TEMPERATURE MEASUREMENTS IN A FIREBALL FROM A METALIZED EXPLOSIVE

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ABSTRACT

Detonation of a metalized explosive generates a fireball that has a spatially non-uniform distribution of particle concentration. The burning metal particles typically have a higher temperature than the interstitial gas. Pyrometry can be used to estimate the maximum temperature of the condensed species in the fireball. Also for optically thick fireballs, only particles near the surface can be probed. Emission spectroscopy can be used to infer the temperature of some short-lived molecular product species (such as AlO in the case of aluminum particles, or tracer species), and absorption spectroscopy within the fireball, although difficult to carry out in field experiments, can in principle be used to determine the temperature of some gaseous species. The present paper presents temperature measurements within multiphase fireballs using in-situ thermocouple measurements. Although the thermocouple temperature lags behind the local gas temperature, when the thermocouple temperature reaches a maximum, the temperature is unambiguously equal to the local gas temperature. The temperature history within the fireball at various distances from the charge is presented for charges consisting of packed beds of various particles saturated with liquid nitromethane. The results for reactive particles (Al, Ti, Zr) are compared with non-reactive particles (Fe, glass), as well as homogeneous NM charges. For NM charges, a maximum gas temperature of about 800°C occurs at times on the order of 100's millisecond, less than the temperature of the soot in the fireball determined with pyrometry (~1625°C). With Al particles, the gas temperature is spatially non-uniform due to particle jetting and non-uniform particle combustion, but gas temperatures above 1000°C were recorded for times up to 0.5 s, less than the temperature of the burning particles (~2400°C). Inert particles act as an effective heat sink and the gas temperatures recorded did not exceed 100°C.