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Maria Molnarne, Volkmar Schroeder. *Hazardous properties of hydrogen and hydrogen containing fuel gases*. Pages 1-5.

The paper provides a summary of safety characteristics of hydrogen and hydrogen fuel gases. The investigations focus on water electrolysis, the feeding of hydrogen into the natural gas grid and the use of hydrogen for the fermentation process in biogas plants. The safety characteristics of hydrogen such as very low minimum ignition energy, very large explosion range and high flame velocity with the resulting rapid pressure increase of hydrogen explosions are of particular importance for explosion protection and they differ strongly from those of natural gas. Explosion ranges of hydrogen-methane-carbon dioxide mixtures have been measured for the use of hydrogen in biomethane production. The paper also shows and discusses explosion ranges of hydrogen and hydrogen-natural gas mixtures. Pressure and temperature dependencies of the explosion limits of mixtures were investigated. Furthermore, pressure rise rates (KG values) were measured with regard to constructive explosion protection. The maximum experimental safe gaps were determined for the classification of the mixtures and assignment to explosion groups according to the European ATEX directives. It was found that admixture of 10% hydrogen to natural gas has only a minor influence on the safety characteristics of gas explosions.

- **Keywords:** Hydrogen safety; Biogas; Renewable energy; Natural gas mixtures; Flammability

Hamid Reza Shamsollahi, Mahboobeh Ghoochani, Kaveh Sadeghi, Jalil Jaafari, Masoud Masinaei, Mika Sillanpää, Mahmood Yousefi, Seyedeh Tahereh Mirtalb, Mahmood Alimohammadi. *Evaluation of the physical and chemical characteristics of water on the removal efficiency of rotavirus in drinking water treatment plants and change in induced health risk*. Pages 6-13.

Rotavirus is one of the main waterborne causes of diarrhoea. Rotavirus type A is responsible for diarrhoea in infants and causes thousands of deaths annually around the world, especially in developing countries. Rotavirus is very small and is highly resistant to common disinfectants, so the World Health Organization (WHO) has chosen this virus as a reference pathogen in drinking water and has recommended a its 6-log removal by the conventional water treatment process to supply safe drinking water. We measured some physical and chemical characteristics of raw water at a water treatment plant in Tehran, Iran, including temperature, pH, total organic compound (TOC) concentration and initial turbidity, to determine their effect on rotavirus removal efficiency in various processes.

We then measured rotavirus removal efficiency in clarified water and filtrate to determine their removal efficiency. Finally, we applied the WHO guideline and an empirical quantitative microbial risk assessment (QMRA) model to estimate probable health risk based on a residual number of rotavirus in finished water. We found that TOC concentration and water temperature are both effective on residual rotavirus in clarified water but they have no significant effect on the efficacy of filtration in rotavirus removal. Maximum rotavirus removal efficiency by clarification and filtration was 97.2% and 4.5% in April and January respectively. TOC and water temperature were shown to have a significant effect on clarification virus efficiency, so filtration performance was independent of these variables. The results showed that induced risk by residual rotavirus is in an acceptable range (99.99945% removal annually), and also showed that the critical process in virus removal is clarification that can be affected by raw water quality.

- **Keywords:** Rotavirus; QMRA; Drinking water; Diarrhoea; Water quality

Grigory Bivol, Sergey Golovastov. *Effects of polyurethane foam on the detonation propagation in stoichiometric hydrogen-air mixture*. Pages 14-21.

The propagation of a detonation wave in a channel with polyurethane foam with different pore size on the wall was experimentally examined. In this study, we performed experiments in a rectangular channel with two walls covered with porous material to study the detonation suppression in stoichiometric hydrogen-air mixtures at room temperature and atmospheric pressure. Four types of polyurethane foam with a number of pores per inch (PPI) ranging from 10 to 80 covering two opposite channel walls were used for detonation attenuation. The width of the channel was 20 mm, the thickness of the porous layer was 10 mm. Piezoelectric pressure sensors were used to obtain the average velocity and shock wave pressure. The results indicate that depending on the pore size, two propagation regimes can be observed: steady detonation decay and detonation reinitiation. By the end of the porous section at 20 channel widths, the shock wave pressure was 0.5 of the von-Neumann pressure while using polyurethane with biggest pores (10 PPI) and 0.25 of the von-Neumann pressure in polyurethane with smallest pores (80 PPI). The evolution of the shock wave pressure and velocity along the porous section for porous material with different pore size is presented. Schlieren images of the detonation wave decay into a shock wave and the flame front in the section with polyurethane foam were obtained. The parameters of porous coatings are determined under which the detonation can be restored.

- **Keywords:** Hydrogen; Porous material; Detonation decay; Polyurethane foam

Andrea López, Jorge Rodríguez-Chueca, Rosa Mosteo, Jairo Gómez, E. Rubio, Pilar Goñi, Maria P. Ormad. *How does urban wastewater treatment affect the microbial quality of treated wastewater?* Pages 22-30.

The design of wastewater treatment plants (WWTP) includes facilities for the removal of suspended solids, organic matter, nitrogen and phosphorous, as required in current legislation, while removal of microorganisms is not literally emphasized. Although the different unit processes have some effect on microbial populations, disinfection is not achieved in many cases unless a specific step is included to regenerate wastewater. This study assesses the effect of the unit processes of six WWTPs that treat municipal wastewater on five microbiological parameters (total coliforms, E. coli, Enterococcus sp., Staphylococcus aureus and Pseudomonas aeruginosa), as well as their contribution to receiving waters. Bacterial concentration in the inlet of WWTPs varies from the lowest concentration of Staphylococcus aureus (104CFU/100mL), to the highest for total

coliforms (108CFU/100mL), independently of the industrial activity discharging to the WWTP. Considering log bacterial removal of each step of treatment processes, trickling filters reduced 2.6 and 1.5-log Enterococcus sp. and Pseudomonas sp. respectively, secondary decanters achieved 2.5-log average removals and ponds reduced bacteria in a range from 1 to 2.2-log, being the processes with the highest bacteria removal, although in the case of secondary decanters this depends on design parameters such as hydraulic residence time, loads of solids, or types of previous biological treatments. The average of the bacteria concentration in the outlet of the six WWTPs was between 103–106CFU/100mL. The effect of discharging these bacteria on the quality of receiving waters was assessed by analyzing microbial concentration upstream and downstream of the discharge point. In almost all cases, the bacterial concentration upstream of the discharge point was similar to downstream concentration because the effluent is rapidly diluted in the receiving river, not representing a risk to ecosystems.

