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Geraint Thomas, Gwyn Oakley, Richard Bambrey. ***An experimental study of flame acceleration and deflagration to detonation transition in representative process piping*****. Pages 75-90.**

The paper summarizes the results of experimental tests and accompanying analyses to investigate the factors that govern flame acceleration and potential transition to detonation in a relatively long unobstructed piping system. The overall aim of the work was to obtain sufficient experimental data so as to be able to develop and evaluate methodologies for classifying and predicting potential detonation flame acceleration and deflagration to detonation transition (DDT) hazard in industrial process pipes and mixtures. The present results show that the flame acceleration process in an unobstructed pipe exhibit three distinct phases: an initial establishment phase; a second rapid acceleration phase and a final transition to detonation phase. Test results with ethylene indicate that the acceleration process is not sensitive to initial pressure (all other parameters remaining constant) but can be sensitivity to initial pipe wall temperature or possibly mixture humidity. The presence of bends increases the local rate of turbulent combustion, an effect attributed to the additional turbulence generated downstream of the bend. For straight pipes, detonation was only observed to develop for hydrogen–air and ethylene–air mixtures. Detonation was not observed with methane, propane or acetone as fuel in the present piping apparatus.

- **Keywords:** Flame acceleration; DDT; Detonation; Fuel–air

Sazal Kumar Kundu. ***Understanding and eliminating pressure fluctuations in an extended chlor-alkali plant due to the size detail of seal pots : a design correlation*****. Pages 91-96.**

When chlorine lines from a new caustic soda plant were added to chlorine lines from an older plant that used the same chlorine compression and liquefaction systems, we encountered abnormal pressure fluctuations on the chlorine side of the new plant. These fluctuations were being transmitted to the chlorine cycle in the older plant, posing a safety hazard in both facilities. After checking the pressure control systems, a design correlation for positive-pressure seal pot was observed and it was found from the inconsistency in the sizes of those equipments in the two plants. The problem was solved by reducing the diameter of the chlorine pipeline in the positive-pressure seal pot of the new plant. After implementing this solution, pressure fluctuations were fully removed, and satisfactory pressure control was attained in both plants.

- **Keywords:** Chlorine plant; Pressure control; Chlorine cycle; Pressure seal pot

M. Moonis, A.J. Wilday, M.J. Wardman. *Semi-quantitative risk assessment of commercial scale supply chain of hydrogen fuel and implications for industry and society*. Pages 97-108.

This paper is derived from a study on the safety of bulk transport and storage of hydrogen as a fuel, carried out by the Health and Safety Laboratory (HSL) for the Department for Transport (DfT). The aim of the study was to identify the knowledge and data required to develop fully a risk assessment for a hydrogen delivery and storage infrastructure. The methodology used was to begin to carry out a risk assessment for a representative delivery and storage supply chain, using a risk assessment methodology commensurate with the availability of necessary data. Semi-quantitative risk assessment was carried out through top-down HAZID brainstorming, consequence modelling using commercially available software, and use of a risk matrix. Finally through the risk assessment carried out and relevant literature review, the gaps in hazard identification, consequence modelling and frequency assessment, which should be filled to develop a quantified methodology, were compiled. Using data for current UK LPG consumption, comparisons were made between hydrogen and LPG for mode of failures and number of trips required to supply equivalent energy demand. The implications of using ammonia as a hydrogen carrier (hydrogen is within the ammonia molecule) and regulatory implications on hydrogen fuelling or storage sites are also discussed.

- **Keywords:** Hydrogen; Risk assessment; LPG; COMAH; Gaps; Consequence assessment

Juan Francisco Sánchez Pérez, Enrique González Ferradás, Fernando Díaz Alonso, Daniel Palacios García, María Victoria Mínguez Cano, José Ángel Bautista Cotorruelo. *New Probit equations for the calculation of thermal effects on humans*. Pages 109-113.

