INCREASE BLAST EFFECTS OF HE WITH AL NANOPARTICLES : EXPERIMENTS, MODELING AND NUMERICAL SIMULATIONS WITH ALE SOLVER

A. Lefrancois, G. Baudin

Centre d'études de Gramat (CEG),
French Ministry of Defense,
46500 Gramat - France

Hemispherical and cylindrical surface burst experiments (detonated on the ground) are developed to evaluate the blast effects of aluminized HE and to validate non-ideal detonation model. The influence of the aluminum particle size, especially by the use of nanoparticle, is also expected.

The need of blast and underwater effects numerical predictions leads to develop also a new hydrocode dedicated for such applications and working very fast on a personal computer. This new hydrocode (hydrospeed software) is based on an arbitrary Lagrangian/Eulerian (ALE) solver for both high explosive and air (or water). This new 1D spherical hydrocode calculates all the blast parameters, including the thermal field. Such a method leads to a computation time divided by several hundreds, compared to classical Eulerian codes. The equations of state of HE detonation products are obtained from the thermo-chemical code Cheetah version 2.0 and the aluminum oxidation is described using a grain burning model of spherical particles, taking into account explicitly the surface to volume ratio of the metallic additive.

Hydrospeed simulations of the experiments show the capabilities of such a numerical tool. The originality of this work is the prediction of the experimental trends of the aluminum size effect on the wall down to 100 nanometer Al particles. The calculations are performed in the 1D spherical geometry, whereas experimental charges are cylindrical ; that is why the shock wave chronometry discrepancies exist.

This study highlights that reflected blast is the potential interest of reducing aluminum additive to nano-scale inside highly non-ideal HE. This effect seems to be correlated to higher temperature measurements in the early stage of the detonation products expansion for Al nanoparticles.