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Seyed Hossein Mousavi, Asadollah Mohammadi. *A cyclodextrin/glycine-functionalized TiO2 nanoadsorbent: Synthesis, characterization and application for the removal of organic pollutants from water and real textile wastewater*. Pages 1-15.

In this paper, β-cyclodextrin-glycine-modified TiO2 nanoparticles (TiO2/Gly/β-CD NPs) as a nano-adsorbent were prepared and employed for the removal of some organic pollutants from aqueous solutions. Results from FT-IR, FESEM, TEM, XRD, EDX and BET surface area measurement showed that the TiO2 NPs was modified with Gly and βeta-cyclodextrin (β-CD). The effect of environmental factors, including pH, contact time, adsorbent dosage, temperature, and initial dye concentration on the adsorption ability of the TiO2/Gly/β-CD were investigated in detail. The results of this study showed that TiO2/Gly/β-CD has high adsorption efficiency toward organic dyes, and were comparable with other adsorbents. The adsorption capacities of MB, MO, AB113, and DR1 onto TiO2/Gly/β-CD NPs are found to be 81.97mg/g, 384.62mg/g, 76.92mg/g, and 138.89mg/g, respectively. In addition, the adsorbent presented can be used in several adsorption–desorption cycles. The dye adsorption kinetics, thermodynamics and isotherms were also investigated. The results indicated that pseudo-second-order kinetic model with correlation coefficients greater than 0.9971, and Freundlich isotherm model with correlation coefficients greater than 0.991 well describe the adsorption of MB, MO, AB113, and DR1 on the TiO2/Gly/β-CD NPs. Moreover, the thermodynamic parameters indicated that the adsorption process for all types of organic dyes was exothermic. Additionally, the adsorbent was successfully applied to remove industrial dyes from real textile wastewater with satisfactory results.

- **Keywords:** Titanium dioxide nanoparticles; Surface-modification; βeta-Cyclodextrin; Water and wastewater treatment; Organic pollutant; Adsorption

Clairon L. Pinheiro, Osvaldir P. Taranto, Edson Tomaz. *Study of volatile organic compounds (VOCs) emitted by orange bagasse drying proces*. Pages 16-24.

Orange juice industries produce essential oils (d-limonene) and citrus pulp. The citrus pulp corresponds to 49kg per 100kg of orange processed and it is the bagasse of processed fruit after pressing, milling, pelleting and drying operations. However, bagasse drying process causes emission of volatile organic compounds (VOCs) because albedo and flavedo are present in the bagasse containing a residual amount of d-limonene and volatile oils unrecovered in other process steps. These compounds are a primary source

of air pollution and it cause problems related to tropospheric ozone formation, photochemical pollution and human health problems, when being into the atmosphere. In this context, the emission of VOCs was studied, exposing particles of albedo and flavedo (Citrus sinensis L. Osbeck) to airflows with constant velocity at different exposure times and at seven temperatures. The experiments were conducted in an experimental module, where gas samples at the airflow outlet were collected for the quantification of furfural, α-pinene, β-pinene, 3-carene, p-cymene and d-limonene by gas chromatography with detector of flame ionization (GC-FID). The results showed that the main compounds emitted were d-limonene, 3-carene and α-pinene from the flavedo with a tendency to increase the emission with the increase of the temperature. The emission of VOCs occurred by steam distillation process predominating between room temperature and 160°C, and by steam distillation followed by evaporation by thermal degradation effect due to the exposure time at temperatures between 160 and 250°C.

- **Keywords:** VOCs; Drying process; Orange bagasse; Albedo; Flavedo; Atmospheric pollution

Nedra Asses, Amel Farhat, Sarra Cherif, Moktar Hamdi, Hassib Bouallagui. *Comparative study of sewage sludge co-composting with olive mill wastes or green residues: Process monitoring and agriculture value of the resulting composts*. Pages 25-35.

The viability of co-composting as a treatment approach for sewage sludge with organic wastes was investigated in the context of management aspects and the agricultural value of the final product. Two composting cycles (P1 and P2) were performed, in which sewage sludge (SS) was used to form two mixtures either with olive mill waste (OMW) or with green waste (GW), respectively. Co-composting of SS with both used organic wastes allowed obtaining hygienic compost with sufficient agronomic quality. Phenols accumulation from the mixture containing OMW caused an important decrease of pathogens within the compost. These products were characterized by a content of P and K that meet similar quality compared to commercial composts and showed an advanced maturation useable directly in agriculture. FTIR analyses and phytotoxicity tests were assessed to evaluate compost maturity. In fact, the germination index (GI) values for maize and tomato seeds, treated with P1, were 79.68% and 97.36%, respectively. However, they decreased to 74.45% and 81.45%, respectively using P2. Furthermore, compost application in peat amended at ratios equal to 30% and 50% improved the growth speed and fresh biomass of maize and tomato plants.

- **Keywords:** Co-composting; Sewage sludge; Olive mill wastes; Green residues; Phytotoxicity; Agriculture bioassay

Jie Zhang, Lan Zhang, Zheng Liang. *Buckling failure of a buried pipeline subjected to ground explosions*. Pages 36-47.

