New Approach To Optimizing the Facility Siting and Layout for Fire and Explosion Scenarios

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ABSTRACT

Accidents involving flammable materials often resulted in a fire or an explosion. In addition to property damages caused by fire/explosion, the concern about the potential of structural collapse on building occupants has become an increasingly emergent. The present work describes a new approach to optimizing facility siting and layout for flammable gas release scenarios, thereby minimizing the consequences of fire and explosion. This approach focuses on integrating quantitative risk analysis in the optimization formulation to obtain the optimal allocation of new facilities based on particular risk criteria derived from accident scenarios. Three different approaches to configure the optimal location of new facilities were used: fixed distance (recommended separation distance), optimized layout by considering the structural damage due to blast overpressures, and, finally, integration of the first two approaches with weighting factors to account for the risk to building occupants and the likelihood of the domino effect. The proposed approach was formulated as a mixed integer nonlinear program (MINLP) problem that determines safe locations of facilities by minimizing the overall cost. Furthermore, the proposed methodology was evaluated using a flame acceleration simulator (FLACS) to consider the congestion and confinement effects in the plant in order to provide substantial guidance for deciding the optimal layout. The outcome of this study can be used as a tool to assess a new or current layout of process plant buildings and to manage fire and explosion risks in the chemical process plant.