- **Keywords:** Urban wastewater treatment; Microbiological quality; Natural receiving waters; Tertiary treatment; Bacteria elimination; Unitary processes

Zhuowei Zhang, Hongbo Xi, Yin Yu, Yuexi Zhou. *Performance and prediction model of a HA+A/O process in the lab-scale under the load shock of 2,4-dichlorophenol*. Pages 31-38.

The performance of a hydrolysis acidification+anoxic/aerobic activated sludge (HA+A/O) process under the load shock of 2,4-dichlorophenol (2,4-DCP) was investigated. Results indicated that 2,4-DCP concentration was below 100mg/L responding to less than 50mg/L chemical oxygen demand (COD) of HA+A/O effluent. However, further increasing 2,4-DCP concentration from 200 to 500mg/L subsequently led to the significant reductions of COD removal. The protein-like and humic-like fluorescence intensities of HAHA+A/OA/O effluent increased gradually with 2,4-dichlorophenol concentration from 0.5 to 500mg/L. 2,4-DCP concentration of HAHA+A/OA/O effluent gradually increased from 1.3 to 475.4mg/L responding to 2,4-DCP removal rate from 98.8 to 4.5%. Meanwhile, the degradation intermediate products (4-chlorophenol, 4-CP; phenol) of 2,4-DCP were monitored continuously. 4-CP and phenol concentrations reached the highest values of 7.89mg/L and 5.73mg/L, respectively with 2,4-DCP concentration 200mg/L. Based on chloride element conservation equation between influent and effluent, the dichlorination efficiencies decreased from 16.2 to 0.02% with 2,4-DCP concentration from 0.5 to 500mg/L. In addition, volatile fatty acids (VAF) and oxygen uptake rate (OUR) inhibition rates of HAHA+A/OA/O increased gradually under the load shock of 2,4-dichlorophenol. When 2,4-DCP exceeded 200mg/L, VAF and OUR inhibited rates were over 50%, respectively. Ultimately, the prediction modelling between biological toxicity and COD removal was established using regression method, which exhibited a good fit (r2=0.78). This study could help to predict the effect of 2,4-DCP on the performance of the HAHA+A/OA/O process.

- **Keywords:** 2,4-Dichlorophenol; Biological toxicity; Hydrolytic acidification-anoxic-aerobic (HA+A/O) process; Prediction model

Zhepei Gu, Ying Wang, Ke Feng, Aiping Zhang. *A comparative study of dinitrodiazophenol industrial wastewater treatment: Ozone/hydrogen peroxide versus microwave/persulfate*. Pages 39-47.

In this study, the effect of operational parameters of the ozone/hydrogen peroxide (O3/H2O2) and microwave/persulfate (MW/PS) processes used for dinitrodiazophenol (DDNP) industrial wastewater treatment were investigated, and the degradation characteristics of organic pollutants in wastewater treated by the two processes were compared. It was found that in the O3/H2O2 process, a certain increase in the O3 and H2O2 dose and a higher initial pH promoted the removal of organics. In the MW/PS process, increasing the PS dosage and MW power increased the treatment efficiency, but

a high ambient pH depressed the removal of organics, and base activation for PS was observed at pH=13. Under optimum conditions, the chemical oxygen demand (COD) and color number (CN) removal efficiencies of O3/H2O2 (O3 dosage=18.92 mg/min, H2O2 dose=18mM, and initial pH=10) and MW/PS (PS dose=8g/L, MW power=600W, and initial pH=3) were 93.81 and 90.01% (O3/H2O2) and 82.29 and 77.89% (MW/PS). Ozone was the main oxidant responsible for organic degradation in the O3/H2O2 process, while the hydroxyl radical (OH) played a lesser role. In the MW/PS process, both OH and the sulfate radical (SO4−) contributed to the degradation of organics, while SO4− was the dominant reactive oxygen species (ROS). In the treatment process, in terms of COD removal, MW/PS had a faster reaction rate due to the introduction of MWs, but its treatment efficiency was inferior to that of the O3/H2O2 process. In addition, the O3/H2O2 process performed better in terms of energy saving for reactions of less than 10 min. This study provides a theoretical reference for DDNP industrial wastewater treatment with two different AOPs.

- **Keywords:** AOPs; Dinitrodiazophenol; Comparative study; Energy consumption assessment

Song Lin, Zhentang Liu, Enlai Zhao, Jifa Qian, Xiaoliang Li, Qiming Zhang, Muhammad Ali. *A study on the FTIR spectra of pre- and post-explosion coal dust to evaluate the effect of functional groups on dust explosion*. Pages 48-56.

Fourier transform infrared (FTIR) spectra of coal dust and its explosion solid residues were studied. Coal dust explosion test was carried out on a 20-L explosion device, and the variation of different functional groups and FTIR structural parameters of pre- and post-explosion dust were semi-quantitatively analyzed by deconvolution of the FTIR spectra. In addition, the relationship of explosion pressure (Pm) and pressure rise rate ((dP/dt)m) with functional groups was investigated. The results show that the largest consumption of functional groups in coal dust explosion process is distributed in 1800–1000cm−1 band, and most of the ether oxygen bond, methyl and benzene ring are removed from the coal macromolecule. The improved condensation degree of coal macromolecular aromatic ring and the decreased aliphatic side chains lead to a more compact coal molecular structure. The consumption of functional groups during coal dust explosion is positively correlated with the Pm and (dP/dt)m. The research provides a new feasible method for the evaluation of the organic dust explosion risk by its functional group. Moreover, it can be used effectively as basis for suppressing the organic dust explosion.

- **Keywords:** Coal dust; Explosion residues; FTIR spectra; Functional groups; Influence mechanism

Wenhe Wang, Kuiling Shen, Shang Tang, Ruiqing Shen, Trent Parker, Qingsheng Wang. *Synergistic effect of O2 and SO2 gas impurities on X70 steel corrosion in water-saturated supercritical CO2*. Pages 57-66.

The synergistic effect of O2 and SO2 on the corrosion behavior of X70 steel was evaluated in water-saturated supercritical CO2 using weight loss analysis and surface analysis techniques. Corrosion experiments were conducted at 40°C and 100bar to simulate typical CO2 transportation conditions. Results indicate that the synergistic effects of O2 and SO2 enhance or inhibit the corrosion rate, depending on the concentration variation of impurities. SO2 had the highest corroding influence on X70 steel, with the corrosion rate of 1.10 mm/year with the addition of 500 ppmv SO2. The presence of SO2 changed the corrosion mechanism and the final products of corrosion consisted mostly of FeSO3. Low concentrations of O2 increased the corrosion rate (0.09 mm/year) primarily by destroying the integrity of the FeCO3 product film in the absence

of SO2. However, the corrosion rate of X70 steel progressively decreased to 0.03 mm/year as the concentration of O2 increased to 1000 ppmv, due to high concentration of O2 causing the steel substrate to enter the passivation zone. This study is important for a number of industrial applications, as it provides a theoretical basis for corrosion control of supercritical CO2 pipelines.

