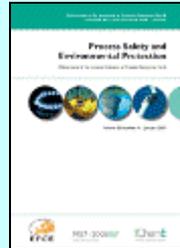


Process Safety and Environmental Protection

rok 2014, ročník 92

Číslo 2 (March 2014)



Rafael Batres, Shinya Fujihara, Yukiyasu Shimada, Testuo Fuchino. *The use of ontologies for enhancing the use of accident information*. Pages 119–130.

Safety engineering is multi-disciplinary in nature, requiring many kinds of information. Particularly, the identification of accident scenarios and the reuse of accident information can be benefited from the computational integration of different sources of information. However, enabling software tools to share, exchange and search information in this area is difficult due to the lack of an unambiguous knowledge representation. Ontologies are formal models based on mathematical logic that describe classes of things and their relations and can facilitate the sharing and exchange of accident scenarios and bring with them the support of automated reasoning which facilitates the location of information of past accidents. This paper discusses the use of ontologies (and the ISO 15926 in particular) for capturing descriptions of accidents and locating them.

- **Keywords:** HAZOP; Accident scenario; Ontologies; ISO 15926

Alireza Noroozi, Faisal Khan, Scott MacKinnon, Paul Amyotte, Travis Deacon. *Determination of human error probabilities in maintenance procedures of a pump*. Pages 131–141.

The “human factor” constitutes an important role in the prediction of safe operation of a facility. Hence, information about human capacities and behaviours should be applied methodically to increase the safety of a systematic process. This paper provides an analysis of human factors in pre- and post-maintenance operations. For possible failure scenarios, this paper considers the procedures for removing process equipment from service (pre-maintenance) and returning the component to service (post-maintenance). In this study, a pump is used as the test example. For each scenario, the human error probability (HEP) is calculated for each activity, using the Human Error Assessment and Reduction Technique (HEART) which is commonly implemented technique in industry, can also be applied in the analyses of safety cases. HEART is a reliable technique for comparing HEP and its approach is based on the degree of error recovery. Consequences are also assessed for each activity in this methodology. The final value of risk for each activity is assigned by combining error likelihood and related consequences. When the calculated risk is beyond acceptable levels, risk management strategies are provided to increase the safety of the maintenance procedures. The most probable human errors for a considered case study are related to the activities of “draining lines” and “open valves”. These two activities have high HEPs, which are $9.57E-01$ and $9.62E-01$, respectively.

- **Keywords:** Human error; Human factors; Risk assessment; Maintenance procedures

Abdelhak Mkhida, Jean-Marc Thiriet, Jean-François Aubry. *Integration of intelligent sensors in Safety Instrumented Systems (SIS)*. Pages 142–149.

This article deals with the assessment of Safety Instrumented Systems using intelligence in the field devices. The integration of intelligent instruments within safety oriented applications presents a challenge. The justification for using these instruments in safety applications is not fully proven and the dependability evaluation of such systems is not trivial. The work presented in this article deals with modeling in order to evaluate the performances relating to the dependability for structures which contains intelligent instruments. This architecture constitutes a Safety Instrumented System (SIS). In the modeling of the system, the functional and dysfunctional aspects coexist and the dynamic approach using the Stochastic Activity Network (SAN) is proposed to overcome the difficulties mentioned above. Monte-Carlo method is used to assess the dependability parameters in compliance with safety standards related to SIS (IEC 61508 & IEC 61511). The proposed method and associated tools allow this evaluation by simulation and thus provide assistance in designing SIS integrating intelligence.

- **Keywords:** Intelligent instruments; Safety Instrumented Systems; Reliability; Stochastic Activity Network; Monte-Carlo simulation

B. Fabiano, F. Currò, A.P. Reverberi, E. Palazzi. *Coal dust emissions: From environmental control to risk minimization by underground transport. An applicative case-study*. Pages 150–159.

Coal dust emission from open coal storage parks and handling plants can represent a significant part of the overall atmospheric emission contribution in different industrial activities, such as power stations or coke production plants. The emissions are strictly connected to technical characteristics of the handling system, chemico-physical properties of coal and environmental conditions. In this paper, we present a full-scale operational solution to the problem of limiting coal dust emissions during transportation from the harbor site to the final utilization plant. To this end, a simple mathematical framework is developed in order to evaluate explosion risk inside the enclosure and set-up proper technical and managerial layers of protection suitable to minimize the risk.

- **Keywords:** Coal accidents; Dust pollution; Explosion; Emissions; Transportation

Kathleen B. Aviso. *Design of robust water exchange networks for eco-industrial symbiosis*. Pages 160–170.

The field of industrial ecology promotes the establishment of resource exchange networks in eco-industrial parks (EIPs) as an approach toward resource conservation. Previous studies have shown that full blown resource integration can be encouraged through the exchange of common utilities such as energy and water. Different approaches such as mathematical programming, pinch analysis and game theory have been used to identify the optimal network designs, which can simultaneously reduce the utilization of freshwater resources and the generation of wastewater streams. Since water exchange in an EIP involves multiple independently operating plants, information exchange between the participants is not completely transparent and multiple future scenarios are expected to happen as the fate and plans of other participants are not completely divulged. These future scenarios may bring about changes in the capacity or characteristic of industrial processes and may also involve the entry of additional companies and the closure of previously operating ones. Such aspects have not been fully addressed in previous

studies. A robust optimization model is thus developed in this work to determine the optimal network design which can effectively operate in anticipation of multiple probable scenarios. Case studies are solved to demonstrate the capability of the model.