Ground explosions are one of the threats to the structural integrities of buried pipelines. To investigate failure modes of buried pipelines subjected to ground explosions, numerical calculation models of buried pipelines in soil and rock layers were established. The stress, strain, plastic deformation and failure modes of the buried pipeline were investigated. The effects of the explosion magnitude, diameter–thickness ratio, burial depth, explosion height and explosion offset on the failure behaviour of the pipeline in the rock layer were studied. The results showed that the pipeline deformation process only lasted for 0.03s. The high stress zone and plastic strain zone were present in the upper part of the pipeline, and a dent appears. A buried pipeline in a rock layer is more dangerous than that in a soil layer due to the reflection of the explosion wave in the rock layer. The deformation, plastic strain and total energy of the pipeline increase gradually in the rock layer with increasing explosion magnitudes or diameter–thickness ratios, but these indices decrease with the increased burial depths, explosion heights and explosion

distances. Empirical formulas can be used to predict the strain and dent rates of the buried pipeline. These results can provide the theoretical basis and references for laying pipeline, as well as for their safety evaluations and maintenance, etc.

- **Keywords:** Buried pipeline; Ground explosion; Numerical simulation; Stress; Dent; Plastic deformation

Jihao Shi, Jingde Li, Yuan Zhu, Hong Hao, Guoming Chen, Bin Xie. *A simplified statistic-based procedure for gas dispersion prediction of fixed offshore platform*. Pages 48-63.

In explosion risk analysis, Frozen Cloud Approach (FCA) and Dimensionless Response Surface Method (DRSM) are both commonly used to achieve a balance between simulation workloads and accurate results. However, the drawbacks of these two approaches are obvious. FCA is not reliable for risk study of fuel-dominated regions. Whereas DRSM usually couples the dimensionless parameters and generates a large numbers of correlations to predict the flammable cloud size, which brings a heavy computation burden for engineers. Therefore, this paper aims to propose a simplified procedure which can quickly and accurately provide a large number of non-simulation data based on limited CFD simulation data. Full Factorial Design of Experiment (FFDOE) based RSM is adopted. Codification is applied to couple all the dimensional parameters into a single correlation. Automatically Selected Model Technology (ASMT) is used to easily determine the suitable structure of correlation. Compared to the conventional procedures, the simplified procedure is proven to be more robust. For subsequent Explosion risk analyses (ERAs) in the fuel-dominated regions, the simplified procedure becomes a superior alternative.

- **Keywords:** Automatically Selected Model Technology; Computation cost reduction; Explosion risk analysis; Frozen Cloud Approach; Dimensionless respond surface method; Fuel-dominated region

Denglong Ma, Wei Tan, Zaoxiao Zhang, Xiaoqiao Wang, Fengshe Xia, Jun Hu. *Recognition of leak CO2 with wavelet analysis based on correlation monitoring between CO2 and O2 in atmosphere*. Pages 64-78.

It is necessary to monitor and identify CO2 leakage from geosequestration project. Some experiments were designed to test the feasibility of characterization and recognition method for CO2 leakage based on correlation analysis between atmospheric CO2 and O2. The monitoring results showed that atmospheric CO2 had a good linear relationship with O2, especially in the day time. The variations of CO2 and O2 were influenced by the weather condition. The results of emission experiments proved the capability of coupling monitoring atmospheric CO2 and O2 to recognize the abnormal CO2 signal due to leakage. Moreover, two parameters, ALF (apparent leakage flux) and ALFs (apparent leakage flux based on surplus variable) were used to distinguish CO2 leakage in real time. The monitoring results verified that it was feasible to identify CO2 leakage with these two parameters. Compared with the results after median filter, the abrupt leakage signal can be more easily recognized with that after wavelet filter. ALFs can be applied to estimate the elevated concentration due to leakage, which can also be predicted by interpolating with related variation of atmospheric O2. ALF reflects the relative leakage rate. Therefore, it is practicable to identify leakage event in real time with the method proposed in this paper.

- **Keywords:** Geosequestration safety; Leakage risk; Leakage verification; Correlation analysis; Gas leakage; Leakage monitoring; Storage failure

Andrea Petrella, Danilo Spasiano, Pasquale Acquafredda, Nicoletta De Vietro, Ezio Ranieri, Pinalysa Cosma, Vito Rizzi, Valentina Petruzzelli, Domenico Petruzzelli. *Heavy metals retention (Pb(II), Cd(II), Ni(II)) from single and multimetal solutions by natural biosorbents from the olive oil milling operations*. Pages 79-90.

In the present paper, the lignocellulosic residues from the olive oil industry in South-East Italy, namely BOP (Biosorbent from Oil Production), were used as sorbents for heavy metals retention (Pb+2, Cd+2, Ni+2) in water and wastewater treatments. To the purpose, thermodynamic and kinetic investigations for single and multispecies systems were carried-out through batch equilibrium isotherms and column dynamic experiments. In the case of batch tests, maximum metals retentions (qmax) in single ion solutions were 22.4mg/gBOP, 10.5mg/gBOP, 5.04mg/gBOP respectively for Pb+2, Cd+2 and Ni+2, lower figures were detected in the case of ternary systems with values exceeding 10.51mg/gBOP, 5.11mg/gBOP, 3.81mg/gBOP respectively. Further drastic reductions were detected in tap water. Langmuir and Freundlich isotherms led to good correlations of the data in single-ion and ternary solutions in demineralized water. Freundlich isotherms gave better correlation in tap water. In the case of column tests, operating capacities resulted in the same order with Pb+2>Cd+2>Ni+2. After retention, the exhausted metal converted materials were included into cement conglomerates for a possible employment in the building industry applications, thus minimizing their potential environmental impact.

