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Ming Yang, Faisal I. Khan, Leonard Lye. *Precursor-based hierarchical Bayesian approach for rare event frequency estimation: A case of oil spill accidents.* Pages 333–342.

Due to a scarcity of data, the estimate of the frequency of a rare event is a consistently challenging problem in probabilistic risk assessment (PRA). However, the use of precursor data has been shown to help in obtaining more accurate estimates. Moreover, the use of hyper-priors to represent prior parameters in the hierarchical Bayesian approach (HBA) generates more consistent results in comparison to the conventional Bayesian method. This study proposes a framework that uses a precursor-based HBA for rare event frequency estimation. The proposed method is demonstrated using the recent BP Deepwater Horizon accident in the Gulf of Mexico. The conventional Bayesian method is also applied to the same case study. The results show that the proposed approach is more effective with regards to the following perspectives: (a) using the HBA in the proposed framework provides an opportunity to take full advantage of the sparse data available and add information from indirect but relevant data; (b) the HBA is more sensitive to changes in precursor data than the conventional Bayesian method; and (c) using hyper-priors to represent prior parameters, the HBA is able to model the variability that can exist among different sources of data.

- **Keywords:** Rare event frequency estimation; Hierarchical Bayesian approach; Precursor-based approach; Deepwater Horizon accident; Oil spill

M. Nalla Mohamed, S.P. Sivapirakasam, M. Surianarayanan. *Experimental investigation on the impact sensitivity of a match head composition influenced by the surface roughness of in-process contact materials.* Pages 343–350.

This study is aimed to investigate the influence of contact materials and their surface roughness on impact sensitivity of a match head composition. It was found that there were variations to the impact sensitivity, ranging from 2 to 14.7 J. The sensitivity response was quicker in case of steel–steel anvil combinations than with aluminium–aluminium anvil and brass–brass anvil combinations. The match head composition was found to be highly hazardous at the surface roughness values of 1.67, 1.80, and 1.60 μm for steel, aluminium and brass material surfaces, respectively. Such data are not available hitherto.

- **Keywords:** Impact sensitivity; BAM; Surface roughness; Matchworks manufacturing; Match head composition

M. Tanabe, A. Miyake. *Forced ventilation effect by Air-Fin-Cooler in modularized onshore LNG plant.* Pages 351–366.

Many base load onshore LNG plants use large number of Air-Fin-Coolers normally mounted on the center pipe rack of the LNG process train. Further, the LNG plant modularized approach requires large, complex structures (modules) for supporting the LNG process equipment and for allowing sea and land transportation. This results in additional congestion of the plant and large voids under module-deck, which are confined by large girders. Thus, in case of leaks, the proper ventilation to reduce the accumulation of gas is critical for the safety of the plant.

This paper evaluates the Air-Fin-Cooler induced air flow in modularized LNG plants using Computational Fluid Dynamics (CFD) analysis.

The results of this evaluation show that the ventilation of the Air-Fin-Cooler induced air flow is influenced by the process train orientation. Further, a moderate increase is observed in specific design conditions or areas, such as shorter separation distances between modules. Based on the results of this evaluation, four design measures are proposed to optimize the use of Air-Fin-Cooler, such as train orientation against prevailing wind direction and use of the grating deck material.

- **Keywords:** Air-Fin-Cooler; Forced ventilation; Separation distance; LNG

Kamarizan Kidam, Markku Hurme. *Method for identifying contributors to chemical process accidents.* Pages 367–377.

The paper presents a new method for identifying contributors to chemical process accidents by exploiting knowledge on causes of past accident cases. Accident reports from the Failure Knowledge Database were analyzed and utilized for hazard identification. The accident information gathered was used as a basis to develop an accidents ranking and points-to-look-for approach for the safe design and operation of chemical process equipment. In the method, accident contributors including technical, design and operation errors of major process equipment types and piping are identified. The method is applicable throughout the process lifecycle, even for process changes in the early design stages. The Bhopal tragedy is used as a case study to demonstrate and test the method. The proposed method can predict on average up to 85% of accident causes and design and operation errors.

