SAND2016-0321PE

The role of pressure during cookoff of explosives

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Most laboratories use small-scale experiments to calibrate cookoff models. Often, these models do not fit data from other laboratories. A good example is Sandia's Instrumented Thermal Ignition (SITI) and Lawrence Livermore National Laboratories' one-dimensional time-to-explosion (ODTX) experiment. In SITI, the pressures typically do not exceed 5,000 psi (34.5×10^6 Pa) wherein ideal gas assumptions are adequate. In contrast, pressures in the ODTX experiments can get as high as 20,000 psi (138×10^6 Pa) where non-ideal gas equations of state are necessary. Cookoff models fit without regard to this pressure difference will fail to scale appropriately or even adequately simulate other small-scale experiments, especially if the decomposition chemistry is pressure dependent.

We have observed strong pressure dependent kinetics for plastic bonded explosive such as PBX 9501 and PBX 9502. Decomposition gases get trapped within crystals and pores when the density is near the theoretical maximum density (TMD). However, if the PBX is damaged, the decomposition gases can escape the interior of the explosive and accumulate in the gas filled space surrounding the explosive, which can be sealed or vented. Predicting scale-up for these explosives is strongly dependent on the pressure of the decomposition gases. Ignition time is difficult to predict without knowing the location of the gases, e.g. internal, external in sealed confinement, or external and vented. However, one can bound the problem my calculating all three scenarios as will be shown with several common explosives.