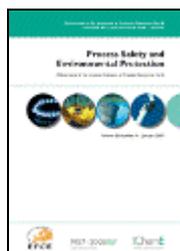


# **Process Safety and Environmental Protection**

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**G.O. Thomas. *Some observations on explosion development in process pipelines and implications for the selection and testing of explosion protection devices.* Pages 153-162.**

**Abstract:** In recent years there has been continuing interest in the potential hazards from detonations in pipelines. The interest has arisen in several instances due to the introduction of vapour recover systems, as part of measures to limit environmental emissions. These environmental pressures initially coincided with the preparation of new European-wide test procedures for explosion arrester devices and, more recently, moves to develop a new international ISO standard for the certification and approval of detonation arrester devices. It is an opportune time therefore to review current understanding of explosion development in pipelines and to consider the implications for plant design and explosion arrester selection and testing.

- **Keywords:** Detonation; Transition; Vent headers; Explosion arresters; International standards

**Rajagopalan Srinivasan, Nguyen Trong Nhan. *A statistical approach for evaluating inherent benign-ness of chemical process routes in early design stages.* Pages 163-174.**

**Abstract:** The choice of chemical process routes is one of the key decisions in the early design stages. An "inherently safer" route will help eliminate many hazards as well as obviate many risk control devices. Many inherent safety indices have been proposed to quantify hazards, health and environmental impact of a chemical process route. These indices measure a route's inherent benign-ness based on various process route descriptors such as temperature, pressure, yield, as well as the properties of the chemicals involved. Usually routes involving more reactive, toxic chemicals and hazardous reactions are considered less safe by these indices. Inherent safety indices typically suffer from several shortcomings including subjective scaling and weighting of factors, and consideration of limited set of aspects. In this paper, we propose the Inherent Benign-ness Indicator (IBI), a statistical analysis-based methodology for comparing process routes. A systematic way to scale disparate factors is also proposed. The IBI can be used to rank the routes; additionally it can determine the broad

similarities and differences in the safety, health, and environmental footprints of the routes. Thus, it can assist the process designer determine modifications needed to improve a route's benign-ness. This easy-to-use, extendable, theoretically sound approach to compare competing routes is illustrated using two case studies involving acetic acid and methyl methacrylate manufacture.

- **Keywords:** Inherent safety; Health and environment; Process design; Route selection; Reactivity incident

**Enrique González Ferradás, Fernando Díaz Alonso, Marta Doval Miñarro, Agustín Miñana Aznar, José Ruiz Gimeno, Juan Francisco Sánchez Pérez. *Consequence analysis by means of characteristic curves to determine the damage to buildings from bursting spherical vessels. Pages 175-181.***

**Abstract:** Since the damage suffered by buildings as a consequence of explosions usually affect the people inside them, it is important to take it into account when performing consequence analysis. The aim of this paper is to provide a methodology to estimate consequences to buildings from pressure waves produced by spherical vessel burst. This is done by combining *characteristic overpressure–impulse–distance curves* [González Ferradás, E., Díaz Alonso, F., Sanchez Perez, J.F., Miñana Aznar, A., Ruiz Gimeno, J. and Martinez Alonso, J., 2006, Characteristic overpressure–impulse–distance curves for vessel burst, Process Safety Progress, 25(3): 250–254] with PROBIT equations. The main advantage of this methodology is that it allows an overview of all the magnitudes involved, as damage is shown in the same graph as the overpressure, impulse and distance. In this paper diagrams and equations are presented to determine minor damage to buildings (broken windows, displacement of doors and window frames, tile displacement, etc.), major structural damage (cracks in walls, collapse of some walls) and collapse (the damage is so extensive that the building is partially or totally demolished).

- **Keywords:** Vessel burst; Tank rupture; Sphere explosion; Consequence analysis; Damage to buildings

**Kaiqian Kuang, Xin Huang, Guangxuan Liao. *A comparison between superfine magnesium hydroxide powders and commercial dry powders on fire suppression effectiveness. Pages 182-188.***

**Abstract:** The effectiveness of superfine magnesium hydroxide powders and commercial dry powder in fire suppression were compared in a laboratory-scale, immovable fire suppression apparatus. The investigation focused on their suppression effectiveness under various pressures. It likewise studied the relationship between the powders' surface structures and their effectiveness on fire suppression. The microcosmic structure of the powders was observed by scanning electron microscope (SEM), while the Thermal Gravity Analysis (TGA) technique was used to analyze the thermal behavior of the superfine magnesium hydroxide powders. By analyzing the results, it could be concluded that the pressure, the particle size, and the microcosmic structure of the powders' surface mainly decide the capability of the powders to extinguish the fire. Comparing this with commercial dry powders, superfine magnesium hydroxide powders extinguished the fire in less than 10 s.

