

Validation Studies of a Model for Thermal Decomposition of Polyurethane Foam

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Abstract

Validation is a process by which we study how accurately a model represents the physical world. Traditionally, validation involved developing a model of a physical phenomena and comparing model results to values obtained from a physical experiment. In many cases the outcome of the comparison between a model and experiment is described in qualitative terms: good, reasonable, excellent, etc. As we rely less on physical experiments, and more on models in the engineering design process a more quantitative assessment of how accurately a model reflects the physical world. Furthermore, the paradigm on combining experiments with models to assess how well a model represents the physical world needs to change in light of the increased reliance on models. A more integrated approach, including the use of the model to design the validation experiment, is needed.

The focus of the validation process is not the model, nor is the focus the experiment; the focus is the interaction between the model and experiment. This focus is closely related to an inverse analysis where an experimentally measured quantity is used to estimate parameters, such as thermal properties or boundary conditions, in the model. In validation, however, we are comparing the model with the experiment to understand how accurately the model represents the physical world (experiment). The requirement on experimental data for validation is quite different from physical discovery type experiments. Validation experiments must be carefully designed and analyzed for the purpose of validation.

A model for the thermal decomposition of polyurethane foam, called CPUF, has been developed and a set of experiments has been conducted to validate the model. Modeling the thermal decomposition of foam is an important aspect of modeling the response of a weapon in an abnormal environment. Comparison of model predictions from CPUF and experimental measurements are used to quantify the accuracy of the model to represent the experiment (physical world). Results of the comparison, quantitative assessment of the accuracy, and quantifying the uncertainty, in both the experiments and model predictions, are discussed.