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Abstract

Effects of turbulent mixing induced by explosion of a 1-g spherical TNT charge in air are investigated. The detonation wave in the charge transforms the solid explosive ($C_7H_5N_3O_6$) to gaseous products, rich in $C_{(s)}$ and CO. The detonation pressure (~210 kb) causes the products to expand rapidly, driving a blast wave into the surrounding air (Brode, 1959). The interface between the products and air is unstable (Richtmyer, 1960; Meshkov, 1960; Anisimov & Zel'dovich, 1977). As shown in Collage Ia-c, this region rapidly transitions into a turbulent mixing layer (Kuhl, 1996). As the embedded shock, *I*, implodes, it draws the mixing structures (Taylor cavities) into the origin (Collage Id-e). In this way air becomes distributed throughout the hot detonation products gases. This process is enhanced by shock reflections from confining walls. In either case (confined or unconfined), rapid combustion takes place where the expanded detonation products play the role of fuel. This leads to a dramatic increase in chamber pressure (Fig. 1)—in contrast to a corresponding TNT explosion in nitrogen. The problem was modeled as turbulent combustion in an unmixed system at large Reynolds, Peclet and Damköhler numbers (Kuhl et al, 1997). The numerical solution was obtained by a high-order Godunov scheme (Colella & Glaz, 1985). Adaptive Mesh Refinement (Berger & Colella, 1989) was used to follow the turbulent mixing on the computational grid in as much detail as possible. The results reveal all the dynamic features (Fig. 2) of the exothermic process of combustion controlled by fluid-mechanic transport in a highly turbulent field (Kuhl & Oppenheim, 1997), in contrast to the conventional reaction-diffusion mechanism of Zel'dovich & Frank-Kamenetskii (1938).

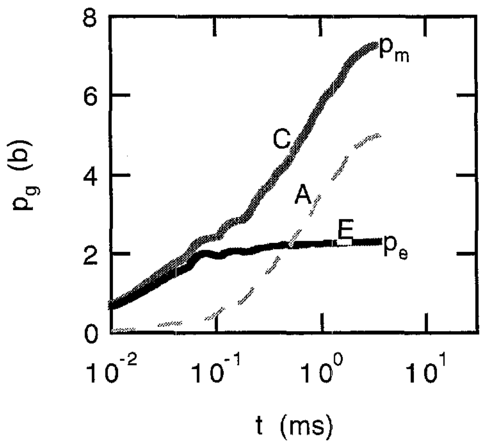

Figure 1. Chamber pressure histories for a 1-g TNT explosion in a 6.28*l* chamber: curve **E** = explosion, and **C** = combustion.

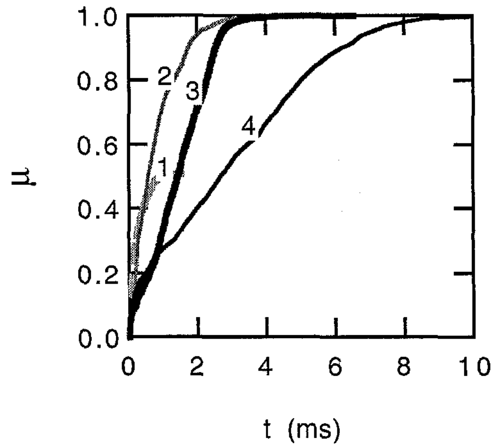

Figure 2. Mass-fraction of fuel consumed by combustion of a 1-g TNT charge in various chambers: **1** = 1.35*l*; **2** = 6.28*l*; **3** = 50.2*l*; **4** = 402*l*.

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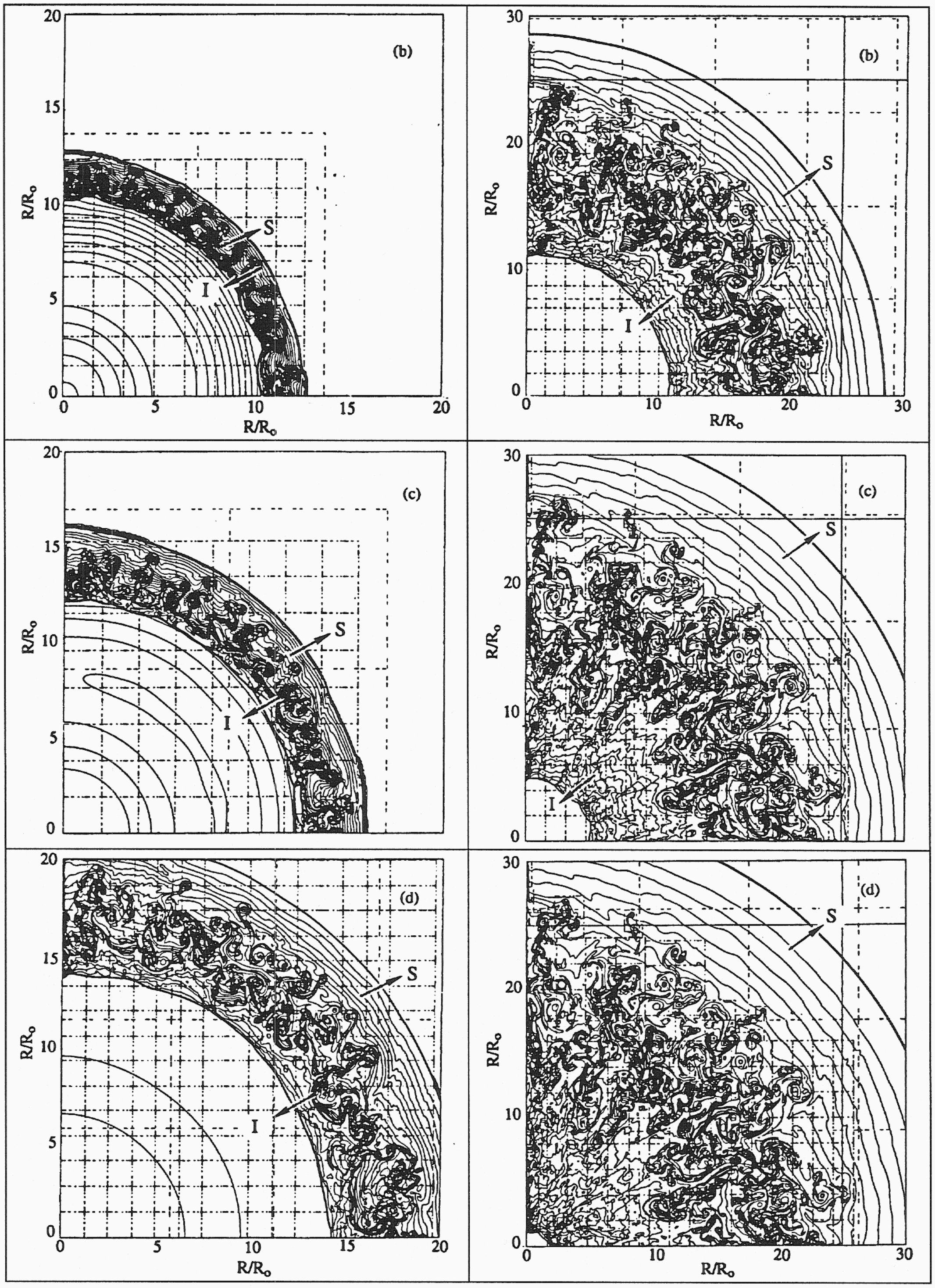

Collage I. Growth of instabilities on TNT-air interface in an unconfined explosion (a-c); penetration of mixing structures during the implosion of shock I (d-f).