- **Keywords:** Olive waste; Sorption; Porous media; Batch reactor; Column dynamic experiment; Wastewater treatment

Min Chen, Zhao Li, Pengwu Huang, Xuewei Li, Jun Qu, Wenyi Yuan, Qiwu Zhang. *Mechanochemical transformation of apatite to phosphoric slow-release fertilizer and soluble phosphate*. Pages 91-96.

This paper introduces a mechanochemical process for the clean production of phosphoric slow-release fertilizer and soluble phosphate powders directly from apatite (Ca5(PO4)3(OH, F)) by just milling with sulfuric acid (H2SO4, 98wt%) and ammonium sulfate ((NH4)2SO4) at room temperature. It was found that, at certain molar ratios of the additives, water soluble ammonium hydro-phosphate was simply produced from apatite and the ratio of the water-soluble one to the insoluble part (soluble in 2% citrate acid taken as slow release fertilizer) could be regulated by changing the added molar ratio of sulfuric acid. The less the (NH4)2SO4-H2SO4 addition was, the higher the proportion of obtained phosphoric slow-release fertilizer to the soluble phosphates would be. 25% addition of the required stoichiometric ratio of (NH4)2SO4-H2SO4 for a complete transformation, for example, gave the product with 50% slow release composition as well as 30% soluble phosphate. The obtained fine solid powders after milling operation may serve directly as fertilizers. Besides its simplicity and easy regulation in product compositions, one significant advantage of the proposed mechanochemical process is the no emission of gaseous and aqueous wastes from the current production line, offering a truly environment-friendly approach.

- **Keywords:** Mechanochemical; Apatite; Slow-release fertilizers; Soluble phosphate; Clean production; Minerals processing

Daniele Perondi, Danielle Restelatto, Christian Manera, Aline Dettmer, Marcelo Godinho, Antônio Cezar Faria Vilela. *Factorial design application to evaluate thermochemical conversion of shredder residues*. Pages 97-106.

Among the different wastes generated by steel industry, there is the shredder residue (SR). SR is a highly heterogeneous mixture, which is most commonly destined to a landfill of industrial waste by the Brazilian steel industry. Considering the high variation of its composition, the use of statistical tools is recommended to obtain consistent data. Pyrolysis can be considered a solution to dispose of this residue. This work aimed at evaluating the SR pyrolysis process using a 2k factorial design. The following variables were investigated: temperature, heating rate, inert gas (N2) flow rate, and CaO/SR ratio. Lower heating rate resulted in higher non-condensable gas yields (>50% w/w). CaO was efficient for CO2 capture in non-condensable gas, thus increasing calorific value. Higher heating rate resulted in higher condensable vapor yields, and the main compound found in this stream was styrene. The thermochemical conversion process, through pyrolysis, presented high potential for SR reuse rather than the disposal in landfills.

- **Keywords:** Factorial design; Pyrolysis; Energy recovery and waste treatment; Steel industry; Shredder residue

Aditya Rajeev Kaveeshwar, Senthil Kumar Ponnusamy, Emmanuel D. Revellame, Daniel D. Gang, Mark E. Zappi, Ramalingam Subramaniam. *Pecan shell based activated carbon for removal of iron(II) from fracking wastewater: Adsorption kinetics, isotherm and thermodynamic studies*. Pages 107-122.

Pecan shell based activated carbon (PSBAC) developed in this work had a high specific surface area (1500m2/g) and pore volume (0.7cm3/g). The maximum adsorption capacity of the PSBAC was found to be 41.66mg/g at 55mg/L iron(II), pH=3, 3g/L adsorbent dose, at 90min and at 30°C. Iron(II) adsorption can be best described by the pseudo second order model. The adsorption system was thermodynamically favorable, endothermic and increase in entropy. The experimental data were fitted against common adsorption isotherms and yielded excellent fits in the following order: Temkin>Freundlich>Sips>Halsey Dubinin–Radushkevich>Langmuir>Harkins–Jura>Redlich–Peterson>Elovich.

- **Keywords:** Adsoprtion; Fracking water; Iron; Pecan shells; Isotherms; Kinetics

Lai-Peng Wong, Mohamed Hasnain Isa, Mohammed J.K. Bashir. *Disintegration of palm oil mill effluent organic solids by ultrasonication: Optimization by response surface methodology*. Pages 123-132.

