Initial Temperature Effect on M1020 Ignition Cartridge Behavior

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In this study, the effect of the initial temperature on the fundamental combustion processes and overall performance of the M1020 ignition cartridge was examined to provide both qualitative and quantitative information for design improvement to the 120mm mortar system as well as advancing and validating existing numerical model (3D-MIB)\(^1\) of the system. Experiments were performed on several mortar subsystems of increasing complexity so that various sub-models of mortar system components can be validated individually, improving the fidelity of the model as well as the understanding of the initial temperature effect on fundamental combustion processes of the ignition cartridge. The temperature sensitivity of the burning rate of the M48 propellant is determined from a series of closed bomb tests at temperatures of -45, -12, 21, and 63°C. Knowing the temperature sensitivity of the propellant burning rate provides more detailed input information for the numerical models, resulting in higher fidelity model predictions. The pressurization and mass discharging behavior of the flash tube at these four temperatures was also examined using high-frequency pressure measurements taken at various axial locations during flash tube firings in a test apparatus shown in Fig. 1. The resulting pressure histories are employed to define the initial temperature effect on an empirical parameter in a flash tube model\(^2\) that accounts for the break-up of the black powder pellets in the flash tube. A previous study\(^3\) found that the mass discharge rate of the product gases and particles from the flash tube into the granular bed of the ignition cartridge is highly non-uniform along the length of the tube. Therefore, a series of tests was performed on a modified flash tube with a non-uniform distribution of vent-hole size. The test data have been used for determining the rate of mass and energy of the discharging jets from the vent holes. The initial temperature dependence of the full M1020 ignition cartridge was tested by static firing of a tail boom section mounted at 65° elevation (shown in Fig. 2). These tests are being conducted at the above four temperatures, and have been instrumented with pressure transducers at multiple axial locations and two thermocouples embedded in the M48 propellant bed. The results of these firings are being compared with the predictions of the 3D-MIB code\(^1\) to validate its performance for extreme temperature cases. Typical results for the flash tube and ignition cartridge tests are given in Figs. 3 and 4, respectively. Complete results and analysis of these experiments will be presented in the final paper.

References


Figure 1. Instrumented flash tube test setup with multiple transducers
Figure 2. Instrumented tail boom test setup at 65° elevation.

Figure 3. Typical measured flash tube P-t traces from a baseline configuration.

Figure 4. Typical comparison of measured and calculated P-t traces from ignition cartridge tests.