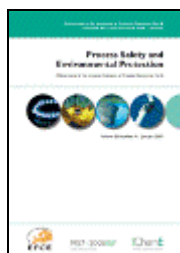


Process Safety and Environmental Protection

rok 2010, ročník 88

Číslo 4 (July 2010)



Mimi H. Hassim, Markku Hurme. *Occupational chemical exposure and risk estimation in process development and design.* Pages 225-235.

Each year more people die from diseases caused by work than are killed in industrial accidents. Therefore, methods are needed to evaluate occupational health hazards as early as possible when the process is still under development. A method for estimating inhalative exposures and risks in petrochemical and related plants is presented. The method is simple and suffices with the limited data availability during the early design stages. The steps of the method, which utilizes preliminary process flow diagrams are as follows: first the fugitive emissions and process plot areas are estimated based on precalculated process modules representing the typical process sections (such as a distillation unit). Chemical concentration in the air is then calculated based on the wind velocity probability and the estimated process cross-sectional area. For this purpose a typical wind velocity distribution in the area is used. The worker risk of exposure to chemicals is evaluated either based on the concentration in air by using the hazard quotient method or calculating the carcinogenic chemicals intake and the resulting risk of cancer. The values are compared to the benchmarks. As a result the process route health characteristics such as fugitive emissions rate, critical wind speed, chemical concentration in air and intake amount as well as the corresponding risk of exposure are produced. By using statistical meteorological data, health risks of occupational exposure can be estimated more realistically as probabilities. The approach is capable of comparing alternative processes to select the concept which is inherently occupationally healthier. Using this method, the exposure problems of a process can be identified earlier and proper decisions can be made early in process development or predesign stage. The concentration-based method is demonstrated by a case study of six competing manufacturing routes for methyl methacrylate (MMA). The C3 is found to be the most harmful alternative to health. Both concentration-based and intake-based methods are applied. The study indicates that the intake-based risk estimation benchmark is stricter than the exposure limit-based benchmark for carcinogens.

- **Keywords:** Worker exposure; Risk assessment; Inherent safety; Occupational health; Process design

Ju Lynne Saw, Jill Wilday, Howard Harte. *Learning organisations for major hazards and the role of the regulator.* Pages 236-242.

A learning organisation is one that not only values and encourages learning from its own experiences, but also looks beyond itself for lessons, and avoids complacency. To be a learning organisation is a key part of the safety culture of any organisation involved with major hazard processes. It facilitates learning which can reduce the risk from major accident hazards. The paper provides a learning organisation toolkit which synthesises, from various literature sources, an understanding of what a learning organisation is and how to begin to develop one within an organisation. The paper illustrates how the regulator can be a learning organisation for major hazards, using the example of HSE's offshore fire, explosion and risk assessment team.

- **Keywords:** Learning organisation; Major hazards; Offshore; Safety culture

J. Labovský, Ľ. Jelemenský. *CFD simulations of ammonia dispersion using "dynamic" boundary conditions. Pages 243-252.*

Ammonia is stored in liquid form at ambient temperature and under high pressure. During an accident, ammonia will flash out of the vessel and disperse in the surrounding area. This paper provides a comparison of the results obtained by the FLADIS field experiments and those of CFD modeling by Fluent 6.3. FLADIS experiments were carried out by the Risø National Laboratory using pressure liquefied ammonia. Time series of meteorological conditions as wind speed, wind direction and source strength were determined from the experimentally measured data and used as the inflow boundary conditions. Furthermore, for more realistic simulation of air flow in the computation domain for the desired atmospheric stability, periodic boundary conditions were used on both side boundaries. The initial two-phase flow of the released ammonia was also included. The liquid phase was modeled as droplets using discrete particle modeling, i.e., the Euler-Lagrangian approach for continuous and discrete phases.

