Energy dissipation; Acoustic emission damage precursors

Yanwu Zhou, Juan Zhou, Jianheng Yu, Xia Huang, Xiaojun Niu, Yiu Fai Tsang. *Improved integrated anaerobic–anoxic–oxic system for landfill leachate treatment using domestic wastewater as carbon source: Performance study and optimization*. Pages 997-1002.

Landfill leachate has been treated by using an anaerobic–anoxic–oxic (A2/O) system at Datansha Wastewater Treatment Plant in Guangzhou, South China for nearly five years. Through the pilot-scale testing and engineering experiments, the impulse loads of the wastewater treatment systems were successfully reduced. The results showed that the highest removal efficiencies of chemical oxygen demand (COD), ammonium-nitrogen (NH4+-N), and total nitrogen (TN) for the combined treatment of domestic wastewater and landfill leachate were achieved under the operating conditions of hydraulic retention time = 11 h, dissolved oxygen = 3 mg/L, mixed liquid return ratio = 200%, and sludge return ratio = 80%. Compared with the data obtained from the previous operating A2/O system, the removal efficiencies of COD, NH4+-N, and TN increased by 5.6%, 9.8%, and 5.3%, respectively, under the optimal operating conditions for one year. The average effluent concentrations of BOD5, COD, NH4+-N, TN, and total phosphorus were 12.4, 29.9, 2.5, 18.0, and 0.5 mg/L, respectively, and these values could be kept below standard discharge limits in China.

- **Keywords:** A2/O system; Landfill leachate; Simultaneous nitrification and denitrification; Wastewater treatment

Fernanda Naiara Campos de Almeida, Anderson Rafael Igarashi, Ariane Cezarotto Fiewski, Wardleison Martins Moreira, Djeine Cristina Schiavon Maia, Pedro Augusto Arroyo, Nehemias Curvelo Pereira. *Evaluation of the performance and feasibility of a pseudo-catalytic solution in the biogas purification process*. Pages 1003-1015.

Biogas is a valuable renewable energy source used as a fuel or feedstock to produce hydrogen, syngas, and chemicals. In addition to the main constituents, CH4 and CO2, biogas also contains several undesirable contaminants. Although it is in small amounts in biogas, hydrogen sulfide must be removed because it is a toxic and corrosive gas pollutant to the air. Thus, the objective of this study was to investigate the operating conditions of a process for the purification of biogas by removing H2S through a pseudo-catalyst solution based on a fertilizer containing FeEDTA. Then, the operating conditions were optimized to obtain maximum H2S removal and minimum degradation of the pseudo-catalyst solution. Operating at the optimum conditions, a maximum H2S absorption capacity and a minimum pseudo-catalyst solution degradation rate achieved were 0.83 molH2S/molPCS and 0.020%/min, respectively. Therefore, oxidative absorption using a pseudo-catalyst solution based on a fertilizer containing FeEDTA is a potential route for biogas purification.

- **Keywords:** Biogas; Hydrogen sulfide; Absorption; FeEDTA

Aijun Yin, Zhendong Long, Tianyou Liang. *Gaussian process flow fusion physical model for fatigue evaluation of petrochemical equipment considering residual analysis.* Pages 1016-1022.

Petrochemical equipment is subjected to frequent discontinuous operation and underwent alternate loads, leading to fatigue failure of metal structure. Due to the fact that petrochemical equipment operates in a harsh environment, it's necessary to assess the fatigue state of metal materials to ensure production safety. The residual stress of metal materials is closely related to the fatigue evolution. Physical model is unable to express the possibility of the evolution of residual stress. Data-driven model requires large-scale data to optimize the model and may not conform to the laws of physical evolution. Therefore, this paper proposes a probabilistic model integrating physical model and Gaussian Process Flow (GPF) for fatigue assessment of metal structure of petrochemical equipment under scarce data. Firstly, different evolutionary trajectories with stochastic parameters are obtained by applying stochastic differential equation (SDE). The uncertainty of SDE is assessed by Gaussian process (GP). Then, from the perspective of a particle filter, the physical model is combined to develop a fusion-driven model to infer the importance of the residual analysis. An example of an irreplaceable metal material in petrochemical equipment is studied to demonstrate the effectiveness of this model. The model proposed could provide a promising solution for preventing fatigue failure at petrochemical processing facilities.

- **Keywords:** Petrochemical equipment; Residual stress; Gaussian Process Flow; Fatigue assessment; Scarce data

Jun Zhao, Qiaoxian Zhang, Wanglin Hao, Qiaolin Su. C*hemical absorption-based biogas upgrading process integrated with a novel poly-generation system: Application of Aspen HYSYS simulation and 4E study*. Pages 1023-1043.