- **Keywords:** Superfine and dry powder; Fire suppression effectiveness; Particle size; Thermal gravity analysis

**Mohammad Shahriari, Anton Frost. *Oil spill cleanup cost estimation : developing a mathematical model for marine environment. Pages 189-197.***

**Abstract:** The field of oil spill cost modelling is not as well explored as desirable. Generally speaking, the existing models have either low accuracy, in that their predictions are far from the real cost, or low applicability, in that they are only valid under very specific conditions; such as in one particular country. This work strives to construct a model that is functional in a global scope and still possess a high level of accuracy. The resulting attempt is in many ways superior to the publicly available competitors, not only because of its predictive capacity but also because the model is quick to use, and its input variables should be readily available to any informed user. The model is more accurate comparing with similar available models. However, further study is needed to modify it to obtain more realistic results.

- **Keywords:** Oil spill cleanup; Regression modelling; Consequence analysis; Insurance; Mathematical cost modelling

**A. Bernatik, W. Zimmerman, M. Pitt, M. Strizik, V. Nevrlly, Z. Zelinger. *Modelling accidental releases of dangerous gases into the lower troposphere from mobile sources. Pages 198-207.***

**Abstract:** The article reports the results of different methods of modelling releases and dispersion of dangerous gases or vapours in cases of major accidents from road and rail transportation in urban zones. Transport accidents of dangerous substances are increasingly frequent and can cause serious injuries in densely inhabited areas or pollution of the environment. For quantitative risk assessment and mitigation planning, consequence modelling is necessary. The modelling of dangerous substance dispersion by standard methods does not fully represent the behaviour of toxic or flammable clouds in obstructed areas such as street canyons. Therefore the predictions from common software packages as ALOHA, EFFECTS, TerEx should be augmented with computational fluid dynamics (CFD) models or physical modelling in aerodynamic tunnels, and further studies are planned to do this. The goal of this article is to present the results of the first approach of modelling using these standard methods and to demonstrate the importance of the next development stage in the area of transport accident modelling of releases and dispersions of dangerous substances in urban zones in cases of major accident or terrorist attacks.

- **Keywords:** Major accidents; Transportation of dangerous substances; Modelling of release and dispersion

**H. Esmaeili Taheri, M.S. Hatamipour, G.Emtiazi, M. Beheshti. *Bioremediation of DSO contaminated soil. Pages 208-212.***

**Abstract:** Seven strains isolated from DSO (disulfide oil) contaminated soils. Among them, two strains had high potential to remove DSO from contaminated soils. These strains identified as *Paenibacillus* (a gram positive, nitrogen fixing spore, spore forming bacillus) and *Rhodococcus* (a gram positive, catalase positive, acid fast forming bacteria), by preliminary tests. The optimal conditions for DSO removal from contaminated soils were determined. The biotic depletion for *Paenibacillus* pre-grown in nutrient broth was 24.3% and for *Rhodococcus* was 19.3%. Bioremediation of DSO in soil was investigated by gas chromatography and UV-vis absorption spectroscopy techniques. The results showed that addition of water (20 µl/g soil) to soil is necessary for DSO removal by both strains and none of the strains could remove DSO in concentrations more than 30 µg/g soil. The results also showed that none of these strains could degrade DSO under anaerobic condition.

- **Keywords:** Contaminated soil; Bioremediation; DSO; *Paenibacillus*; *Rhodococcus*

**Wen-Yao Chang, Ping-Kun Fu, Chiun-Hsun Chen, Yi-Liang Shu.**  
***Performance evaluation of a water mist system in semiconductor wet bench fires. Pages 213-218.***

**Abstract:** Wet benches are typically utilized in semiconductor facilities for wafer and parts cleaning. Heaters and some flammable liquids, such as acetone and isopropyl alcohol (IPA), are employed during the cleaning process. Wet bench fires have caused serious losses in the semiconductor industry. To assess the fire protection performance, several field tests were performed using a water mist system installed in the wet bench. In this study, acetone pan fuel was used as fire source. The test parameters were operational pressure, pan size, nozzle location, cylinder obstruction and degree of door closure. An appropriate design for operating pressure and the location of water mist nozzles extinguished wet bench fires effectively in the early fire stages. The nozzles are suggested to be fixed above or on the each side of the pan, ensuring that mist can completely cover a pan surface with sufficient momentum. With this suggested design, fires can be extinguished in the pan and do not spread over the wet bench.

- **Keywords:** Water mist; Wet bench; Semiconductor; Fire