In this paper new Probit equations are proposed to estimate damage produced by thermal radiation on humans (for first- and second-degree burns). They are compared to empirical threshold values and also to existing Probit equations. Results obtained are in good agreement with previous empirical experience. They also provide better estimations than existing equations. When an analysis is performed to study the evolution in the percentage of affected people by different degrees of damages, results show that proposed equations produce more consistent results than existing equations.

- **Keywords:** Thermal effects; Damage; Probit; First-degree burns; Second-degree burns

Zhang Haiying, Zhao Youcai, Qi Jingyu. *Characterization of heavy metals in fly ash from municipal solid waste incinerators in Shanghai*. Pages 114-124.

This study aims to develop a methodology for analysis of characteristics of heavy metals in MSWI fly ash. It performed analysis of composition of heavy metals, leaching toxicity, leaching behavior as a function of pH, specification distribution and corresponding mineral components of residue derived from each step of the sequential extraction. It is found that content of heavy metals follows the sequence of Zn > Pb > Cu > Cr > As > Ni > Cd approximately Hg in both plants, and that total heavy metals account for less than 1% by mass of fly ash. Major hazardous heavy metals in fly ash are As, Cd, Hg, Pb and Zn, whose leaching ratios exceed the limit value described in hazardous waste identification standard. Measured leaching results of Cu, Pb and Zn are essentially consistent with the simulated results at pH between 0 and 13. Content of

calcium-silicates, alumino-silicates and glass phases in residue derived from sequential extraction procedure increases steadily from the first step to the fifth step of the sequential extraction procedure. Cu, As, Cr, Hg, Cd, and Ni, relatively stable under strong basic conditions, can be leached out under strong acidic conditions, while Zn and Pb tend to be leached out under both strong acidic and basic conditions.

- **Keywords:** MSWI fly ash; Heavy metals; Characterization; Leaching toxicity; Specification analysis; Leaching behavior

Quentin Falcoz, Daniel Gauthier, Stéphane Abanades, Fabrice Patisson, Gilles Flamant. *A general kinetic law for heavy metal vaporization during municipal solid waste incineration*. Pages 125-130.

Metal emissions from waste incineration plants become a great environmental concern because of their toxicity for both human health and environment. Metals are not destroyed by high-temperature thermal treatment and some vaporized metals may be emitted. It is thus essential to understand the release mechanism of metals during high-temperature waste treatment, in order to improve the understanding of their behavior and the control of their emission. The objective of this study is to identify the kinetic law for metal release from realistic artificial waste. The vaporization of three metals of most concern (Cd, Pb and Zn) during municipal waste incineration was studied. The vaporization rate at the particle level was determined from the experimental concentration profile in the outlet gas of a fluidized bed reactor, by using the inverse method that was previously developed and validated by our team. As a first step, the kinetic parameters were determined thanks to experiments carried out at several temperatures. Specific laws, for each studied metal, were thus obtained as a function of temperature. Nevertheless, it is very useful to identify all the experimental kinetic curves (all studied metals at all temperatures) to one single mathematical law. Therefore, a general kinetic law, expressing the solid matrix influence on the metal vaporization dynamic, was determined as a second step. It permits to predict the vaporization characteristic time and the time course of the metal concentration in the waste.

- **Keywords:** Vaporization kinetic; Heavy metal; Incineration; Fluidized bed; Model waste

Sukanya Satapathy, A. Nag, Golok Bihari Nando. *Thermoplastic elastomers from waste polyethylene and reclaim rubber blends and their composites with fly ash*. Pages 131-141.

Waste polyethylene (WPE) collected from the municipality solid waste (MSW) was melt blended with reclaim rubber (RR) in different proportions and composites with fly ash (FA) were prepared and characterized. Mechanical and dynamic mechanical properties of the blends and composites were studied in presence as well as in absence of a silane-coupling agent (Si-69). Tensile strength, flexural strength, flexural modulus, impact strength and hardness properties of the FA composites was found to improve in presence of Si-69. Phase morphology of the blends has been reported.

- **Keywords:** Waste polyethylene; Reclaim rubber; Fly ash composites; Impact strength; Blend phase morphology; Dynamic mechanical properties