FREE-AIR CURVES FOR SPHERICAL EXPLOSIVE CHARGES

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A methodology has been developed for determining the free-air cur e for spherical explosive charges based on shock front time-of-arrival (TOA) measurements. This methodology was used to determine the free-air curve for a newly developed castable composite/molecular explosive called ATX-27R. The results have been compared with the standard freeair curves for TNT, Pentolite, and PBX-9404.

The free-air curve for an explosive is defined as the peak overpressure vs range relationship that results from the detonation of a spherical charge of a given mass in a homogeneous volume of air at a given pressure and temperature such that the propagation of the shockwave in the air is not perturbed due to interactions with mechanical boundaries. The free-air curve produced by a given explosive is unique to that particular explosive, thus the experimental determination of the free-air curve is the fundamental means for characterizing a given explosive when the specific application of interest is that of airblast phenomenology.

The uniqueness of the free-air curve is due to the dependence of the blast wave on the details of how the explosive energy is hydrodynamically coupled to the air. This coupling is primarily affected by the source physical characteristics, the time-dependent nature of the energy release, and the characteristics of the expanding reaction products.

The properties of a given explosive that determine the hydrodynamic coupling, and thus the free-air curve, are the explosive energy, detonation pressure, detonation velocity, charge density, oxygen balance of the reaction products, the solid and gas phase species kinetics, and the heat transfer between phases in the expanding reaction products. For detonations of ideal oxygen-balanced explosives in air, all of the energy available for hydrodynamic coupling is released at the detonation front. The expansion of the reaction products for ideal explosives is described by some pressure-volume relationship such as the well-known JWL model'. For oxygen deficient explosives, ideal or nonideal, reaction of the carbon and hydrogen in the detonation products with the oxygen in the air can add a substantial amount of energy to the blast wave. For nonideal explosives, reaction rates can be such that a substantial portion of the total energy released occurs at a relatively late time at pressures well below the detonation pressure. Nonideal explosives are sensitive to confinement and scale and, for diameters below some minimum, exhibit a strong dependence of detonation velocity on diameter.