

# Analyzing Hazards in Process Systems Using Multilevel Flow Modelling: Challenges and Opportunities

*Ruixue Li, Jing Wu, Xinxin Zhang*

*Department of Electrical and Photonics Engineering, Technical University of Denmark, Kgs. Lyngby, 2800, Denmark*

Process safety is complex since the production process is a unified system comprised of mass, energy, and information, in which the effects of failures are interconnected and transmitted, leading to a chain reaction throughout the process. Multilevel Flow Modeling, as a methodology in functional modeling, performs well in supporting situation awareness and fault diagnosis, through modeling process systems and reasoning about hazard scenarios. Applying Multilevel Flow Modeling to hazard identification and deviation analysis and developing a computer-aided HAZOP tool can potentially improve the efficiency of the conventional HAZOP study. Multilevel Flow Modeling is not sufficient for computer-aided cause and consequence analysis since individual deviations are examined independently in terms of their causes and effects. Because of this limitation, risk can be underestimated because of a lack of consideration for the "duplicate effect" of deviations, resulting in an insufficient barrier configuration. By reviewing the methods of risk assessment, illustrating the development of Multilevel Flow Modeling in process safety, and comparing the results of a manual HAZOP report with the MFM-assisted HAZOP model, this poster discusses the opportunities and challenges that can be encountered when combining hazard analysis with "duplicate effect" and the representation and analysis of deviations and barriers in Multilevel Flow Modeling. The authors aim to develop an approach to enhance hazard analysis and barrier representation through the extension of Multilevel Flow Modeling, which will facilitate the identification and optimization of safeguards.