FRAGMENTATION OF METAL PARTICLES IN URBAN STREET EXPLOSIONS

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ABSTRACT

Semi-confined heterogeneous blast from metalized explosives may produce structural loading beyond expected levels from conventional explosives, due to enhanced afterburning and metal particle impacts with target structures. In order to better understand the efficiency of metal particle combustion this study focuses on particle fragmentation and target interaction effects. Specifically, detonation fragmentation of solid particles, aerodynamic break-up of molten particles, and the impact reflection, coating, or fragmentation of dispersed metallic particles in an urban street scenario is investigated. Reflection of metal particles improves mixing with oxidizing gases, while the breakup of metal particles produces smaller fragments with higher reactivity and increased burning rates.

Modeling of aluminized explosives in a two-wall scaled urban street has been performed using the Chinook CFD code. The Chinook multiphase model combines an Eulerian fluid solver in conjunction with a group Lagrange particle solver capable of representing a distribution of particle sizes. Particles subjected to charge detonation and target impacts with sufficient velocity are treated with Grady and Kipp dynamic failure models to determine the fragment number, size, and other properties. Particle impacts of lesser velocity are treated with a velocity and surface dependent reflection model ranging from elastic to fully dissipative impact reflection. Aerodynamic induced breakup of molten particles is treated according to a Weber number threshold. Reaction of dispersed metal particles is calculated using a diffusion limited rate model.

Model results show particle fragmentation and extensive droplet breakup resulting in a substantial increase in overall particle reaction. Comparisons to experimental data are given, and calculated results agree well with experimental pressure gauge loadings. Discussion is provided on the implication of these results for increased understanding and modeling capability of particle fragmentation, and recommendations are given on the inclusion of additional models to improve overall accuracy.