Palm oil mill effluent (POME) is a complex wastewater that consists of high concentration of chemical oxygen demand (COD) and insoluble organic solids. Anaerobic digestion has been successfully used in treating POME due to its low cost and ability to produce biogas. Nevertheless, biogas production can be enhanced by increasing the solubility of organic compounds during anaerobic treatment. To improve organic matter solubilization in POME, this study focuses on investigating the applicability of low frequency ultrasonication as a pretreatment to anaerobic digestion. Experiments were statistically designed by central composite design (CCD) and response surface methodology (RSM) was used to examine the impacts of independent variables (i.e., ultrasonication density, ultrasonication time and total solids concentration) on treatment performance in terms of organic matter solubilization and concentration of soluble chemical oxygen demand (SCOD). Analysis of variance (ANOVA) showed both models to be significant with Prob>F<0.01. The coefficient of determination (R2) values were greater than 0.80, implying satisfactory agreement between the quadratic models and the experimental data. The optimum ultrasonication performance was obtained at 0.88W/mL ultrasonication density, 16.20min ultrasonication time and 6% total solids concentration. This resulted in 16.10% organic matter solubilization and increased SCOD from 29,000mg/L to 31,675mg/L. The differences between the predicted and experimental

values were less than 5%. This supports the successful use of CCD and RSM for the design of this set of experiments and determination of optimum responses.

- **Keywords:** Organic matter; Palm oil mill effluent; SCOD; Solubilization; Ultrasonication; Optimization

Chen Chen, Yabin Yang, Mengtong Wang, Xinmei Zhang. *Characterization and evolution of emergency scenarios using hybrid Petri net*. Pages 133-142.

Accident scenarios are the foundations of emergency responses. Hybrid Petri net is used to model emergency scenarios and responses comprehensively and systematically. Here, both the discrete events of scenarios and their evolution are characterized clearly. Elements of accident scenarios are expressed normatively using a knowledge element model and hierarchical theory, providing standardized descriptions of the different scenario stages. Then, a case study of an oil pipeline leak is examined to verify the logic of the hybrid Petri net and the expressions of attributes using the knowledge element model. The results show objective realizations of the scenario and the evolution of emergent events, enabling a formalized expression of emergency knowledge that can be used to establish an emergency knowledge base.

- **Keywords:** Emergency scenario; Hybrid Petri net; Knowledge element model; Characterization; Hierarchical theory; Evolution

Deepshikha Datta, Gopinath Halder. *Enhancing degradability of plastic waste by dispersing starch into low density polyethylene matrix*. Pages 143-152.

The present investigation emphasizes the synthesis and characterization of an extruded biodegradable film developed by dispersion of corn starch in LDPE matrix. Biodegradable films of different composition were prepared and compared with virgin LDPE film. The effect of detergent solution, mustard oil, petroleum oil and saline water was determined as per ASTMD 543-67 to assess its durability. The chemical resistance of the film under 10% HCl and 10% NaOH was also checked. The developed biodegradable film of composition 60:30:10 by weight of LDPE:starch:additive showed a tensile strength of 16.2MPa and elongation at break of 140% indicating that only 10–12% loss of tensile strength and 15% loss in impact strength can be observed by incorporating just 30% starch as compared to virgin LDPE film. The application of the biodegradable film as an environmental friendly packaging material can be effectively judged by its decrease in tensile strength and elongation at break by 8% and 2% respectively by addition of just 10% starch under soil burial condition whereas the burst strength has increased by 16% which makes it to be extensively applicable for packaging.

- **Keywords:** Starch; LDPE; Biodegradable; Durability; Tensile strength; Elongation

K. Suresh Kumar Reddy, Ahmed Al Shoaibi, C. Srinivasakannan. *Mercury removal using metal sulfide porous carbon complex*. Pages 153-158.

Utilization of impregnated carbons (silver/sulfur/iodide) for mercury removal is common, however with limitations in adsorption capacity and application. Continued efforts to develop porous sorbents with better mercury adsorption capacity and kinetics are evident from open literature with the recent focus being on metal sulfide based impregnated porous carbons. However reports on application of metal sulfide based porous carbon adsorbents for gas phase mercury removal are not available in open literature. Towards this objective, the present work attempts to synthesis three different metal sulfide based porous carbons identified as C/CuS, C/ZnS and C/FeS utilizing ultrasound induced wet

impregnation method. The adsorbents were subjected to characterization utilizing BET, XRD, FTIR and SEM and were tested for its mercury adsorption capacity. The adsorption capacity of the metal sulfide porous carbons increased nearly three to four fold times with increase in adsorption temperature from 50 to 100°C attributed to the predominance of the chemisorption. Among the three metal sulfide based porous carbons C/CuS was found to exhibit highest adsorption capacity of 23mg/g at 100°C.

- **Keywords:** Elemental mercury; Metal sulfide; Sorption capacity; Wet impregnation; Fixed bed reactor; Sorbent handling

J.M. Ochando-Pulido, J.R. Corpas-Martínez, A. Martinez-Ferez. *About two-phase olive oil washing wastewater simultaneous phenols recovery and treatment by nanofiltration*. Pages 159-168.

Olive oil industry is concerned to make the whole production process environmentally friendly, and this includes the treatment of the wastewater produced in the mills. In the present work, concentration and recovery of high-added value compounds (phenolic fraction) from two-phase olive-oil washing wastewater (OOWW) and the simultaneous treatment of the effluent by nanofiltration (NF) with a polymeric membrane was studied. Primarily, different pretreatments upstream the membrane unit were examined, adequating the effluent characteristics, that is, reducing the organic and inorganic concentration without compromising the phenolic content for its ulterior recovery. Among them, centrifugation was the most effective in terms of TSS abatement, no phenolic compounds loss, and subsequent highest EC and COD NF rejection. The availability of the centrifuges in the olive mills already, implying minimization of fix costs and needless of chemicals (flocculants), reinforces the proposed process. Moreover, this pretreatment enhanced the downstream stable membrane flux, up to 64.52L/hm2, concentrating the feed up to 8.33 times. The obtention of a permeate stream with very good saline quality, COD reduced 86.76% and practically free of phenolic content, thus minimized in its recalcitrant and phytotoxic potential, and a concentrate pool enriched in these high added-value antioxidant compounds (up to 1315.7mg/L) would allow to counter-balance the economic feasibility of the reclamation process.