- **Keywords:** CFD modeling; Gas dispersion; Ammonia release; Emergency preparedness

Bo Zhang, Guo-ming Chen. *Quantitative risk analysis of toxic gas release caused poisoning : a CFD and dose-response model combined approach. Pages 253-262.*

Some major toxic gas release accidents demonstrate the urgent need of a systematic risk analysis method for individuals exposed to toxic gases. A CFD numerical simulation and dose-response model combined approach has been proposed for quantitative analysis of acute toxic gas exposure threats. This method contains four steps: firstly, set up a CFD model and monitor points; secondly, solve CFD equations and predict the real-time concentration field of toxic gas releases and dispersions; thirdly, calculate the toxic dose according to gas concentration and exposure time; lastly, estimate expected fatalities using dose-response model. A case study of hydrogen sulfide releases from a gas gathering station has been carried out using a three dimension FLUENT model. Acute exposure fatalities have been evaluated firstly with a simplified ideal model which assumes workers stay at original exposure location without moving. Then a comparison has been made with a more realistic model which assumes workers start evacuating according to a prearranged course as soon as hydrogen sulfide detection system alarms. These two models represent the worst and best emergency response effects, respectively, and the analysis results demonstrate significant differences. Results indicate that the CFD and dose-response combined approach is a good way for estimating fatalities of individuals exposed to accidental toxic gas releases.

- **Keywords:** CFD; Dose-response; Toxic gas release; Poisoning; Hydrogen sulfide

Shao-qi Zhou, Wei-dong Lu, Xiao Zhou. *Effects of heavy metals on planting watercress in kailiyard soil amended by adding compost of sewage sludge.* Pages 263-268.

Mixture of sewage sludge with organic garbage was alternatively composted by aerobic and anaerobic technology for 60 days. A basin-scale experiment was performed by planting *watercress* with kailiyard (KY) soil amended with the compost. The results show that average total organic carbon (TOC) increases from 98.45% to 787.69%, and average total nitrogen (TN), total phosphorus (TP) and total potassium (TK) increases to 98.53%, 27.34%, and 41.62%, respectively. The results of *watercress* in 6 pot experiments with a control treatment show that biomass production increases from 76.47% to 312.00% with the increase of addition of compost from 50 g to 150 g per pot but decreases from 312.00% to 102.29% with the addition of compost to soil and further increases from 150 g to 400 g per pot. The optimal amount of compost added to KY soil is 0.4 g of compost 1 kg of KY soil. Heavy metals accumulated by *watercress* demonstrate that Cu, Ni, Cd, Pb, Cr, Zn in the crop are much lower than the limited levels of Chinese criteria for vegetables. KY soil is proper to be amended with compost of sewage sludge without threat of bio-magnification of heavy metals to planting *watercress*.

- **Keywords:** Heavy metals; Sewage sludge; Compost; Kailiyard soil; *Watercress*

Zhang Haiying, Zhao Youcai, Qi Jingyu. *Thermal characterization of fly ash from one municipal solid waste incinerator (MSWI) in Shanghai.* Pages 269-275.

This study aims to develop a methodology for the thermal characterization of MSWI fly ash. We performed TGA-DTA and component variation analysis, microstructure transfer of sintered fly ash, as well as leaching toxicity, volatilization ratio and specification transformation of heavy metals as a function of temperature. It is found that content of crystal phases first increases between room temperature and 800 °C and then decreases between 800 °C and 1200 °C, while that of glass phases registers a reverse trend. Fly ash registers a SiO₂-Al₂O₃-metal oxides system and its content of glass phases is around 57%. Increase of sintering temperature between 600 °C and 1200 °C is conducive to the reduction of soluble As, Cd, Cu, Hg, Pb, Ni and Zn, while content of soluble Cr increases as temperature rises from 800 °C to 1200 °C.

- **Keywords:** MSWI fly ash; Leaching toxicity; Specification distribution; Microstructure

Yanyu Wu, Shaoqi Zhou, Fanghui Qin, Huaping Peng, Yanglan Lai, Yiming Lin. *Removal of humic substances from landfill leachate by Fenton oxidation and coagulation.* Pages 276-284.