- **Keywords:** Water conservation; Industrial ecology; Industrial symbiosis; Robust optimization

Mingmei Zhang, Haiyun Wu, Hong Chen. *Coupling of polyhydroxyalkanoate production with volatile fatty acid from food wastes and excess sludge*. Pages 171–178.

In this paper, the synthesis of polyhydroxyalkanoates (PHAs) by activated sludge with aerobic dynamic feeding process was conducted in a sequencing batch reactor by using food wastes and excess sludge fermentation liquid as the carbon source. The volatile fatty acids (VFAs) in the fermentation liquid were divided into even-numbered (acetic and butyric acid) and odd-numbered (propionic and valeric acid). The experiments conducted by central-composite design (CCD) showed that the pH could significantly affect the ratio of even-numbered to odd-numbered VFAs. Statistical analysis indicated a positive correlation ($R^2 = 0.97$, $P < 0.05$) between the consumption of even-numbered VFAs and the synthesized of PHB, while the consumption of odd-numbered VFAs were correlated with the synthesized PHV. By controlling the ratio of even-numbered to odd-numbered VFAs, the contents of PHV in the PHAs could be controlled within the range of 22–30%. When fermentative VFAs were used as the substrate for the synthesis of PHAs, the microbial synthesis of PHA and biomass was higher than that mixture of analytically pure acids was used. These results are of vital significance for the comprehensive utilization of solid wastes.

- **Keywords:** Polyhydroxyalkanoates; Activated sludge; Volatile fatty acids; Food waste

Mehdi Atapour, Hamid-Reza Kariminia, Parivash Moslehi Moslehabadi. *Optimization of biodiesel production by alkali-catalyzed transesterification of used frying oil*. Pages 179–185.

Biodiesel as an alternative fuel for fossil diesel has many benefits such as reducing regulated air pollutants emissions, reducing greenhouse gases emissions, being renewable, biodegradable and non-toxic. In this study, used frying oil was applied as a low cost feedstock for biodiesel production by alkali-catalyzed transesterification. The design of experiments was performed using a double 5-level-4-factor central composite design coupled with response surface methodology in order to study the effect of factors on the yield of biodiesel and optimizing the reaction conditions. The factors studied were: reaction temperature, molar ratio of methanol to oil, catalyst concentration, reaction time and catalyst type (NaOH and KOH). A quadratic model was suggested for the prediction of the ester yield. The p -value for the model fell below 0.01 (F -value of 27.55). Also, the R^2 value of the model was 0.8831 which indicates the acceptable accuracy of the model. The optimum conditions were obtained as follows: reaction temperature of 65 °C, methanol to oil molar ratio of 9, NaOH concentration of 0.72% w/w, reaction time of 45 min and NaOH as the more effective catalyst. In these conditions the predicted and observed ester yields were 93.56% and 92.05%, respectively, which experimentally verified the accuracy of the model. The fuel properties of the biodiesel produced under optimum conditions, including density, kinetic viscosity, flash point, cloud and pour points were measured according to ASTM standard methods and found to be within specifications of EN 14214 and ASTM 6751 biodiesel standards.

- **Keywords:** Biodiesel; Used frying oil; Design of experiments; Optimization; Response surface methodology

H.N. Chanakya, Himanshu Kumar Khuntia. *Treatment of gray water using anaerobic biofilms created on synthetic and natural fibers.* Pages 186–192.

Gray water treatment and reuse is an immediate option to counter the upcoming water shortages in various parts of world, especially urban areas. Anaerobic treatment of gray water in houses is an alternative low cost, low energy and low sludge generating option that can meet this challenge. Typical problems of fluctuating VFA, low pH and sludge washout at low loading rates with gray water feedstock was overcome in two chambered anaerobic biofilm reactors using natural fibers as the biofilm support. The long term performance of using natural fiber based biofilms at moderate and low organic loading rates (OLR) have been examined. Biofilms raised on natural fibers (coir, ridge-gourd) were similar to that of synthetic media (PVC, polyethylene) at lower OLR when operated in pulse fed mode without effluent recirculation and achieved 80–90% COD removal at HRT of 2 d showing a small variability during start-up. Confocal microscopy of the biofilms on natural fibers indicated thinner biofilms, dense cell architecture and low extra cellular polymeric substances (EPS) compared to synthetic supports and this is believed to be key factor in high performance at low OLR and low strength gray water. Natural fibers are thus shown to be an effective biofilm support that withstand fluctuating characteristic of domestic gray water.

- **Keywords:** Gray water; Anaerobic biofilms; Extracellular polymeric substance (EPS); Confocal imaging