- **Keywords:** Olive oil washing wastewater; Nanofiltration; Phenolic compounds; Pretreatments; Wastewater reclamation; Sustainability

Jushi Chen. *Property experiments on the foam generator and its influencing factors during down-the-hole drilling*. Pages 169-178.

The present study developed a suitable foam dust-remove device for down-the-hole (DTH) drilling in open-pit mines and researched its foaming properties to solve the resulting serious dust pollution. We researched the foam dust removal mechanism and two-phase foaming principle to improve the disadvantages of traditional dust removal technology such as poor effects, big air consumption and water intake difficulties. We obtained the main factors that influence the foaming performance and optimum working point of the foam generator based on performance tests on the foam flow, foaming multiple, and half-life period of the foam generator. Based on the experimental results, the gas flow rate, liquid flow rate (gas–liquid ratio), foaming net, and foaming agent concentration were deemed the four main factors that affected the foaming performance of the foam generator. The following working conditions were operated: (1) foam net 1; (2) A 1.5% concentration of the formulation 2; (3) gas pressure of 0.7MPa; (4) liquid flow rate of 18L/min; (5) gas flow rate of 30m3/h. Based on these conditions, the foam generator achieved its best performance with a foam flow rate of 515L/min, foaming multiple of 22, and half-life of 65min. The average dust removal rate throughout the field test was as high as 90% using foam dedusting in stope.

- **Keywords:** Open-pit mine; DTH drill; Foam generator; Influencing factors; Foam flow rate; Foaming multiple; Half-life period

Timothy G. Holloway, Ana Soares. *Influence of internal fluid velocities and media fill ratio on submerged aerated filter hydrodynamics and process performance for municipal wastewater treatment*. Pages 179-191.

Submerged aerated filters (SAFs) treat wastewater to achieve stringent organic carbon and ammonium (NH4+) effluent consents. Currently SAF design follows a black box approach, where inlet and outlet contaminant concentrations are monitored, with little consideration for internal hydrodynamic conditions. Although tracer tests have been used on bioreactors, integrated monitoring of internal fluid velocities, mixing characteristics and process performance has not been established for SAFs. Tracer tests were performed on a 7.74m3 SAF, with internal recirculation at 100, 75, 50, 25 and 0% media fill ratios with and without biofilm on the media surface. Results suggested that, SAF internal hydrodynamic conditions directly influenced process performance and media fill ratios could be manipulated to provide optimum conditions for removal of biochemical oxygen demand (BOD5) and NH4+. A 50% media fill ratio showed optimum hydrodynamic conditions for BOD5 removal, with a removal efficiency of 70% (mass removal of 1.59kgm−3d−1). A 100% media fill ratio showed optimum hydrodynamic conditions for NH4+ removal, with a removal efficiency of 60% (mass removal of 0.14kgm−3d−1). Therefore optimisation of internal hydrodynamic conditions is key for selective contaminant removal and achieving high effluent quality.

- **Keywords:** Biofilter; Biofim bioreactor; Hydrodynamics; Tracer test; SAF; Wastewater

Oscar Omondi Donde, Cuicui Tian, Yingying Tian, Bangding Xiao. *Efficacy of macrophyte dominated wastewater inclosure as post-treatment alternative in domestic wastewater quality polishing for eradication of faecal pathogenic bacteria pollution*. Pages 192-205.

Variation in microbial strains and pathogenicity within wetland ecosystem is a topic that needs more considerable attention due to the rising climate change and in human population. Despite many current studies focusing on wetlands ecology, there is still inadequate documentation that are specific to the relationship between bacterial abundance, diversity and pathogenicity, as well as the principles and roles of aquatic plants in wastewater polishing. To provide an understanding on the fate and virulence of members of Enterobacteriaceae and Enterococcaceae in a winter tolerant macrophyte dominated artificial wetland system, this study evaluated the efficacy of macrophyte dominated Wastewater Polishing Pond Inclosures (WPPIs) in influencing the abundance, survival and pathogenicity of faecal bacterial pathogens. The study reveals that WPPIs provides more than 95% reduction of pathogenic forms of Escherichia coli as well as Enterococcus faecalis and Enterococcus faesium. WPPIs provides a good sustainable and environment friendly alternative approach in wastewater polishing and the efficiency is a factor of macrophytes percentage cover. Therefore, the application of WPPIs in domestic wastewater polishing is recommended for sufficient pollution control on aquatic ecosystems that receive enormous effluents from a highly populated urban set up with huge domestic wastewater generation.