- **Keywords:** Carbon capture and storage; Pipeline; Supercritical CO2; Impurity; Corrosion mechanism

Renata Żyłła, Tomasz Boruta, Marta Gmurek, Rafał Milala, Stanisław Ledakowicz. *Integration of advanced oxidation and membrane filtration for removal of micropollutants of emerging concern*. Pages 67-76.

The aim of the work was the removal of diclofenac (DCF) and amoxicillin (AMX) pharmaceuticals by integrated methods of advanced oxidation and membrane filtration. The advanced oxidation process was carried out using UV/H2O2. Two polymer membranes, HL and NF270, were applied for the separation procedure. The effectiveness of the UV/H2O2 treatment, nanofiltration and the integrated processes was comparatively evaluated by monitoring the concentration of DCF/AMX and the removal of chemical oxygen demand (COD) and total organic carbon (TOC). It was found that despite the complete disappearance of the tested compounds during advanced oxidation process the slight reduction of COD and TOC was observed. Moreover, the solution after UV/H2O2 treatment exhibited higher toxicity towards Vibrio fischeri than the initial solution, proving that the transformation by-products of DCF and AMX are more toxic than the parent compound. The nanofiltration process led to an almost complete removal of DCF and AMX from the solution. The integration of the two methods enabled both the chemical modification of tested compounds and the removal of their toxic oxidation products from the solution.

- **Keywords:** Diclofenac; Amoxicillin; Advanced oxidation; Nanofiltration; Toxicity

Lijun Luo, Junhong Long, Shimin Zhao, Jianhui Dai, Lici Ma, Hongbin Wang, Lihong Xia, Li Shu, Fengzhi Jiang. *Effective visible-light-driven photocatalytic degradation of 17α-ethynylestradiol by crosslinked CdS nano-rod/TiO2 (B) nano-belt composite*. Pages 77-85.

New CdS nano-rod/TiO2 (B) nano-belt composites (denoted as CdS-NR/TiO2 (B)-NB) were successfully prepared via a two-step hydrothermal process. The chemical composition and structure of synthesized materials were characterized by X-ray diffraction (XRD), field emission scanning microscopy (FESEM), transmission electron microscopy (TEM), element map, UV visible diffuse reflectance spectroscopy (UV–vis DRS) and photoluminescence spectroscopy (PL). The prepared samples were used to remove 17α-ethynylestradiol (EE2) under visible light irradiation, which has most potent estrogenic activity and resists to biodegradation. The results show that the B-type TiO2 (TiO2(B)) nano-belts are crosslinked with CdS nano-rods to form heterojunction with higher removal rate (92.00%) than pure CdS nanorods (55.67%) for 3 mg/L EE2 within 120 min when the mass ratio of CdS nanorods to TiO2 (B) nanobelts is 1:15. The degradation rate constant of EE2 over CdS-NR/TiO2 (B)-NB (0.001763 min−1) is 3 times higher than pure CdS-NR (0.00567 min−1) under visible light irradiation. Charge generation, migration and possible photocatalytic mechanism of EE2 on CdS-NR/TiO2 (B)-NB photocatalyst has been proposed based on the theoretical calculation and reactive species trapping experimental results.

- **Keywords:** 17α-ethinylestradiol; CdS; TiO2 (B); Heterojunction; Visible light

Xuxu Sun, Shouxiang Lu. *Effect of large-scale perturbation on the critical condition of detonation formation in stoichiometric CH4-2O2 mixtures*. Pages 86-93.

The effects of large-scale perturbation induced by orifice plate on the critical condition of detonation formation are investigated systematically in a circular tube with an inner diameter of 90mm and 6m long. The orifice plates with the blockage ratio (BR) of 0.5, 0.7, 0.93 and 0.96 are employed. Four pressure transducers (PCB102B06) are used to determine the average velocity while the smoked foils are employed to record the detonation cellular patterns. The experimental results indicate that a detonation can propagate at a steady velocity with small deficit when the initial pressure (P0) is greater than the critical value (Pc). The velocity deficit is enhanced sharply as the critical condition is approached by gradually decreasing the initial pressure. At P0 below the critical pressure, the detonation failure can be observed. In the smooth tube without obstacles, the critical pressure is 2.5kPa and the corresponding velocity deficit is 25% approximately. After the orifice plates are introduced into the tube, the critical pressure and the velocity deficit both are increased significantly. The critical pressure are 7.5, 11, 15 and 16kPa, respectively. The maximum velocity deficit is about 30%. By measuring the average velocity immediately after the combustion wave propagation through the orifice plates, it can be found that only when the average speed is greater than 85% times the products speed of sound, can the detonation be produced at the end of the tube. Finally, the critical condition of detonation propagation are analyzed in detail. In the cases of smaller BRs (0.5 and 0.7), the critical conditions are consistent with the criterions of $d/\lambda>1$ and $L/\lambda>7$. However, these two criterions both are invalid for BR=0.93 and 0.96 cases.

- **Keywords:** Perturbation; Detonation; Velocity deficit; Critical condition

Deepshikha Datta, Sumit Mahto, Nitin Kumar, Gopinath Halder. *Parametric optimization and kinetic elucidation of degradation of starch blended LDPE films through central composite design approach towards application in packaging*. Pages 94-114.

The present investigation emphasizes on the parametric optimization of degradation of starch blended LDPE films towards the development of an optimum composition for its utilization as a biodegradable packaging film. The individual effect of the essential parameters influencing the degradability determined by loss in weight and loss in tensile and tear strength were reported. Optimization of the process parameters was done using Central Composite Design approach of Response Surface Methodology. ANOVA (Analysis of variance) study suggested that the obtained equation for the degradation of the films is quadratic in nature and is significant for the process. The produced films were extensively characterized by SEM, XRD and EDAX analysis. The addition of starch by 60% in the matrix reduces the tensile strength from 13.25MPa to 3.82MPa and MFI and tear strength to a value of 0.3g/10min and 59.62N/mm respectively, however the Young's modulus and stiffness increased to 469.37MPa and 33851.78N/m respectively. The degradation rate constant (k) calculated in both garden soil and vegetable waste increased as starch content increased. Thus the obtained kinetics and optimized conditions suggests the optimum content of the biofiller needed for superior mechanical properties with enhanced biodegradation.

