CORRELATING BLAST TEMPERATURE AND PRESSURE MEASUREMENTS FOR METALLIZED EXPLOSIVES

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ABSTRACT

Enhancing the blast output of explosives through the addition of reactive metals is a well-established practice. Numerous questions remain about the extent and timescale of metal particle reaction, and how the energy released through particle reaction couples with the blast wave. To study these factors, experiments were carried out to simultaneously measure blast temperature and blast pressure at different radial distances from constant-volume spherical charges containing gelled nitromethane with various loading densities of aluminum or magnesium particles. Only blast results for aluminum particles are discussed in this paper, while details of the temperature measurements are included in a companion paper. Peak overpressure versus radial distance in the mid-field was determined by tracking the trajectory of the blast wave outside the fireball with high-speed video and extracting pressure from the shock velocity via the Rankine-Hugoniot relations. Pressure history profiles both within and outside the fireball were collected at five radial distances using fast-response piezoelectric pressure gauges paired with slower piezoresistive gauges. Analysis of data within the fireball is further complicated by non-uniformities from particle jetting and the non-Friedlander nature of the pressure histories. Peak overpressure and positive phase impulse enhancement were calculated via averaging over several trials to compensate for these non-idealities. Pressure impulse monotonically increased with increasing mass fraction of aluminum, with the most substantial increases occurring within the fireball. Peak overpressure enhancement varied non-monotonically both spatially and with increasing mass fraction of Al. The authors interpret this behaviour to imply: 1) Variable timescales and completeness of reaction with increasing fractions of Al; 2) Reduction in explosive material not being overcompensated by the slower aluminum reaction at higher loading densities. The thermocouple triplet technique resolved only limited enhancement of thermal impulse with increasing aluminum loading for the charge size considered, making it impossible to correlate blast properties with thermal properties.