- **Keywords:** Contamination; Faecal bacteria; Macrophytes; Pollution; Wastewater polishing; Constructed wetlands

Claire M. Benson, James M. Ingram, Philip F. Nolan. *Identification of ignition sources in high pressure enriched gaseous oxygen system*

***incidents using flow chart road map diagram methodology*. Pages 206-218.**

High pressure enriched oxygen is used in a wide number of areas, including aircraft, medical breathing apparatus, and a number of industrial processes including combustion. Unwanted ignition in such systems can cause significant damage to property and danger to life. It is important to gain as much information, and record relevant data for every oxygen incident, enabling both immediate analysis, and post-event evaluations (especially where circumstances are repeated). The lack of clear concise guidance can result in data loss. This work successfully develops investigation 'road maps' as guidance documents for investigators to use, even under difficult & time pressured conditions. The work demonstrates their usefulness and importance for information collection and the down-selection' or elimination of possible ignition causes through their use with a 'real world' case study. The benefit of this work will be to enable faster and more effective investigation of oxygen incidents, ensuring key details are recorded (benefitting post-accident academic data & meta-study analysis). The roadmaps can also benefit designers of oxygen systems allowing them to test their designs and operating procedures against specific ignition scenarios.

- **Keywords:** Oxygen systems; Health & safety; Incident investigation; Road maps; Fires; Explosions; Exothermic reactions; Systems analysis

In the last decades, increasing industrial development A.V.M. Silveira, M. Cella, E.H. Tanabe, D.A. Bertuol. *Application of tribo-electrostatic separation in the recycling of plastic wastes*. Pages 219-228.

has led to huge consumption of plastic materials, due to their versatility and low cost. Therefore, the implementation of efficient and environmentally friendly recycling technologies is of great importance. This study proposes an alternative separation process for recycling mixtures of plastic wastes, using a tribo-electrostatic separation process. The methodology adopted in this work was firstly characterization of the polymeric wastes, followed by preparation of the wastes using different unit operation processes (washing, drying, and comminution), tribo-charging, and electrostatic separation of different combinations of plastics (HDPE/PP, LDPE/PP, and PET/PVC). Various parameters were evaluated in the tribo-charging process and the electrostatic deflection. Separation of a mixture of HDPE and PP achieved PP recovery of 92.8% (purity of 95.7%) and HDPE recovery of 95.9% (purity of 93.1%). Recovery and purity values higher than 90.2% and 95.9% were obtained for PP/LDPE and PET/PVC mixtures, respectively. These results demonstrated that tribo-electrostatic separation is a promising and efficient method for use in the recycling of plastic wastes. The process studied enabled significant recoveries of the components at high levels of purity.

- **Keywords:** Tribo-electrostatic separation; Plastic; Recycling; Mechanical processing; Solid wastes; Tribo-charging

Reza Abedini, Amir Mosayebi, Mania Mokhtari. *Improved CO2 separation of azide cross-linked PMP mixed matrix membrane embedded by nano-CuBTC metal organic Framework*. Pages 229-239.

The CO2/light gases separation of azide crosslinked poly(4-methyl-1-pentyne) (PMP), morphology and physical stabilities of membranes were studied. The gases permeability and membrane fractional free volume (FFV) both decreased as the crosslinking percent increased. The CO2/CH4 and CO2/N2 selectivities were increased from 11.2 to 15.2 and 16.4 to 20.5; respectively upon crosslinking. The gases permeability was increased by adding CuBTC particles into PMP matrix. CO2 showed the superior permeability compared to other gases upon adding CuBTC due to the high affinity to filler. Selectivity for the gas

pairs CO2/CH4, CO2/N2 and CO2/H2 raised for all MMMs as CuBTC loading increased from 5 to 20wt.%. The quality of filler dispersion in polymer was evaluated by means of scanning electron microscopy (SEM) and the outcomes proved the appropriate dispersion of MOF particles within the PMP matrix. Moreover, the thermal stability of membrane enhanced upon crosslinking and particles inclusion. The physical aging of neat PMP, crosslinked PMP and MMMs was studied through long term CO2 permeation and the results showed that crosslinking was the effective method to maintain both permeability and selectivity of PMP and MMMs over the time.

- **Keywords:** PMP; Crosslinking; CuBTC; Gas separation; Permeability; Selectivity

Domnina Razus, Maria Mitu, Venera Giurcan, Codina Movileanu, Dumitru Oancea. *Methane-unconventional oxidant flames. Laminar burning velocities of nitrogen-diluted methane–N2O mixtures*. Pages 240-250.

The flame propagation in nitrogen-diluted CH4–N2O mixtures was monitored by pressure measurements during explosions in a spherical vessel with central ignition. The burning velocities were obtained from experimental measurements of pressure variation during closed vessel explosions and from the detailed modelling of free laminar premixed flames. Lean- and stoichiometric methane–nitrous oxide mixtures (equivalence ratios: 0.8 and 1.0) diluted by various amounts of nitrogen between 40 and 60vol% were studied at various initial pressures between 0.3 and 1.8bar and ambient initial temperature. Nitrogen addition to each CH4–N2O mixture results in the decrease of laminar burning velocity and flame temperature, along with the increase of flame width. Examination of burning velocity variation against average flame temperature in experiments at constant initial pressure and various inert concentrations allowed the determination of the overall activation energy; examination of burning velocity dependence on pressure, at constant inert concentration, allowed the determination of the overall reaction orders. For all CH4–N2O–N2 mixtures, the temperature, volumetric rate of heat release and reactive species concentration profiles across the flame front were examined versus similar data characteristic to stoichiometric methane–air mixtures. The most important elementary reactions in CH4–N2O–N2 and CH4–air mixtures were identified by means of sensitivity analysis.