- **Keywords:** Degradability; Central composite design; Optimization; Kinetics; Biofiller

Yun-An Chen, Pao-Wen Grace Liu, Liang-Ming Whang, Yi-Ju Wu, Sheng-Shung Cheng. *Biodegradability and microbial community investigation*

***for soil contaminated with diesel blending with biodiesel*. Pages 115-125.**

Due to intensified usage of diesel-biodiesel blending oils, solving potential contamination problems becomes crucially important. The objective is to investigate various percentages of diesel-biodiesel mixtures caused contamination and remediation approaches, including bioaugmentation with seven proved diesel-degrading bacterial species. Degradation of 80%-99% was achieved with the proposed remediation approach. The TPHd degradation efficiency (%) and rates (k) in the control batch (CT) found either similar or superior to the bioaugmentation batch (BA). The batches with 20% and 50% biodiesel achieved 10% improvement of TPHd degradation in CT over BA. The TPHd degradation was enhanced by the increase of biodiesel. For example, degradations of 99% were achieved in the soil polluted with 100% biodiesel. The increase of the biodiesel enlarged the total heterotrophic bacterial counts from 107 to 109 CFU/g dry soil. The molecular data concluded Gordonia alkanovorans and Gordonia desulfuricans were most dominant in the indigenous community. Pseudomonas aeruginosa was a strong survivor last for the entire remediation. The growth patterns of bacteria indicated the introduced species were useful only in the beginning. Using the recommended molecular tools to identify the useful bacteria prior to a remediation project would be helpful in reducing the cost and determine a wise remediation strategy.

- **Keywords:** Total petroleum hydrocarbon-diesel (TPHd); Bioaugmentation; Biodiesel; Terminal restriction fragment length polymorphism (T-RFLP); ITS microarray

Guangji Hu, Haroon R. Mian, Kasun Hewage, Rehan Sadiq. *An integrated hazard screening and indexing system for hydraulic fracturing chemical assessment*. Pages 126-139.

Various chemicals used in hydraulic fracturing have raised environmental and human health (EHH) concerns regarding water resources contamination, leading to the transition towards the use of chemicals with minimum EHH hazards. Chemical hazard screening and indexing approaches have been used to measure the chemical hazard of hydraulic fracturing, and each approach is associated with inherent advantages and limitations. In this study, the two chemical hazard assessment approaches were discussed, and an integrated chemical hazard screening and indexing system was developed to combine the strengths of the two approaches. The integrated system was applied to assess the EHH hazards of representative hydraulic fracturing chemicals used in British Columbia, Canada. The hazard screening results showed that more than half of the ingredients and additives were classified into high hazard groups. Moreover, the integrated system generated more critical hazard assessment results than two hazard indexing systems, revealing that using the individual hazard indexing approach could result in underestimated EHH hazards for chemicals. The integrated system can significantly improve the data confidence levels of hazard assessment results compared to a previously developed indexing system. The integrated system can also help formulate fracturing fluids with low EHH hazards by identifying ingredients of high hazard concerns.

- **Keywords:** Hydraulic fracturing; Environmental and human health; Oil and gas chemical; Hazard screening; Hazard indexing; Chemical hazard assessment

P. Lindhout, J.C. Kingston-Howlett, G. Reniers. *Learning from language problem related accident information in the process industry: A literature study*. Pages 140-152.

Misunderstandings due to language problems are emerging as an underlying causal factor in a wide variety of occupational accidents. Implicated in this are language

proficiency and literacy, but also readability of instructions. Coupled to these is the fact that the global workforce holds more migrant workers than ever before, and there are a growing number of multi-lingual shop floor environments, especially in the transportation and health care sectors. The term 'language problem related accident' (LPRA) is proposed here. This article reviews LPRA trends in industry, especially in the process industry and construction industry. Proposals are made about how to better manage the safety risks associated with LPRAs. LPRA information was gathered via a literature survey using search-terms related to LPRAs. This search included the governmental resources in Europe, the USA, Australia, several Far East countries, and Africa. Both the information found and the difficulties encountered while gathering this information were analysed and validated by interviews with experts. Causal information about LPRAs is partial at best: 21 access difficulties are identified. Their resolution will create opportunities for further safety improvement. The main proposals made here relate to public information systems, company safety management, regulatory inspections, accident investigation activities and safety science research.

- **Keywords:** Language problems; Illiteracy; Readability; Multi-lingual shop floor; Occupational accident

S. Raja, Tasneem Abbasi, S.M. Tauseef, S.A. Abbasi. *Equilibrium models for predicting areas covered by accidentally spilled liquid fuels and an assessment of their efficacy*. Pages 153-162.

Majority of the accidents occurring in chemical process industry begin with the accidental spill of one or the other liquid fuel. This makes it important to forecast the areas likely to be covered by the spill of a given fuel on a given surface of a given inclination, and to devise accident prevention strategies on its basis. This work reviews all the reported models for forecasting the area attained by a liquid spill at equilibrium. It then evaluates the efficacy of these models by testing them with available data. It was possible to run four of the six reported models as data was not adequate to operate the remaining two. It is seen that three of the four models thus tested under-predicted the spill area for some liquid—surface combinations and over-predicted it for some others the percentage error covering large ranges. Only one model consistently under-predicted the area and did so in a much narrower error range. After a 'weight' or a 'correction factor' was attached to that model it was able to forecast spill area with adequate accuracy.

- **Keywords:** Denatured alcohol; Gasoline; Equilibrium spill area; Concrete; Vinyl sheet

Ghada M. Rashad, Mamdoh R. Mahmoud, Mohamed A. Soliman. *Combination of coprecipitation and foam separation processes for rapid recovery and preconcentration of cesium radionuclides from water systems*. Pages 163-173.

Foam separation of 137Cs+ radionuclides coprecipitated with cadmium(II) hexacyanoferrate (137Cs-CdHCF) particles is investigated in this study using two types of surfactants. The effects of several coprecipitation and foam separation parameters on the recovery percentage and volume reduction of cesium radionuclides are evaluated. The cationic surfactant, hexadecyltrimethylammonium bromide (HDTMA), and the anionic one, sodium lauryl sulfate (NaLS), had the ability to float 137Cs-CdHCF particles at [Cd(II)]/[KHCF] molar ratios of 0.5 and 2, respectively. Recovery percentages of 92% and 88% are obtained in the pH range of 4.7–8.3 and 3.8–9.5 using HDTMA and NaLS, respectively. The addition of stable cesium during the coprecipitation process improved the recovery percentage (98% for HDTMA and 96% for NaLS). The recovery process is very fast where induction time of <15min (for coprecipitation process) and <5min (for foam separation process) are sufficient for efficient recovery of cesium radionuclides. The

proposed strategy succeeded to efficiently preconcentrate cesium radionuclides from surface water where recovery percentage more than 99% with high volume reduction is achieved using HDTMA. Comparison of the present combined process with previously reported preconcentration processes proved its applicability for preconcentration of cesium radionuclides from water systems.