In this study, chemical oxygen demand (COD) was characterized as total organic constituents and the isolated humic substances (HS) were characterized as an individual organic contaminant in landfill leachate. It was found that the HS content of landfill leachate was 83.3%. The results of laboratory tests to determine the roles of HS in reducing the organic content of landfill leachate during Fenton process are presented. Furthermore, the performances of oxidation and coagulation of Fenton reaction on the removal of HS and COD from leachate were investigated. The change curves of HS removal were similar to those of COD. The HS removal was 30% higher than COD removal, which indicated that HS were mostly degraded into various intermediate organic compounds but not mineralized by Fenton reagent. The oxidation removal was greatly influenced by initial pH relative to the coagulation removal. The oxidation and coagulation removals were linear dependent with hydrogen peroxide and ferrous dosages,

respectively. Ferrous dosage greatly influenced the coagulation removal of COD at low ratio ($[\text{H}_2\text{O}_2]/[\text{Fe}^{2+}] < 3.0$), but not at extremely high ratio ($[\text{H}_2\text{O}_2]/[\text{Fe}^{2+}] > 6.0$). The coagulation removal of HS was not affected obviously by oxidation due to both Fenton oxidation and coagulation remove high molecular weight organics preferentially. Higher temperature gave a positive effect on oxidation removal at low Fe^{2+} dosage, but this effect was not obvious at high Fe^{2+} dosage.

- **Keywords:** Landfill leachate; Humic substances; Fenton; Oxidation; Coagulation

Xiang Yulin, Zhang Weijiang, Zheng Hao. *Synergetic decolorization and deodorization of sludge protein foaming solution by ^{60}Co γ -ray irradiation/ H_2O_2 oxidation. Pages 285-291.*

Sludge protein foaming solution was effectively decolorized and deodorized by gamma irradiation in the presence of hydrogen peroxide. The existence of a synergetic effect on the decolorization and the deodorization was demonstrated by means of UV/vis spectrophotometry, chemical, and sensory analyses every 14 days during 98 days of storage. Furthermore, the foamability was measured using the Ross–Miles method. Results showed that color, odor, and foamability of irradiated samples under hydrogen peroxide oxidation were significantly improved. Sensory evaluation indicated that irradiated samples under hydrogen peroxide oxidation were better than nonirradiated samples in odor, and color. Finally, a preliminary cost analysis revealed that ^{60}Co γ -ray/ H_2O_2 process was more cost-effective than the H_2O_2 alone.

- **Keywords:** Sludge protein foaming solution; Decolorization; Deodorization; Synergetic effect; Gamma irradiation; Hydrogen peroxide

Zhenlan Xu, Hong Chen, Haiyun Wu, Lingxiangyu Li. *7 mT static magnetic exposure enhanced synthesis of poly-3-hydroxybutyrate by activated sludge at low temperature and high acetate concentration. Pages 292-296.*

The effect of 7 mT (milliTesla) SMF (static magnetic field) on poly-3-hydroxybutyrate (PHB) production was studied at an acetate concentration of 260 Cmmol l^{-1} and temperature of $10 \text{ }^\circ\text{C}$. The SMF decreased the specific acetate uptake rate by 29%, but increased the maximum PHB content and the yield of PHB on acetate by 32 and 28% respectively. The ratio $q_p/(q_s - q_p)$, which described specific PHB production rate over the difference between specific acetate uptake rate and specific PHB production rate, was introduced for evaluation of the ratio of carbon flux into PHB synthesis and into the TCA (tricarboxylic acid) cycle. This value reached 2.3 when activated sludge culture was exposed to magnetic field of 7 mT, which was 1.1 times higher than the $q_p/(q_s - q_p)$ value obtained without magnetic exposure. Therefore, the SMF promoted diversion of more acetyl-CoA towards PHB synthesis and could offset adverse effects of high acetate concentration and low temperature. These results provide evidence that SMF enhances PHB production by activated sludge.

- **Keywords:** Poly-3-hydroxybutyrate; Static magnetic field; Low temperature; High acetate concentration