SUMMARY

Modelling thermal runaway initiation and propagation for batteries in dwellings to evaluate tenability conditions

Thermal propagation is one of the major challenges when batteries will be used in dwellings in large scale. It means the exothermic reactions in the cell are out of control and can lead to a fast release of flammable and toxic gases.

Purpose or goals

The aim is to simulate the battery thermal runaway initiation and propagation using a multi-scale and multi-physics model and to compare the simulated results with experimental data. In addition, a short circuit test will be modelled. Finally, the model will be used to simulate conditions in a simple dwelling and assess how well tenable conditions are maintained, e.g. determining conditions where it is safe for egress without too high concentrations of asphyxiant and irritant gases.

Methods and implementation

A battery thermal runaway model containing 12 prismatic cells based on 3-D Finite Element approach was built using GT-Suite. The computed thermal runaway time instants versus thermal runaway cell number were compared with full-scale experimental data with reasonable agreement.

Results

Quantitative sensitivity study on the model input parameters and model space and time resolutions on the computed start time instant and time duration of thermal runaway were performed. The thermal runaway model was then extended with an electric equivalent sub-model to simulate the short circuit. With the electrical model acting as the input to the thermal model, the most interesting output of the simulation is the change in temperature of the cells, dependent on the current in the cells, with respect to time. The current is determined by the value of the external resistance through which the short takes place and the voltage level of the battery pack. The obtained results from the above short circuit simulations can only be used as a starting point and not as absolute values for neither triggering the thermal model nor for accurately simulating a battery under an electrical load. Furthermore, GT-Suite was applied to simulate the gas dispersion inside a room and compared with corresponding simulations in Fire Dynamics Simulator (FDS). The outcome suggests that GT-Suite should be coupled to a regular CFD solver.

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