PDR Alliance: Collaborative research on consequence modelling of accidental explosions in complex geometries

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Accidental explosions cause severe losses in industry and society, and safe and cost-effective design of facilities requires models that can estimate the consequences of explosions with sufficient accuracy, within reasonable time. Although models based on empirical correlations may be adequate for some applications, computational fluid dynamics (CFD) is increasingly used in quantitative risk assessments (QRAs) for systems that entail complex geometries. The theoretical foundation for CFD is the Navier–Stokes equations, but analytical solutions are primarily of academic interest, direct numerical simulation (DNS) is restricted to idealised systems, and large eddy simulation (LES) is too computationally expensive for most QRAs. This implies that CFD simulations of explosion scenarios in large-scale complex geometries will remain under-resolved for the foreseeable future, and the *de facto* industry standard entails the use of models based on the porosity/distributed resistance (PDR) formulation [1]. This includes commercial tools such as FLACS-CFD and KFX-EXSIM, and the open-source solvers PDRFoam and STOKES. Results from blind-prediction benchmark studies show that pressure loads predicted by consequence models may deviate by orders of magnitude relative to experimental results [2]. Of particular concern are scenarios involving gaps between congested regions, delayed ignition of massive releases in congested geometries, and deflagration-to-detonation-transitions (DDT). The aim of the PDR Alliance initiative is to facilitate international cooperation on pre-competitive research and development of PDR solvers for modelling the consequence of explosions. The intention is to involve modellers from academia and industry, as well as experimentalists and other stakeholders, and to utilise results from highly resolved numerical simulations (DNS, LES) in conjunction with experiments at various spatial scales to formulate, implement, and validate improved subgrid models for PDF solvers.

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References

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