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A New Approach for Facility Siting by Mapping Risks on a Plant Grid Area and Optimization

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Abstract

Past incidents at petrochemical industries such as and Texas City (2005) have higlighted safety concerns associated with facility siting. Facility siting involves the assessment of the possible impacts of known hazards (toxic, fire, and explosion) on people, structures, and equipment, and developing a means of managing the risks of these hazards. Such studies are usually conducted by evaluating the location of existing process plant buildings. To prevent accidents associated with facility siting, hazard identification must be conducted in the initial stage of process design.

This research aims in determining a safer assignment of hazardous facilities and other process plant buildings by mapping risks on a given area and optimizing facilities layout in order to minimize financial risk. By applying the event tree analysis technique on some fire and explosion consequences such as jet fire, pool fire, vapor cloud explosion (VCE), and boiling liquid expanding vapor explosion (BLEVE), we obtained the estimation of flammable gas concentration and its release frequency from hazardous facilities. Other parameters are also investigated, such as failure frequency of containment, which gives the estimation of release probability and initial hole size.

In this work, the given land area is modeled as square grids of a certain mesh size, in which each grid acquires a risk score depending on the type of consequence and type of exposed receptor/ target associated to the affected area. These risk scores such as probability of structural damage, will then be multiplied by the cost of potential facilities. Accompanying by the suggested safety concepts, the new methodology also considers the economics factor. Here, the overall cost of placing facilities on a certain location is a function of piping cost, management cost, land cost, and financial risk. The proposed formulation is a mixed integer optimization problem (MIP) that identifies attractive locations by minimizing overall cost. This approach gives the coordinates of each facility, and estimates the total piping length and the occupied land area. Results generated from this approach will enhance process safety in the conceptual design and provide useful information for emergency preparedness and response program