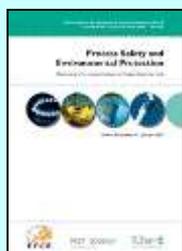


# Process Safety and Environmental Protection

rok 2013, ročník 91

Číslo 4 (July 2013)



**R.M. Kasmani, G.E. Andrews, H.N. Phylaktou. *Experimental study on vented gas explosion in a cylindrical vessel with a vent duct. Pages 245–252.***

A study of vented explosions in a length over diameter ( $L/D$ ) of 2 in cylindrical vessel connecting with a vent duct ( $L/D = 7$ ) is reported. The influence of vent burst pressure and ignition locations on the maximum overpressure and flame speeds at constant vent coefficient,  $K$  of 16.4 were investigated to elucidate how these parameters affect the severity of a vented explosion. Propane and methane/air mixtures were studied with equivalence ratio,  $\phi$  ranges from 0.8 to 1.6. It is demonstrated that end ignition exhibited higher maximum overpressures and flame speeds in comparison to central ignition, contrary to what is reported in literature. There was a large acceleration of the flame toward the duct due to the development of cellular flames and end ignition demonstrated to have higher flame speeds prior to entry into the vent due to the larger flame distance. The higher vent flow velocities and subsequent flame speeds were responsible for the higher overpressures obtained. Rich mixtures for propane/air mixtures at  $\phi = 1.35$  had the greatest flame acceleration and the highest overpressures. In addition, the results showed that Bartknecht's gas explosion venting correlation is grossly overestimated the overpressure for  $K = 16.4$  and thus, misleading the impact of the vent burst pressure.

- **Keywords:** Duct-vented gas explosion; Vent burst pressure; Ignition location; Equivalence ratio

**Qingqing Xu, Laibin Zhang, Wei Liang. *Acoustic detection technology for gas pipeline leakage. Pages 253–261.***

Gas leakage from pipeline leads to significant environmental damages and industrial hazards, so small leakage detection for gas pipeline is essential to avoid these serious leakages. However, because of the high frequency component of leakage signal attenuates quickly, traditional detection method which inspects pressure or vibration signal has problem to get effective information from leakage signal. So, a novel detection method based on acoustic wave is proposed. This paper, firstly, researches on the phonation principle of pipeline leakage and the characteristic of sound source, and simulates the leakage acoustic field on the basis of aero acoustics. Secondly, using Wavelet Packet Transform method and Fuzzy Support Vector Machine pattern classification, the laboratory testing for identifying acoustic signal of gas pipeline leakage is presented. Finally, the field application demonstrates that the detection system could identify small gas leakage effectively and avoids false-alarms which caused by running conditions with a good prospect.

- **Keywords:** Gas pipeline leakage; Acoustic detection; Fuzzy Support Vector Machine

**A. Valiūnienė, G. Baltrūnas, V. Keršulytė, Ž. Margarian, G. Valinčius. *The degradation of cyanide by anodic electrooxidation using different anode materials.* Pages 269–274.**

Cyanides are very popular electrolytes used in metal electroplating, metal ore processing, chemical and electrochemical applications. Due to wide utility of these technologies cyanides become increasingly harmful effluent, which has to be treated. One of the best ways to degrade cyanides is an anodic electrooxidation. In this work the destruction of free cyanide on platinum, titanium and stainless steel (SS) electrodes has been investigated. It was determined that anode material greatly influences the process of cyanide electrooxidation. The best results were obtained by using the Pt electrode. This kind of anode allows us to reduce  $\text{CN}^-$  concentration from 0.1 M to 0.06 M during the first hour of electrolysis at a current density of  $200 \text{ A m}^{-2}$ , with a current efficiency up to 80%. To substitute expensive Pt anodes Ti electrodes covered with nanolayers of Pt were prepared and used for the anodic oxidation of cyanide ions. An effect of a thickness of Pt layer and temperature of an electrolyte solution were studied. It was established that using platinized Ti electrodes the current efficiencies of electrooxidation of cyanides of about 60% can be obtained. The usage of chloride ions to facilitate the destruction of cyanide was also studied.

- **Keywords:** Cyanide; Electrooxidation; Anode material

**Uday Kumar Chakrabarti, Jigisha K. Parikh. *A societal risk study for transportation of class-3 hazmats – A case of Indian state highways.* Pages 275–284.**

