12006

Experimental Studies of Scalable Effects Warhead Technologies

Markus Graswald & Werner Arnold

TDW Gesellschaft für verteidigungstechnische Wirksysteme mbH
Hagenauer Forst
D-86529 Schrobenhausen, Germany
Phone: +49 8252 99 7264
email: markus.graswald@mbda-systems.de

November 24, 2010

Abstract

Session: Explosion Mechanics

Current warfare scenarios like military operations on urban terrain (MOUT) or combat air support (CAS) missions demand a novel warhead capability providing sufficient effects to a specific target while minimizing risks of collateral damage at the same time. However, there is no warhead technology readily available fulfilling these needs, since nowadays munitions typically offer the full output mode and variable output warheads produce two distinct output modes only.

The dial-a-yield technology already suggested in a TDW patent filed in 1999 provides a radially adaptive warhead response by using two timely adjustable initiating devices: a deflagrator and a detonator. The detonative output of such a scalable effects warhead (SEW) and its associated fragment and blast effects can be continuously reduced from this full-output mode to a deflagrative output, i.e., low-output mode. In practice, this performance reduction can be realized by deflagrating the explosive and initiating the detonator after a specific, selectable time delay. This solution requires a stable deflagration that might be hard to achieve.

This technological approach was verified in a recent experimental study using generic cylindrical steel casings that were filled with a plastic-bonded, insensitive explosive. Results were gathered using witness plates as well as the synchro-streak technique (SST) of the ultra-high-speed rotating mirror camera Cordin 200 at a very slow mirror speed. The streak records

and framings provide valuable cylinder expansion data of detonative, subdetonative, and mixed processes.

The first experimental campaign consisted of tests for determining initiation parameters for various deflagrator devices where the corresponding warhead responses for these low outputs were documented. The holes in the witness plates and the recovered fragments show a low hit density of large fragments with a high L/D ratio that can be clearly distinguished from a detonation response with a large number of small fragments. Independently of the deflagrator device used, wall velocities recorded by the rotating mirror camera can be found within a specific velocity range significantly lower than those caused by detonations.

During the main campaign, tests were conducted with charges deflagrated through the deflagrator on top, while the detonator at the other end was initiated after a given time delay in the microsecond regime. This time delay mainly depends on the desired yield of the warhead, its dimensions, and the explosive charge. The streak records and framings remarkably depict the small wall expansion from the top end by the deflagrator and the significantly higher wall expansion and velocities from the bottom caused by a detonation wave. These overlayed reactions consequently result in fragment numbers, sizes, and velocities ranging between the low-output and high-output mode.

The unique experimental results provide a sound basis for additional modeling and simulations as well as further experimental studies. This successfully proven dial-a-yield technology may be used in future flexible response blast / fragmentation warheads where the lethal radius can be controlled and the collateral area minimized.

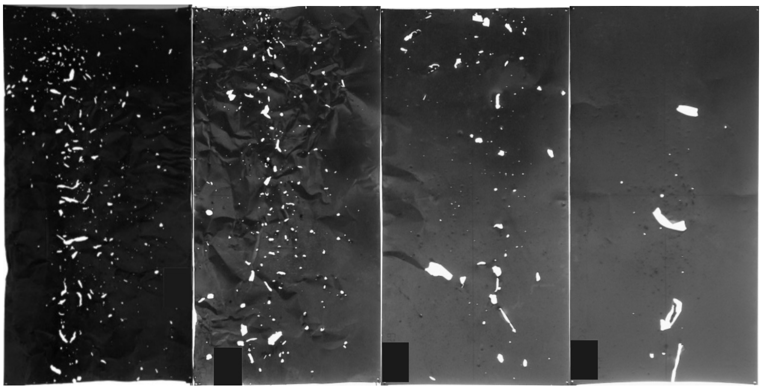
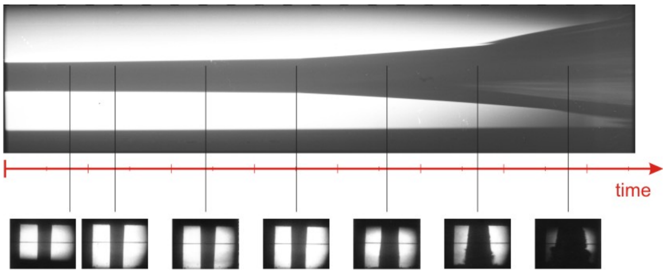
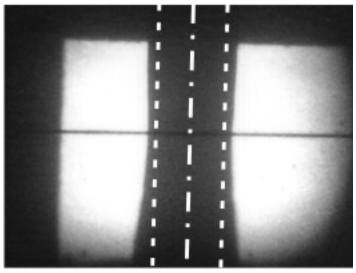


Figure 1: The detonative output can be continuously reduced to the low output mode as shown by these witness plates pictures.



(a) Streak record and framings



(b) Individual Framing

Figure 2: Streak record with corresponding framings for a mixed process: the wall slowly expands after deflagrator initiation at the top end, before the wall velocity rapidly increases after the detonation wave has arrived in the streak slit plane. At the end of the recording, the casing begins to break and gaseous detonation products escape. The right figure clearly demonstrates the different wall expansions.

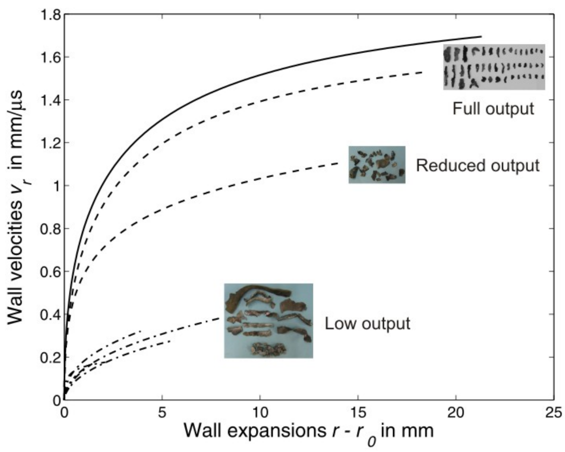


Figure 3: Cylinder expansion results and corresponding fragments. The different velocity regimes are related to specific initiator and time delay settings and, as a result, to different reaction levels observed.