- **Keywords:** Laminar burning velocity; Methane; Nitrous oxide; Overall activation parameters

Giordano Emrys Scarponi, Gabriele Landucci, Frederic Heymes, Valerio Cozzani. *Experimental and numerical study of the behavior of LPG tanks exposed to wildland fires*. Pages 251-270.

The safety of small and medium LPG (liquefied petroleum gas) storage tanks in civil and industrial facilities when affected by forest fires in the framework of Wildland–Urban Interface (WUI) was investigated. Large scale experimental tests were carried to characterize the behavior of LPG tanks in case of distant source radiation caused by forest fires. A data set was obtained and used for the validation of a dedicated two-dimensional computational fluid dynamic (2D CFD) model for the analysis of pressure build-up in vessels exposed to different types of transient heat radiation, featuring different geometry types and operating conditions. The combined experimental and numerical analysis allowed determining the critical exposure conditions for LPG vessels. Specific key performance indicators were defined and calculated on the basis of 2D CFD simulation results in order to derive conservative indications on failure conditions of LPG storage vessels induced by forest fires.

- **Keywords:** Forest fire; LPG tank; CFD modeling; Heat transfer; Liquid stratification; Distant source radiation; Wildland–Urban Interface

Yan Fu Wang, Biao Li, Tao Qin, Biao Zhang. *Probability prediction and cost benefit analysis based on system dynamics*. Pages 271-278.

It is known that optimizing the investments on safety to reduce probabilities of blowout fire is very challenging due to the complexity of operational systems which involve varieties of potential contributors and ranges of safety measures. In this paper, a new method to evaluate blowout fire prevention and control measures is proposed in a cost effective manner. Firstly, a dynamic probability prediction model for blowout fire is proposed through the system dynamics (SD) method. The dynamic probability of blowout fire on offshore drilling platform is predicted according to the proposed model. Secondly, cost-benefit analysis of the corresponding safety measures is carried out using SD simulation via Vensim software. Thirdly, a case study of blowout fire probability prediction and the cost-benefit analysis of safety investments are demonstrated for some offshore drilling platform. The simulation results show that the predicted probability of blowout fire on offshore drilling platform increases from 2.41E−6 to 3.997E−6. The probability prediction formula of blowout fire is nonlinear fitted to obtain the intrinsic relationship between the probability of blowout fire and time. The case study shows that the built cost-benefit analysis model can be used to optimize the allocation of safety investments.

- **Keywords:** Dynamic probability prediction; Blowout fire; System dynamics; Cost benefit analysis; Safety investment allocation; Blowout fire of offshore drilling platform

Mohammad Mobin, Ruby Aslam. *Experimental and theoretical study on corrosion inhibition performance of environmentally benign non-ionic surfactants for mild steel in 3.5% NaCl solution*. Pages 279-295.

Two 'natural' non-ionic surfactants namely, N-alkyl-N'-glucosylethylenediamine with formula CnH2n+1NH(CH2)2NHCO(CHOH)4CH2OH (n=10, 12), designated as Glu (n) were prepared and identified by FT-IR and 1H NMR. Synthesized compounds were investigated for mild steel corrosion in 3.5% NaCl medium using electrochemical measurement, gravimetric measurement and surface characterization techniques like Fourier transform infra-red spectroscopy (FT-IR), atomic force microscopy (AFM) and scanning electron microscopy (SEM)/energy dispersive spectroscopy (EDAX). The compounds act as predominantly anodic corrosion inhibitors and their inhibition efficiencies are observed to increase with increasing inhibitors' concentrations, chain length and temperature. The adsorption of Glu (n) inhibitor on the mild steel surface in 3.5% NaCl solution followed the Langmuir adsorption isotherm. The AFM micrographs showed a reduction of surface roughness in the presence of the investigated inhibitor. SEM micrographs confirmed the existence of an adsorbed protective film on the mild steel surface. EDAX was carried out to characterize the chemical composition of the inhibitive film formed on the steel surface. Density functional theory (DFT) calculations are made to correlate the efficiencies of Glu (n) with their intrinsic molecular parameters.

- **Keywords:** Mild steel; EIS; Polarization; AFM; Anodic protection; Neutral inhibition

Y.Y. Loy, G.P. Rangaiah, Lakshminarayanan S. *Surrogate modelling of net radiation flux from pool fires in a hydrocarbon storage facility*. Pages 296-309.

Computational fluid dynamics has been used for consequence modelling in place of traditional methodologies, to obtain more accurate results and better understanding of complex problems. With today's computational technology, it is not difficult to run CFD simulations for several selected scenarios. However, its use to produce a full quantitative

risk assessment, involving thousands of scenarios, is impractical given the extensive computational resources required. In this paper, a modified QRA methodology proposed recently, with the integration of sampling algorithms, surrogate models and error measures, is extended to a higher dimensional hydrocarbon pool fire problem. The characteristics, advantages and challenges of a local linear model and a global non-linear model are identified and addressed. The addition of time as an input variable to surrogate models provides an extension of the methodology to safety studies where the resolution of time-varying output is important. We demonstrate the effectiveness of the modified QRA methodology through a case study of pool fire in a hydrocarbon storage facility.