United Nations Class-3 hazardous materials (hazmats) are basically liquid products and transported in road tankers under ambient temperature and atmospheric pressure. They are mostly flammables and some of them are toxic (e.g. benzene) as well. The spillages due to collision related incidents involving the road tankers, carrying such hazmats through highways, pose not only flammability hazards due to pool fire, flash fire and vapor cloud explosion (VCE), but create substantial toxic hazards also. The paper presents the risk-based study of route evaluation of two state highways and one urban city road in western India on account of transportation of class-3 hazmats, namely benzene, toluene, p-xylene, methanol, cyclohexane and acetone. A comparative evaluation of study routes was undertaken based on their societal risks presented in terms of  $F-N$  curves and assessed against HSE, UK as well as VROM, The Netherlands risk acceptance criteria. Societal risks contribution of cyclohexane to the overall flammability risk mainly VCE is found to be the highest followed by acetone and benzene compared to other study hazmats. This is due to highly explosive nature of cyclohexane resulting into vapor cloud explosion. While acetone and methanol pool fires are likely to cause larger area of damage compared to others, benzene supersedes others as far as toxicity risk is concerned and larger evacuation area is encountered, as it poses greater Immediately Dangerous to Life or Health (IDLH) distance than others. Besides, study of initial isolation distance following an accident in case of benzene tanker found that benzene spillage requires larger initial isolation distance than others and so are the day and night protective action zone distances.

- **Keywords:** Hazmat; Vapor cloud explosion; Consequence assessment; Initial isolation; Societal risk

**Huosheng Li, Shaoqi Zhou, Guotao Huang, Bin Xu. *Partial nitrification of landfill leachate with varying influent composition under intermittent aeration conditions. Pages 285–294.***

The start-up and operation of a partial nitrification sequencing batch reactor for the treatment of landfill leachate were carried out on intermittent aeration mode. Partial nitrite accumulation was established in 15 days after the mode was changed from continuous aeration to intermittent aeration. Despite the varying influent composition, partial nitrification could be maintained by adjusting the hydraulic retention time (HRT) and the air flow rate. An increase in the air flow rate together with a decrease in air off duration can improve the partial nitrification capacity and eventually result in the development of granular sludge with fine diameters. A nitrogen loading rate of  $0.71 \pm 0.14 \text{ kg/m}^3/\text{d}$  and a COD removal rate of  $2.21 \pm 0.13 \text{ kg/m}^3/\text{d}$  were achieved under the conditions of an air flow rate of  $19.36 \pm 1.71 \text{ m}^3 \text{ air/m}^3/\text{h}$  and an air on/off duration of 1.5 min/0.7 min. When the ratio of total air flux (TAF) to the influent loading rate (ILR) was controlled at the range of 163–256  $\text{m}^3 \text{ air/kg COD}$ , a stable effluent  $\text{NO}_3^- - \text{N}/\text{NO}_x^- - \text{N}$  ( $\text{NO}_2^- - \text{N}$  plus  $\text{NO}_3^- - \text{N}$ ) ratio below 13% was achieved. Interestingly, the effluent pH was found to be a good indicator of the effluent  $\text{NO}_2^- - \text{N}/\text{NH}_4^+ - \text{N}$  ratio, which is an essential parameter for a subsequent anaerobic ammonium oxidation (Anammox) reactor.

- **Keywords:** Landfill leachate; Sequencing batch reactor; Partial nitrification; Intermittent aeration; Anammox; Granular sludge

**Zhenhua Li. *Evaluation of decentralized treatment of sewage employing bio-contact oxidation reactor integrated with filter bed. Pages 295–303.***

A bio-contact oxidation reactor integrated with filter bed (COR-FB) was developed for decentralized treatment of sewage, which consisted of a biofilm reactor and a gravitational filter bed. It has been investigated to treat municipal wastewater for reuse. The evaluation of COR-FB performance demonstrates that it produced good quality effluent regarding carbonaceous compound, nitrogenous compound, suspended solid and fecal coliform. The efficiencies of COD,  $\text{NH}_4^+ - \text{N}$ , TN, TP and turbidity removal were 90.7%, 81.4%, 64.6%, 60.1% and 96.7%, respectively. The residual geometric mean of fecal coliform counts in the final effluent of COR-FB was only  $7.8 \times 10^3 \text{ MPN}/10^3 \text{ ml}$ , corresponding to removal value of 3.8 log 10. However, TP removal indicates the necessity of an addition of a bagger and mud valve or an enhanced chemical phosphorus removal prior to treated water reuse. Microfauna communities were monitored in COR-FB, which was found to contain 5 genres and 19 species in the biofilm layer. Also, a simple kinetics model for COR-FB was developed based on the influent, effluent soluble COD concentration and the reaction time by regression simulation. In general, available data proved that COR-FB system can be recommended as a compact and cost-effective technology for decentralized treatment of sewage, especially for developing countries.