- **Keywords:** Cesium; Radionuclide; Preconcentration; Coprecipitation; Recovery; Foam separation

Yang An, Xiaocen Wang, Bin Yue, Shuo Jin, Liqun Wu, Zhigang Qu. *A novel method for natural gas pipeline safety online monitoring based on acoustic pulse compression*. Pages 174-181.

A novel method based on acoustic pulse-compression and envelope extraction is proposed and discussed to detect and locate hydrate blockage and leak in natural gas pipelines. Linear frequency modulation (LFM) signal rather than single frequency sinusoidal signal is emitted to inspect the pipeline. Reflected signal is firstly processed through a matched filter and then demodulated with Hilbert transform so that the envelope is obtained. By envelope subtraction, the detection and location of hydrate blockage and leak can be achieved. Based on the measurement and signal processing principle, a simulation model has been established with COMSOL which verifies the feasibility of the method. Experimental results demonstrate that the technique can not only locate hydrate blockage and pipeline leak precisely but also monitor the hydrate formation process in real time. Besides, the spatial resolution is improved and the interference of noises is reduced significantly thanks to matched filtering. The novel method has significantly enhanced the performance of existing system and has considerable application prospect in natural gas pipeline safety online monitoring.

- **Keywords:** Natural gas pipeline safety monitoring; Hydrate blockage; Leak detection; Pulse compression; Matched filtering; Envelope extraction

Chengkang Gao, Chengbo Gao, Kaihui Song, Zhou Ye, Jiahua Dong. *Regional water ecosystem risk assessment based on GIS and pollutant diffusion model: A case study of Shenzhen eco-industrial park*. Pages 182-189.

The emerging eco-industrial parks are established in an attempt to use shared infrastructure efficiently in industrial communities, while the concentrated discharge of wastewater in eco-industrial parks causes great pressure on the water ecosystem. The modern environmental challenges require updated systematic approaches to assess the water risk in eco-industrial parks. This research established a comprehensive index evaluation system with Analytic Hierarchy Process (AHP) and fuzzy theory to evaluate the risk of the water ecosystem in eco-industrial parks. Geographic Information System is combined with pollutant diffusion model to analyze the risk status of water ecosystem and provide early warning of water pollution. The model is applied to a case of Shenzhen Eco-industrial Park. The result showed that the concentrations of TN, suspended solids and coliforms in Longgang River at the entrance to the eco-park were 11.71 mg/L, 29.01 mg/L and 8.65×104 CFU/L, respectively, which exceeded the 5th class of environmental quality standard for surface water. The concentration of coliforms at the exit of Chunzi River reached 15.5×104 CFU/L, reaching the inferior 5th class standard. The early warning result shows that the ecological hazards caused by the same amount of pollutants in the dry season present much higher risks than those in the wet season. Stringent pollutants discharge regulations in dry season are suggested to effectively manage water risks in eco-industrial parks.

- **Keywords:** Regional water ecosystem; Geographic information system; Pollutant diffusion model; Risk assessment and early warning; Eco-industrial parks

STMLD Senevirathna, Shahid Ramzan, Jim Morgan. *A sustainable and fully automated process to treat stored rainwater to meet drinking water quality guidelines*. Pages 190-196.

Exponential growth of water demand and a decrease in usable freshwater due to various climate, environmental and anthropogenic events make rainwater harvesting a useful practice. According to Australian health regulations, drinking rainwater is low risk, if the roof catchment, collection system and storage are well maintained. The CSU Engineering building, which has received an architectural award for its sustainable design, produces its drinking water (3.7L/person/day) within the premises. Rainwater is collected from the roof catchment, stored outside the building and treated on demand at a fully transparent water treatment plant installed at the entrance of the building. The water treatment facility is fully powered by solar panels installed on the roof. The treatment process consists of several operations, including aeration, sand filtration, GAC adsorption and UV disinfection. The performance of the CSU Engineering water treatment plant for the past 30 months is discussed in this paper. Primary and secondary water quality parameters of treated water were well within Australian drinking water quality standards and showed better results than municipal water available in the host town. The aeration unit improved secondary water quality standards (odor and taste) and the adsorption process was effective for elimination of metals. The result of this experiment indicated that this process could be a promising solution for providing safe drinking water in remote Australia, including sessional demands in rest areas and caravan parks.

- **Keywords:** Australia; Rainwater harvesting; Sustainable development; UV disinfection; Decentralized water treatment

Jayishnu Singla, Vikas K. Sangal, Anoop Verma. *Evaluation and optimization of the process parameters for the photo-electrochemical treatment of urea using mixed metal oxide anodes*. Pages 197-208.

The present study investigates the electro-oxidation (EO) treatment of urea containing wastewater using mixed metal oxide (MMO) anodes. Box-Behnken design (BBD) was employed to analyze the effects of various operational process parameters like current density (j), NaCl dose (n), treatment time (t) and pH in an EO reactor in batch mode. The performance of the treatment process was evaluated in terms of % degradation and energy consumption. Under optimum conditions, the experimental results showed that more than 94.78% of degradation of urea was achieved. Electro-oxidation has effectively reduced the TOC (90%) under optimum conditions. Attempts were made to integrate the two process electro-oxidation and photocatalysis i.e. Photoelectrocatalysis within the same treatment unit for the enhanced degradation of target pollutant. The electro-oxidation process with mixed metal oxide anode has also attained a significant removal of nitrogen by transforming into the NO3− and NH4+ through the formation of OH and reactive chlorine species. Characterization techniques like SEM-EDX and XRD have confirmed the durability of mixed metal oxide anodes even after 90 recycles of the experimental run. The total operating cost for electro-oxidation treatment of urea under optimized conditions is found to be 0.78 $/m3.

- **Keywords:** Electro-oxidation; Urea; Mixed metal oxide; Energy consumed; Box-Behnken design; Optimization

Tatiele D. Ferreira, Sávio S.V. Vianna. The Gilbert Johnson *Keerthi distance algorithm coupled with computational fluid dynamics applied to gas explosion simulation*. Pages 209-220.

We investigate how the flamelet combustion model coupled with the collision distance algorithm reproduces turbulent reacting flows. The wrinkling length scale of the flame is

modelled as function of the turbulent fluctuating velocity due to shear stress and wake effects calculated by a porous computational mesh. The porous media is based on the Minkowski difference to check the collision among convex objects. The combustion and porosity models are implemented in the framework of an in house Fortran code (Shock Towards Kinetic Explosion Simulator) that solves the full set of Navier–Stokes equations for reacting flows. Results are presented for large Reynolds numbers in relatively small combustion chambers with Karlovitz number around unity. Comparison with experimental data leads to good agreement. The novel approach for calculation of porosities is fully described as it was coded.

