A Computational Aluminum Particulate Burn Model

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ABSTRACT

At previous symposia we have presented results of numerical models of the effects of adding energy to explosive detonations by burning aluminum in Tritonal or PBXN-109. Explosives which use larger percentages of aluminum are not readily treated using the earlier model (Miller, NSWC). That relatively simple time dependent model assumed that a predetermined amount of energy would be released by the burning aluminum.

We have developed a numerical particulate burn model which is based on the physical environment surrounding the particulates as a function of time. The metal particulates are represented by numerical particles having the following descriptive characteristics: Mass, Density, Radius, Temperature, Position (X, Y, Z), and Velocity (U, V, W).

The particles exchange heat with the surrounding gasses, and are accelerated by drag forces due to the velocity differences between particles and gasses. When the particles reach a critical temperature, which is dependent upon the chemicals present, the particles are allowed to burn. The burn rate for aluminum particles is proportional to a cubic function of the oxidizer concentration. As the particles burn, the radii of the particles are decreased while the energy and burned oxide mass are added to the gasses in the zone. Separate materials are used for the gasses. For example, air is treated as a combination of nitrogen and oxygen which are carried as separate materials. This model is very flexible and permits a broad range of effects to be simulated.

Results of first principle hydrodynamic computer code will be compared with experimental data.

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Introduction

ARA has developed an aluminum particulate burn model for use in Computational Fluid Dynamics (CFD) codes. Specifically we have added this capability to the government owned Second order Hydrodynamic Automatic Mesh Refinement Code (SHAMRC). It is an Eulerian based CFD code which is fully conservative of mass, momentum and energy and is second order accurate in space and time (except at shock fronts). The region of interest is divided into a number of rectangular cross section computational zones. Each zone characterizes the volume of space represented by that zone with the hydrodynamic parameters: pressure, density, internal