- **Keywords:** Accident contributor; Design error; Hazard identification; Plant design; Process lifecycle

T.J. Rainey, I.M. O'Hara, A.P. Mann, C.H. Bakir, F. Plaza. *Effect of depithing on the safety and environmental aspects of bagasse stockpiling.* Pages 378–385.

Large scale sugarcane bagasse storage in uncovered stockpiles has the potential to result in adverse impacts on the environment and surrounding communities through hazards associated with nuisance dust, groundwater seepage, spontaneous combustion and generation of contaminated leachates. Managing these hazards will assist in improved health and safety outcomes for factory staff and reduced potential environmental impacts on surrounding communities. Removal of the smaller fibres (pith) from bagasse prior to stockpiling reduced the dust number of bagasse by 50% and modelling suggests peak ground level PM_{10}dust emissions would reduce by 70%. Depithed bagasse has much lower water holding capacity (~43%) than whole bagasse.

This experimental and modelling study investigated the physical properties of depithed and whole bagasse. Dust dispersion modelling was undertaken to determine the likely effects associated with storage of whole and depithed sugarcane bagasse.

- **Keywords:** Depithing; Bagasse; Dust; Effluent

Qiang Tang, Qin Wang, Pengfei Cui, Weiwei Cao, Shifeng Hou. *Numerical simulation of flue gas desulfurization characteristics in CFB with bypass ducts.* Pages 386–390.

A new process of flue gas desulfurization in circulating fluidized bed with flue gas bypass ducts is presented. $k-\varepsilon$ Model, Discrete Phase Model and Finite-Rate Chemistry Model are proposed to simulate the desulfurization process characteristics in circulating fluidized bed reactor. The proposed model is validated by the comparison of experimental data and simulation results. The results show that the desulfurization reactor with bypass ducts is superior to the reactor without bypass ducts. The reactor with bypass ducts has higher desulfurization efficiencies and lower flow resistances than the reactor without bypass ducts, and it is more suitable for flue gas flow variation. Desulfurization reaction rate is controlled by absorption reaction on sorbent particles surface. When water content and Ca/S ratio increase, desulfurization efficiency of the reactor with bypass ducts increases. When SO_2 concentration increases, desulfurization efficiency decreases.

- **Keywords:** CFB reactor; Flue gas desulfurization reactor; Desulfurization efficiency; Numerical simulation

Changjun Zou, Pinwen Zhao, Ju Ge, Jianxiu Li, Linchao Yu, Jun Qiu, Rangong Sun. *Recycling of valuable chemicals through the catalytic decomposition of phenol tar in cumene process.* Pages 391–396.

The base catalyst LZ-2, which was the mixture of CaO and Na–NaOH/$Al_2O_3 \cdot 3H_2O$, was chosen for the decomposition of phenol tar to generate valuable chemicals. The selectivity of LZ-2 for dimethyl phenyl carbinol, α-methyl styrene dimer and cumenyl phenol was 100%, 100% and 98%, respectively. Under the optimum operating conditions of catalyst 2.5 wt%, operating temperature 603.15 K and decomposition time 3.5 h, decomposition ratios of cumenyl phenol and dimethyl phenyl carbinol were 98.7% and 99.97%, respectively. In addition, the experimental repeatability demonstrated that the total yield of valuable chemicals still reached 90.1% after the catalyst being used five times. Mass and energy balance indicated that the catalytic decomposition was a high potential for the recycling of chemicals from phenol tar.

- **Keywords:** Phenol tar; Recycling; Catalytic decomposition; Cumene process

R.Z. Liu, Alistair G.L. Borthwick, D.D. Lan, W.H. Zeng. *Environmental risk mapping of accidental pollution and its zonal prevention in a city.* Pages 397–404.