- **Keywords:** Explosion; Porosity distributed resistance; Gilbert-Johnson-Keerthi algorithm; CFD

Jie Yang, Yuan Yu, Yunhao Li, Qingwu Zhang, Liju Zheng, Taiyu Luo, Yifan Suo, Juncheng Jiang. *Inerting effects of ammonium polyphosphate on explosion characteristics of polypropylene dust*. Pages 221-230.

This study experimentally investigated that the inerting effect of Ammonium Polyphosphate (APP) on characteristics of Polypropylene (PP) dust explosion. The results indicated that the maximum explosion pressure (Pmax), the explosion index (Kst) and the minimum explosion concentration (MEC) of PP powders were 8bar, 257barm/s and 25g/m3, respectively. Moreover, the minimum ignition energy (MIE) and the minimum ignition temperature (MIT) were 10mJ and 335°C, correspondingly for PP dust cloud. The explosion of PP powders could be inerted completely by 80wt% APP. In addition, the MIE of PP powders increased when the mass fraction of APP increased. Furthermore, APP had a significant inerting effect on the MIT of PP dust cloud. The MIT of PP powders increased by 80°C when the mass fraction of APP increased to 80wt %. Thermal analysis results showed that the introduction of APP could improve the thermal stability of PP. Furthermore, thermogravimetric analysis/infrared (TG-IR) spectroscopy was employed to gain insights into the pyrolysis mechanism of the PP/APP mixtures. The TG-IR results showed that the volatilized products formed in the pyrolysis were H2O and NH3 which could dilute and consume oxygen in gas phase.

- **Keywords:** Ammonium polyphosphate; Polypropylene; Inerting effect; Minimum inerting concentration; Thermal analysis

Chen-Rui Cao, Shang-Hao Liu. *Thermal hazard characteristic evaluation of two low-temperature-reactive azo compounds under adiabatic process conditions*. Pages 231-237.

As a key initiator of polymerization, azo compounds (azos) can supply abundant energy to the polymerization process. Although polymerization can be implemented more smoothly and the product can be modified, the use of azos also increases the probability of process hazards caused by high heat accumulation and release. To preserve the thermal safety of using azo initiators in the synthesis process, the frequently used azo initiators dimethyl 2,2′-azobis(2-methyl propionate) (AIBME) and 2,2′-azobis(2,4-dimethylvaleronitrile) (ABVN) were chosen for investigation. Under process conditions, initiators are essential for evolving and monitoring chemical reactions on both the laboratory scale and process environment. The assessment, control, and mitigation of reaction hazards are primarily based on kinetic models, which are used to estimate multiple critical safety parameters, such as TMRad in process safety and TCL and SADT in storage and transportation operation. The data from the adiabatic calorimeter correspond to real process situations are combined with the nonlinear adiabatic kinetic model, which is rarely applied to analyze the thermal hazard properties of azos. The results indicated that the kinetic model of azos in the actual process, the thermal hazard characteristics, and simulation of the runaway mode of azos in setting boundary conditions should also be investigated.

- **Keywords:** Polymerization; Process hazard; Thermal safety; Kinetic models; Adiabatic calorimeter

Nouha Bakaraki Turan, Hanife Sari Erkan, Guleda Onkal Engin, Mehmet Sinan Bilgili. *Nanoparticles in the aquatic environment: Usage, properties, transformation and toxicity—A review*. Pages 238-249.

Nanoparticles are defined as a group of particles having sizes between 1 and 100nm and characterized by some specific physicochemical properties such as surface area, surface charge, degree of agglomeration, particle morphology and surface coating. Nanoparticles have been widely used in different fields resulting in their intentional or unintentional release into the aquatic environment. This work focused on reviewing the main sources of nanoparticles in the aquatic environment, their interactions and transformation processes. This review also summarizes all the possible toxicity forms and the factors affecting nanoparticles toxicity in the aquatic environment.

- **Keywords:** Nanoparticles; Aquatic environment; Nanoparticles toxicity; Nanoparticles transformations

Mingyi Chen, Dongxu Ouyang, Jingwen Weng, Jiahao Liu, Jian Wang. *Environmental pressure effects on thermal runaway and fire behaviors of lithium-ion battery with different cathodes and state of chargé*. Pages 250-256.

The environmental pressure effect on thermal runaway and fire behaviors in the 18650 lithium-ion battery (LIB) with various cathodes and states of charge (SOC) are experimentally investigated in this work. The fire hazards were characterized by the combustion process, total mass loss (TML) and total heat release (THR). The TML and THR increase with the ascending of the SOC at two pressures. The amount of materials ejected by both LiFePO4 and LiCoO2 batteries during the combustion is slightly affected by the environmental pressure. Meanwhile, the environmental pressure has a significant influence on the combustion heat that the THR value at high pressure is relatively bigger than that at low pressure. The unit growth rate in combustion heat between the two pressures also increases with the SOC.

- **Keywords:** Lithium-ion battery; Environmental pressure; Thermal runaway; Fire; Combustion heat

Xiaoju Yan, Lu Huo, Cong Ma, Jinfeng Lu. *Layer-by-layer assembly of graphene oxide-TiO2 membranes for enhanced photocatalytic and self-cleaning performance*. Pages 257-264.

A GO-TiO2 membrane was fabricated using a layer-by-layer method to assemble graphene oxide (GO) on a polyacrylonitrile (PAN) support, interconnecting GO nanosheets with polyethylenimine (PEI). The surfaces of the GO nanosheets were modified by depositing titanium dioxide (TiO2) nanoparticles on them using an ethanol/ultraviolet (UV) post-treatment, that enhanced their photocatalytic and self-cleaning properties. The GO-TiO2 membrane showed good photocatalytic performance with a 58.8% removal rate of methylene blue (MB) under UV for 250 min. The self-cleaning properties were illustrated via the flux recovery by UV irradiation and the effect of UV irradiation before membrane filtration. The experimental results indicated that the J/J0 ratio of the GO-TiO2 membrane increased from 41% to 54% after the fouled membrane was exposed to UV irradiation for 30 min. When UV irradiated the GO-TiO2 membrane for 40 min prior to filtration, the flux increased from 1.67 to 1.88 L/m2•h. This may be a result of the photo-induced superhydrophilicity of TiO2.

