SAND2013-3389 C

SAND2013-3389C

Thermal-Mechanical Failure Exclusion Region Barrier Experiments

Jill Suo-Anttila and Amanda Dodd
Fire and Aerosol Sciences and Thermal/Fluid Science Engineering
Sandia National Laboratories

Polymer foam encapsulants provide mechanical, electrical, and thermal isolation in engineered systems. In fire environments, foams can vaporize, liquefy, and flow during thermal decomposition. Evolved gases can cause pressurization and failure of sealed containers. The safety theme for nuclear weapon systems typically relies on the integrity of the exclusion region barrier for a period of time during an abnormal thermal environment. Thus, there is a driving need to have a validated computational capability to model the decomposition of foams within hermetically sealed volumes, along with the pressurization and subsequent failure of the barrier.

To meet this need, model validation quality data on the pressurization and failure of hermetically sealed stainless steel 304L cans containing structural 20 lb/ft^3 PMDI foam was acquired for heating rates representative of abnormal thermal environments. The cans were heated at 10, 50, and 150^0C/min to 800^0C in upright and inverted orientations. A methodology for applying a consistent thermal boundary condition to the cans was developed which resulted in acquisition of model validation quality data for pressurization, failure pressure, and failure time. Failures observed were either by complete detachment of the lid or a leak in the weld. Leak failures were further analyzed to gain insight into parameters impacting the integrity of exclusion region barriers. Corresponding computational simulations of the experiments were performed to assess the model capability in predicting heat transfer, foam decomposition, and pressurization.

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.