- **Keywords:** Consequence analysis; Consequence modelling; Computational fluid dynamics; Design of experiments; Pool fire; Quantitative risk assessment; Surrogate modelling

Chunshan Zheng, Mehmet S. Kizil, Zhongwei Chen, Saiied M. Aminossadati. *Role of multi-seam interaction on gas drainage engineering design for mining safety and environmental benefits: Linking coal damage to permeability variation*. Pages 310-322.

Methane gas drainage is an effective method to ensure mining-process safety and deliver greater environmental benefits through reducing greenhouse gas (GHG) emissions. As most coal seams actually coexist with one or several other coal seams, i.e. the multi-layer coal seam group. A better understanding of the interaction between the adjacent coal seams could provide better guidance for the gas drainage engineering design to enhance its performance. Extensive studies on the multi-seam interaction have focused on the effect of mining the underlying coal seam on the overlying seam from perspectives of rock deformation, stress change and permeability variation. Meanwhile, as there is few coupled permeability models taking the coal-damage effect into account, previous permeability-variation analysis seldom commonly considered the mining-induced coal damage, coal mechanics changes and gas adsorption, which results in the permeability underestimation. Therefore, in this paper, a mathematical model which incorporates the coal permeability with coal damage, coal mechanical property and the gas adsorption was developed. Then this model was implemented into a finite-element numerical simulation, which was used to investigate the impact of the overlying coal seam mining on the underlying relieved seam from the perspective of damage-based permeability variation. Meanwhile, the effect of damage on gas-emission performance from the underlying seam was analyzed. Results show that there are four permeability areas under the mine-out panel, permeability increases greatly in areas I to III (the highest as over 650 times) while it increases slightly in the area IV. These permeability results are largely consistent with the stress-analysis conclusions obtained by other researchers. By taking the damage into account, the evaluation on gas-emission condition could become more reasonable. Above research outcomes could help to determine the favorable gas-drainage areas under the longwall mining panel and guide the drainage borehole design in the relieved coal seam, to deliver better drainage outcomes for the mining safety and GHG-emission reduction.

- **Keywords:** Mining safety; Environmental benefits; Multi-seam interaction; Damage-based permeability variation; Gas drainage engineering design

J.M. Ochando-Pulido, A. Martinez-Ferez. Optimization of the fouling behaviour of a reverse osmosis membrane for purification of olive-oil washing wastewater. Pages 323-333.

The core of this paper was the performance prediction and optimization of a reverse osmosis (RO) membrane process for purification of tertiary-treated olive-oil washing

wastewater (OOW2TT). To this end, fouling control and minimization is irretrievably needed for successful implementation of membrane plants at industrial scale. Statistical multifactorial analysis showed all three operating variables – pressure (PTM), tangential flow (vt) and temperature (T) – affect the flux productivity of the membrane, confirming a statistically significant relationship among them at 95% confidence level. However, vt and T exhibited higher impact, according to the p-values withdrawn. On another hand, P and vt were noted to have very relevant effect on the membrane fouling rate, thus having key implications on the stable control and feasibility of the process. These results were mirrored by the response surfaces obtained. The optimized parameters – ambient temperature (24–25°C), moderate operating pressure (25–30bar) and turbulent tangential flow (3.1–3.5ms−1) – were found to provide a stable permeate flux (32.3Lh−1m−2). These results highlight the proposed process could be operated successfully at ambient temperature conditions, boosting the economic efficiency of the RO purification of this kind of effluents.

- **Keywords:** Reverse osmosis; Olive mill wastewater; Membrane processes; Fouling; Optimization; Wastewater reclamation

Vishnu B.R., Sivapirakasam S.P., Satpathy KK, Shaju K. Albert, Gopa Chakraborty. *Cr6+ reduction in welding fumes by nano composite coatings on stainless steel manual metal arc welding electrodes*. Pages 334-346.

A new manual metal arc welding electrode was developed using a nano composite coating on the core wire prior to flux coating. As fume formation rate (FFR) and hexavalent chromium (Cr(VI)) concentration in the welding fumes are trade off with each other, a concurrent method was attempted to reduce both. Al2O3 and TiO2 were used via nano coating as the arc stabilizers to reduce the fume formation rate and a tertiary material, a reactive metal oxide (ZnO) was coated to reduce hexavalent chromium concentration in the welding fumes. The collective behavior of all three materials brought out an effective reduction in both the fume formation rate and the Cr(VI) concentration in welding fumes. An effective reduction of Cr(VI) concentration in the welding fumes accounting to 47% with reasonable reduction in fume formation rate as well as other harmful constituents was achieved among the tested tertiary nano coated electrodes. The optimum combination of process parameters which favored the maximum reduction in Cr(VI) concentration in the welding fumes at the source was arrived using the Taguchi methodology of experimental design. The stability of the statistical model was verified and found adequate.

- **Keywords:** Hexavalent chromium concentration; Fume formation rate; Nano coating; Reactive metal oxide; Manual metal arc welding; Taguchi experimental design