PALM Model Conference, 23-26 February 2026

OT03

Numerical Study of Battery Fire Exposure Scenarios with LES

Mikko Auvinen[*1], Mikko Poikkimäki[2], Antti Hellsten[1]

[1]Finnish Meteorological Institute

[2]Finnish Institute of Occupational Health

The widespread use of electrical devices in homes and workplaces makes preparedness for battery fires an important aspect of safety management. While such fires are typically studied experimentally, laboratory setups have limitations that constrain the range of conditions that can be explored. High-fidelity computational modelling provides a flexible alternative for examining battery fire behaviour and associated exposure risks. In this study, the PALM LES model is applied to simulate small battery fires under typical indoor conditions, with the aim of quantifying toxic exposure time scales for battery sizes ranging from mobile phones to hand-held power tools.

The indoor PALM LES model is based on earlier solver developments. The simulated room represents a mechanically ventilated indoor environment with a single inlet–outlet system, measuring (L,W,H) = (8.6, 4.6, 2.3) m (volume 87 m^3). A grid resolution of (2.2, 2.4, 2.2) cm is used, which adequately resolves the dominant dispersion features. Battery fire forcing is based on experimental heat release rate (HRR) and gas emission data for a single 18650 cell. The HRR curve is parametrized and implemented via a user module, and multi-cell fires are represented by combining several partially overlapping single-cell events. Gas release follows the same temporal profile, consistent with measurements. Total HF emission per 18650-cell fire is taken from literature and applied in post-processing to convert the passive scalar field into HF concentration.

A series of LES runs is performed with varying battery sizes. Each simulation spans 5 min, which is sufficient to capture key exposure scenarios. The passive scalar field $s(t,x,y,z)$ is saved at 1 Hz and converted into HF concentration. The resulting HF concentration time series are compared against Acute Exposure Guideline Levels (AEGL) limits to evaluate the severity of potential indoor toxic exposures.