- **Keywords:** Layer-by-layer; PAN; Photocatalytic; Self-cleaning

Dilaeleyana Abu Bakar Sidik, Nur Hanis Hayati Hairom, Abdul Wahab Mohammad. *Performance and fouling assessment of different membrane types in a hybrid photocatalytic membrane reactor (PMR) for palm oil mill secondary effluent (POMSE) treatment*. Pages 265-274.

This study attempted to treat POMSE via photocatalytic membrane reactor (PMR) using different types of commercial membranes (NF-TS 40, UF-UA 60, MF-PVDF, and MF-PES membranes). The results showed that nanofiltration membrane (NF-TS 40) demonstrated the best performance due to the greater photodegradation efficiency and less fouling propensity. The best PMR condition using NF-TS 40 membrane indicated the most effective performance with greater normalized flux (0.33) and higher removal percentage of colour (99.84%), chemical oxygen demand (COD) (99.97%), biological oxygen demand (BOD) (96.24%), and turbidity (99.89%). The severity of membrane fouling based on the membrane characterisation showed a declining trend when using NF membrane in terms of foulant layer and surface roughness. Thus, the finding from this study can be set as a benchmark of an effective polishing method to treat POMSE for water reclamation due to the mitigation of membrane fouling and better performance in producing a good quality permeate.

- **Keywords:** Photocatalytic membrane reactor (PMR); Palm oil mill secondary effluent (POMSE); Nanofiltration membrane; Normalized flux; Colour removal

Syaza I. Ahmad, Haslenda Hashim, Mimi H. Hassim, Roslina Rashid. *A graphical inherent safety assessment technique for preliminary design stage*. Pages 275-287

User-friendly plants are needed for equipment failure to not seriously affect its safety, productivity, or efficiency. Safer and user-friendly plants can be designed through the implementation of hazard prevention strategies during the design phase, which is known as the concept of inherent safety. The Graphical Inherent Safety Assessment Technique (GISAT) for preliminary engineering design stage is presented in this paper. GISAT incorporates information obtainable from the process flow diagram (PFD) in the assessment of inherent safety features of a process. This technique evaluates three inherent safety parameters, namely flammability, explosiveness, and toxicity. GISAT also utilises accident statistics in the construction of its graphical rating as the hazard level indicator for chemical process equipment assigned under five groups—reactor, heat transfer equipment, separation equipment, storage tank, and other equipment. In this technique, quantity of the chemicals involved in an equipment represents the weightage of the assessment that is used to identify the root-cause of hazards in each equipment. Hydrodealkylation process of toluene (HDA) to produce benzene is used as a case study to demonstrate the application of GISAT. The results indicate that heat transfer equipment E102 as safer in terms of flammability compared to other equipment while all equipment were found to be safer in term of explosiveness. Separation equipment V102, heat transfer equipment E102, and recycle gas compressor C101 were found to be safer in terms of toxicity. Meanwhile, heat transfer equipment E101, E102, and E103 as well as gas compressor C101 are regarded as safer in terms of fire, explosion, and toxic release combination type of accident as represented by the GISAT Total Score. After the level of hazard in each equipment have been identified, hazard prevention strategies can be applied to equipment with higher level of hazard for hazard reduction.

- **Keywords:** Inherent safety assessment; Preliminary design stage; Accident database; Graphical rating; Flammability; Explosiveness; Toxicity

Zhurui Tang, Beidou Xi, Caihong Huang, Wenbing Tan, Xiangqin Xia, Tianxue Yang, Mingda Yu, Xinyu Zhao, Wenchao Yuan. *Linking phytoavailability of heavy metals with microbial community dynamics during municipal sludge composting*. Pages 288-296.

Municipal sludge compost contains residual heavy metals (HMs), which could limit the utilization of compost as a resource. Studies have revealed that the availabilities of HMs in composting system are affected by microbial-driven organic matter and physicochemical indices. However, how the microbial community dynamics affect the availability of HMs during municipal sludge composting remains unclear. In this study, high-throughput sequencing technology was applied to investigate the response relationship between microbial dynamics and different availability of HMs. A total of 31 main genera within 5 phyla were identified. The concentrations of the most available HMs increased, and the increasing rates varied from 102% to 240%. Proteobacteria, Firmicutes, and Chloroflexi could affect organic matter to control the phytoavailability of Cr and Pb, whereas Proteobacteria, Bacteroidetes, and Actinobacteria could affect the phytoavailability of Cu and Zn. The bioaccessible HMs are only affected by organic functional groups, whereas the leachable HMs are not affected by organic matter or microorganisms. The "physicochemical index-microorganisms-available heavy metal" response pathway and principal component analysis showed that the increase in total C and N and the decreasing content of NO3−−N reduce the phytoavailable HMs. We finally proposed a regulation method to improve the resource utilization of municipal sludge composting and provide theoretical support for the harmlessness of municipal sludge composting.

- **Keywords:** Municipal sludge composting; Microorganisms; Phytoavailability; Heavy metals

Zeynep Yıldız, Nihan Kaya, Yıldıray Topcu, Harun Uzun. *Pyrolysis and optimization of chicken manure wastes in fluidized bed reactor: CO2 capture in activated bio-chars*. Pages 297-305.

In this study, the Response Surface Methodology (RSM) based on Central Composite Design (CCD) was used to determine the optimization of bio-char production from chicken manure wastes. The effects of temperature, heating rate and reaction time on pyrolysis of chicken manure waste were investigated in the fluidized bed reactor. Operation conditions were selected between the reaction temperatures was 200–500°C, the heating rate was 5–20°C/min and the reaction time was 30–120min. The optimum condition was determined using the surface area results of the bio-chars. As a result of the optimization studies, it was determined that the temperature should be 400°C, the heating rate should be 5°C/min and the reaction time should be 110min in order to obtain bio-char with highest surface area. Bio-char obtained in optimum condition in fluidized bed reactor was subjected to chemical activation with KOH and HCl, respectively. The CO2 adsorption capacity of raw and activated bio-char products was determined as 48.7, 76.8 and 85.7mg/g at 25°C using thermogravimetric analysis method, respectively. As a result, it has been found that the activated bio-chars are effective adsorbents for CO2 storage and it has been demonstrated that it is possible to evaluate chicken manure wastes for removing environmental pollutant in an economical way.

- **Keywords:** Central composite design; Response surface methodology; Chicken manure wastes; Pyrolysis; Fluidized bed reactor

Alexander Moen, Lorenzo Mauri, Vagesh D. Narasimhamurthy. *Comparison of k-ε models in gaseous release and dispersion simulations using the CFD code FLACS*. Pages 306-316.