- **Keywords:** Bio-contact oxidation; Filter bed; Decentralized treatment; Water reuse; Kinetics modeling

**Fatemeh Sadat Fateminia, Cavus Falamaki. *Zero valent nano-sized iron/clinoptilolite modified with zero valent copper for reductive nitrate removal. Pages 304–310.***

Nitrates constitute one of the main toxic contaminants of groundwater. On the other hand, groundwater may be considered anoxic (oxygen concentration less than  $9 \mu\text{g L}^{-1}$ ). This fact justifies the use of nano zero valent metals for nitrate removal. In such conditions, zero valent metals are quite stable against oxidation due to the very low level of dissolved oxygen concentration. It has been shown that the performance of zero

valent iron coated clinoptilolite zeolite for the reduction of nitrate anion in un-buffered conditions may be enhanced by coating small amounts of Cu<sup>0</sup> onto the freshly prepared Fe<sup>0</sup>/zeolite composite. An optimum loading of Cu<sup>0</sup> exists for which the rate of nitrate removal is maximal. For this optimal composition, the nitrite anion production curve with time passes through a maximum. Nitrite production, however, is slightly higher for the Cu modified zeolite. It has been shown that the nitrate removal process is only slightly dependent on the initial solution pH. In the temperature range of 20–60 °C, the process is controlled by both the liquid phase mass transfer and intrinsic reaction rate resistances. FESEM analysis of the zero valent metal/zeolite composite showed that upon the metal reduction reaction, an egg-shell distribution of zero valent metal in the zeolite agglomerate particle is produced.

- **Keywords:** Nano sized zero valent iron; Clinoptilolite; Nitrate removal; Copper; Nitrite

**A. Siciliano, C. Ruggiero, S. De Rosa. *A new integrated treatment for the reduction of organic and nitrogen loads in methanogenic landfill leachates.* Pages 311–320.**

Because of their high organic and nitrogen loads and the presence of toxic and phytotoxic compounds, methanogenic landfill leachates are not easily biodegradable; therefore, direct biological treatment of these wastewaters in conventional treatment plants is not recommended.

In the present paper, we report the results of an experimental investigation conducted with the aim of defining an innovative integrated process that is low in cost and easily manageable and that is able to substantially improve the characteristics of methanogenic leachates.

Thus, an initial oxidation process was developed using hydrogen peroxide without a catalyst, which, operating under ambient conditions, reduces the phytotoxic compound content to 10% of the initial level, reduces the COD (chemical oxygen demand) content by 50% and increases the rapidly biodegradable substrate content by 50%. Next, nitrogen removal is accomplished by means of struvite precipitation using seawater bittern and bone meal as sources of magnesium and phosphorus, respectively, with this process, abatements were reached of approximately 90% of the ammonia nitrogen, which was recovered as struvite powder.

- **Keywords:** Methanogenic landfill leachate; Hydrogen peroxide; Struvite precipitation; Seawater bittern; Bone meal

**T. Stephenson, E. Reid, L.M. Avery, B. Jefferson. *Media surface properties and the development of nitrifying biofilms in mixed cultures for wastewater treatment.* Pages 321–324.**

Plastic was tested to select biofilm support media that would enhance nitrification in the presence of heterotrophs. Eight different types (acrylonitrile butadiene styrene, nylon, polycarbonate, polyethylene, polypropylene, polytetrafluoroethylene (PTFE), polyvinyl chloride and tufnol) were immersed in an aerobic fed-batch reactor receiving domestic settled wastewater. Nitrification rates did not correlate with biomass concentrations, nor surface roughness of the plastics as measured by atomic force microscopy (AFM). The maximum nitrification rate of 1.5 g/m<sup>2</sup> d<sup>-1</sup> was obtained from biofilms growing on PTFE which had the lowest surface adhesion force (8 nN). Nitrification rates for the biofilms were inversely correlated with the attraction forces as measured by AFM.

- **Keywords:** Atomic force microscopy; Biofilms; Nitrification; Plastic media; Wastewater treatment

**Zuoming Zhou, Guohua Jing, Qi Zhou. *Enhanced NO<sub>x</sub> removal from flue gas by an integrated process of chemical absorption coupled with two-stage biological reduction using immobilized microorganisms.* Pages 325-332.**

An integrated process of metal chelate absorption coupled with two stage bio-reduction using immobilized cultures has been proposed to continuously removal of NO<sub>x</sub>, and the effects of SO<sub>2</sub>, NO and O<sub>2</sub> concentration, gas/liquid flow rate on NO<sub>x</sub> removal efficiency were investigated. Although nitrogen-containing components, such as Fe(II)EDTA-NO, NO<sub>2</sub><sup>-</sup> and NO<sub>3</sub><sup>-</sup> in the scrubbing solution, inhibited the bio-reduction of Fe(III)EDTA obviously, it was feasible to abate the inhibition effect by using the two stage bio-reduction system, and thus to improve NO<sub>x</sub> removal efficiency. The removal efficiency decreased slowly with the increase of SO<sub>2</sub>, O<sub>2</sub>, NO concentration and gas flow rate, and increased with the increase of liquid flow rate. Continuously operating for 18 days, a high removal efficiency around 95% was reached by using the two-stage bio-reduction system with immobilized microorganisms, while the value decreased to 85% after 5 days of operation by using the suspended microorganisms, at a constant gas flow rate of 60 L/h containing 424–450 mg/m<sup>3</sup> NO, 2428–2532 mg/m<sup>3</sup> SO<sub>2</sub> and 3% O<sub>2</sub>.

- **Keywords:** NO<sub>x</sub> removal; Fe(II)EDTA; Immobilized microorganisms; Absorption