In this paper, an integrated poly-generation process using biogas for the simultaneous production of useful products, including methanol (0.745 kmolMeOh/kmolbiogas), liquid carbon dioxide, CO2, (11.39 m3/h), desalinated water (34.19 m3/h), and heating (23.31 tonLPS/h) is simulated in the Aspen HYSYS software. Due to the feasibility of increasing

the methane content of the biogas, the current study is motivated to upgrade the existing biogas stream through a chemical absorption process toward a novel poly-generation model. Hence, an innovative heat integration is arranged, where the arranged system is made of a chemical absorption unit, a biomethane reforming unit, an integrated CO2 compression unit, an ammonia Rankine cycle, a modified organic Rankine cycle, an integrated synthesis gas compression unit, a methanol synthesis unit, and a water desalination unit. The arranged model is analyzed from the 4E perspective (energy, exergy, economic, and environmental), and a comprehensive parametric study is also done. It is demonstrated that the energy and exergy efficiencies of the newly designed model are found as 54.79%, and 61.54%, respectively. In addition, the exergy analysis shows that the total exergy destruction rate equals 74795 kW, to which the biomethane reforming unit has the largest contribution (40%). The CO2 emission intensity corresponding to the model is also calculated to be 1.33 kgCO2/kgMeOh, which is lower compared to that of coal-to-methanol and steam methane reforming methods. Besides, the total annual cost and total product cost of the model are 166732539 $/year and 0.78 $/kgMeOh, respectively. According to the parametric study, methanol production and overall energy efficiency enhance with increasing the gases recycled to the methanol synthesis reactor and the methanol production cost reduces.

- **Keywords:** 4E analysis; Biomethane reforming; Desalinated water; Liquid carbon dioxide; Methanol; Poly-generation

Francesco Zanobetti, Gianmaria Pio, Sepideh Jafarzadeh, Miguel Muñoz Ortiz, Valerio Cozzani. *Inherent safety of clean fuels for maritime transport*. Pages 1044-1055.

The urgent need to reduce the emission of harmful pollutants in maritime transport promoted the development of several alternative propulsion systems based on clean fuels or carbon-neutral energy vectors. However, the alternative solutions under development pose new concerns from the safety perspective. Thus, an innovative methodology to rank the inherent safety performance of alternative systems at early design stages was developed. A case study representative of long-distance maritime transportation was analysed. The inherent safety performances of Liquefied Natural Gas (LNG), Liquid Hydrogen (LH2), and Liquid Ammonia (LNH3) were compared to that of Marine Gas Oil (MGO), assumed as a benchmark representing state-of-the-art technologies. Uncertainty and robustness of the safety ranking obtained were tested via a Monte Carlo analysis. The results show that technologies based on LNG have similar safety performances with respect to the benchmark option. Conversely, LH2 safety performance is currently limited by the lack of mature technologies for its safe storage whilst the safety of LNH3-based applications is affected by the toxicity of ammonia.

- **Keywords:** Clean technologies; Clean fuels; Inherent safety; Inherently safer design; Maritime transportation; Safety in energy transition

Fu-Rong Xiu, Ruiqi Yang, Yingying Qi, Ke Zhou, Jiali Wang, Wenting Shao, Haipeng Zhou, Longsheng Zhan. *High-efficiency promotion on dechlorination of polyvinyl chloride in subcritical water treatment by introducing waste concrete*. Pages 1056-1064.

Polyvinyl chloride (PVC) is one of the most widely used plastics in the world. Due to the generation of corrosive HCl and chlorine-containing organic pollutants during the recycling process, waste PVC can cause great environmental risks. At the same time, a large number of waste concrete in the construction industry have not been effectively utilized. Subcritical water (SubCW) has showed good prospect for treatment of PVC due to that dechlorination can be carried out with lower energy consumption. In this study, a high-efficiency and low-temperature SubCW treatment for dechlorination of PVC using

waste concrete as an enhancer was proposed. The effects of temperature, residence time, solid-to-liquid ratio and PVC-to-Concrete ratio on dechlorination efficiency, chlorine distribution and weight loss ratio were studied. The PVC dechlorination efficiency could be enhanced to as high as 95.04% by introducing waste concrete. Significant dechlorination occurred under the conditions of 220 ℃, 60 min, solid-to-liquid ratio of 1:30 g/mL, and PVC-to-Concrete ratio of 4:1. Under the optimal conditions, all the removed chlorine from PVC was transferred into the liquid phase in the form of inorganic chlorine. Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), scanning electron microscope (SEM), and elemental analysis were used to analyze the PVC dechlorination mechanism. The dechlorination pathway of PVC was found to include both direct dehydrochlorination and hydroxyl substitution. The enhancement mechanism of the waste concrete on the PVC dechlorination could be attributed to the rapid capture ability of CaCO3 for HCl. The SubCW-Concrete process proposed in this study was beneficial to both the low-temperature dechlorination of PVC and the resource utilization of waste concrete.

- **Keywords:** Waste polyvinyl chloride; Dechlorination; Low-temperature subcritical water; Waste concrete