Risk Optimization in Solving Facility Layout and Siting Problem with Toxic Gas Release Scenarios

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Abstract

In this work, a new approach to optimize facility layout for toxic release is presented. By integrating a risk analysis in the optimization formulation, we propose a safer assignment for facility layout and siting. Accompanying with the economical concept used in a plant layout, the new model considers the cost of willing to avoid a fatality, the injury cost due to accidents associated with toxic release near residential areas. The proposed formulation incorporates the effect of wind speed, wind direction, and stability class from real meteorological data to calculate the injury risk through the probit model and Monte Carlo simulation using dense gas dispersion (DEGADIS) model. The overall problem is initially modeled as a disjunctive program where the coordinates of each facility and cost-related variables are the main unknowns. Then, the convex hull approach is used to reformulate the problem as a Mixed Integer Non-Linear Program (MINLP) that identifies potential layouts by minimizing overall costs. This approach gives the coordinates of each facility, and estimates for the total length of pipes, the land area, and the selection of safety devices. Finally, the 3D-computational fluid dynamics (CFD) was used to determine the best layout among the local optimums obtained from optimization or to compare between the initial layout and the final layout. Moreover, analyses of separation distances from hazard facilities and hindrance effects will be discussed based on the approach used in this work.

Key words: risk optimization, toxic gas release, facility layout and siting, MINLP, CFD