Several model validation studies on gas dispersion scenarios have been conducted in the past on the Reynolds averaged Navier Stokes (RANS) based eddy viscosity turbulence models. However, many of these studies are based on a limited number of validation cases involving simple geometries and conformal mesh. In the area of safety engineering, the application of RANS-based CFD for consequence analysis is a widely used methodology. Best practice on use of CFD in this context, as the document developed in the COST Action 732 (Franke et al., 2007), focus primarily on validation and verification aspects as well as simulation setup and definition of input data. Guidelines on turbulence models also exist, among which the ERCOFTAC CFD Best Practice Guidelines, and the works of Meroney et al. (2016) and Mcbride et al. (2001). However, there is no unique recommended model for dispersion simulations. The objective of the present study is to assess the three well-known RANS eddy viscosity models, namely, Standard k-ε, Re-Normalization group (RNG) k-ε and Realizable k-ε, in a representative range of gas dispersion cases by comparing models' behavior with experimental data. The current validation cases include dense CO2 release in a cross-wind, impinging hydrogen jet, and a dense chlorine jet release in an industrial site. All the simulations were conducted using the commercial CFD code FLACS. Turbulence models were assessed based on the ability to reproduce experimental concentrations, required computational-time and numerical-stability. Overall, Standard k-ε and RNG k-ε models were found to be reasonably good in all cases. Nevertheless, Realizable k-ε model shows promise in yielding good results in cases involving complex-geometries and dense-phase gas-releases. These results may also be explained with the interplay between the Porosity/Distributed Resistance subgrid models used in FLACS and turbulence models.

- **Keywords:** Consequence analysis; Consequence modelling; Model uncertainty; Computational fluid dynamics (CFD)

Pengjia Dou, Jianfeng Song, Shuwei Zhao, Shanshan Xu, Xuemei Li, Tao He. *Novel low cost hybrid extraction-distillation-reverse osmosis process for complete removal of N,N-dimethylformamide from industrial wastewater*. Pages 317-325.

Toxic N,N-dimethylformamide (DMF) is extensively used as a versatile solvent in various processes and thus released in large quantities in many industrial effluents. Low degradability requires effective treatment of DMF wastewater. A novel process combining extraction, distillation, and reverse osmosis (RO) was proposed. After screening, chloroform was selected as the solvent for DMF extraction. The extraction process conditions, namely phase ratio and the number of counter-current theoretical stages were determined by calculation and batch simulation. Kerosene was then used for the extraction of the dissolved chloroform in the wastewater after DMF extraction. The distillation columns for the separation and recovery of DMF and extractants were designed by Aspen Plus. The simulation results showed that more than 99.8% of DMF could be recovered with a purity of 99%. The salinity of the wastewater was reduced to a much lower level through RO process, and the quality of the wastewater improved greatly. Economic analysis showed that a significant reduction of 72.74% in the total annual cost (TAC) can be obtained by using the proposed process.

- **Keywords:** N,N-Dimethylformamide; Wastewater; Extraction; Distillation; Reverse osmosis; Economic analysis

Xiaoguang Li, Lingyan Zeng, Hongye Liu, He Du, Xiuchao Yang, Hui Han, Wenjie Liu, Shaofeng Zhang, Minhang Song, Zhichao Chen, Zhengqi Li. *Numerical simulation study on the influences of the secondary-tertiary air proportion on the airflow mixing effects and pulverized coal combustion characteristics in a 300-MW down-fired boiler*. Pages 326-343.

In this paper, based on the MIMSC (multi-injection and multi-stage combustion) technology, new burner arrangement and air distribution parameter settings were proposed for a 300-MW subcritical down-fired boiler originally using MBEL (Mitsui Babcock Energy Limited) combustion technology. Numerical simulations were conducted to study the influences of the secondary-tertiary air proportion on the airflow mixing effect in the furnace, the ignition and pulverized coal combustion characteristics. The airflow mixing effect in the furnace is characterized by the size of the dimensionless vertical velocity decay area (Vda) and the fluctuation of the maximum vertical velocity decay curve (Vdc). During the research, the sum of the secondary and tertiary air rate remained constant, and the secondary air rate was set to 30.54%, 33.54%, 36.54%, 39.54%, and 42.54%. It was found that under the condition of using new type burner, with the secondary air rate increased from 30.54% to 42.54%, the ignition distance of pulverized coal decreased from 1.30m to 0.84m, the dimensionless penetration depth decreased from 1.46 to 1.27, and the NOx emission and carbon in the fly ash decreased first and then increased. The variation of Vdc showed the following regulation. At the secondary air rate of 30.54% to 33.54%, increasing the secondary air rate decreased the fluctuation amplitude. While at the secondary air rate of 39.54% to 42.54%, increasing the secondary air rate increased the fluctuation amplitude. Only at the secondary air rate of 36.54%, Vdc in the tertiary air mixing area was smooth. When Vdc was smooth, Vda was small at 0.043, the carbon in fly ash at the furnace outlet was the lowest at 4.19%, and the NOx emission was low at 675.9 mg/m3 at 6% O2. An optimal secondary air rate of 36.54% is recommended. For the subsequent design of burner structure and parameters, it is suggested that Vdc in the tertiary air mixing area should be smooth.

- **Keywords:** Down-fired boiler; Numerical simulation; Secondary-tertiary air proportion; Airflow mixing; Dimensionless velocity decay; Coal combustion

Yongjun Li, Pengfei Wang, Ronghua Liu, Runze Gao. *Optimization of structural parameters and installation position of the wall-mounted air cylinder in the fully mechanized excavation face based on CFD and orthogonal design*. Pages 344-358.

In order to obtain the reasonable structural parameters and installation position of the wall-mounted air cylinder attached to the fully mechanized excavation face in coal mines, a scaled physical model was established based on the C103 fully mechanized excavation working face of Nahe Coal Mine of Baise Bailing Group in Guangxi Autonomous Region. The orthogonal design and the numerical simulation were combined to investigate the wind flow field and the distribution of dust concentration under different structural parameters and installation positions of the wall-mounted air cylinders. The results of orthogonal numerical tests showed that as the width (W) and the length (L) of the strip-shaped air outlet increased, the dust concentration cm in the breathing area of drivers first decreased and then increased. In addition, cm increased with the increase of the installation distance (D). The optimal dust-control effect of the wall-mounted swirling ventilation was achieved under the following condition: the width (W) and the length (L) of the strip-shaped air outlet were 0.05 m and 1.4 m, respectively, and the distance (D) between the wall-mounted air cylinder and the tunneling end was 5.6 m. Under this condition, the dust concentration at the driver's location was the lowest, and the dust-blocking efficiencies for both total dust and respirable dust were 92.14% and 94.08%, respectively.

- **Keywords:** Fully mechanized excavation face; Wall-mounted air cylinder; Structural parameters; Installation position; Numerical simulation; Orthogonal design