Accidental releases of pollution can have severe environmental, societal, economic, and institutional consequences. This paper considers the use of risk mapping of accidental pollution events, and zonal prevention measures for alleviating the impact on large urban areas. An Environmental Pollution Accident Risk Mapping (EPARM) model is constructed according to a mapping index system supported by quantitative sub-models dedicated to evaluating the risk arising from different sources of potential accidental pollution. The EPARM approach consists of identifying suitable indexes, assessment of environmental risk at regional and national scales based on information on previous pollution accidents and the prevailing environmental and social conditions, and use of GIS to map the overall risk. A case study of pollution accidents in Minghang District, Shanghai, China is used to

demonstrate the effectiveness of the model. The paper also proposes a systemic framework for accidental environmental pollution risk prevention, and detailed countermeasures for specific risk zones.

- **Keywords:** Risk mapping; Environmental pollution; Accident; Zonal governance; Prevention; Shanghai

Shreemoyee Bordoloi, Manoranjan Nath, Robin K. Dutta. *pH-conditioning for simultaneous removal of arsenic and iron ions from groundwater.* Pages 405–414.

The effects of some commonly used pH conditioners, *viz.*, lime, banana ash, the carbonate and the bicarbonate of sodium and potassium and their binary mixture, on simultaneous removal of arsenic and iron ions from water have been studied. $KHCO_3$ has been found to be the most suitable pH conditioner for the purpose. About 80 mg/L $KHCO_3$ can remove both arsenate and iron ions from initial 250 μg/L and 20 mg/L to below their respective guideline values of the WHO for drinking water, retaining the final pH in the acceptable range for drinking. The simultaneous removal of arsenate and iron by the pH-conditioners decreases in the order: Lime > $KHCO_3$ > $NaHCO_3$ > K_2CO_3 > Na_2CO_3 > ash. However, lime requires post-treatment correction of highly alkaline pH. The arsenate ion is removed predominantly through goethite or ferrihydrite in the presence of the bicarbonates and through ferric hydroxide in the presence of the more alkaline pH-conditioners. $KHCO_3$ is more advantageous over the more basic substances including $NaHCO_3$, because with it, one not only needs the smallest dose but also can avoid careful adjustment of the dose for regulating the initial and the final pH. The paper clearly demonstrates the potential of $KHCO_3$ to substitute the currently used pH-conditioners, *viz.*, ash, lime and $NaHCO_3$ for simultaneous removal of arsenate and iron ions.

- **Keywords:** Arsenate ion removal; Bicarbonate; Iron ion removal; Groundwater; pH

Hassimi Abu Hasan, Siti Rozaimah Sheikh Abdullah, Siti Kartom Kamarudin, Noorhisham Tan Kofli. *On–off control of aeration time in the simultaneous removal of ammonia and manganese using a biological aerated filter system.* Pages 415-422.

The biological aerated filter (BAF) system, a new alternative in drinking water treatment, was designed to remove NH_4^+–N and Mn^{2+} simultaneously. This study aimed to control the aeration time in the BAF system for simultaneous NH_4^+–N and Mn^{2+} removal to achieve the Malaysian effluent quality regulation for drinking water. The experiment was conducted under four strategies of S1, S2, S3 and S4. The results demonstrated that acceptable levels of NH_4^+–N and Mn^{2+} were achieved over a 6 h aeration period (S1), producing effluent concentrations of 0.7 mg/L (93.2% removal) and 0.08 mg/L (79.6% removal), respectively. At the initial treatment of S1 and S2, the dissolved oxygen (DO) level rapidly increased until it reached a saturated concentration (6.8 mg/L DO) after 2 h period. Automatic on–off aeration time to maintain 3 mg/L DO set point (S4) resulted with a good effluent quality of NH_4^+–N and Mn^{2+} compared with the 2 mg/L DO set point (S3) which did not meet the regulated standard limits. Through the automatic on–off aeration time, the saturated and excessive DO levels in the BAF system can be avoided consequently reduce the wastage of energy and electrical consumption for simultaneous NH_4^+–N and Mn^{2+} removal from drinking water treatment.

- **Keywords:** Simultaneous ammonia and manganese removals; Drinking water treatment; Biological aerated filter; Real-time monitoring; On–off aeration; Dissolved oxygen