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Evaluation of Barrel Coating Materials for Thermal-Mechanical Behavior in a 155 mm Howitzer

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ABSTRACT

This study analyzes the thermo-mechanical coupling behavior of a 155 mm howitzer; specifically, the interaction between the inner barrel coating material and the substrate. The purpose of this study is to compare the thermomechanical performance of two different coating materials: Chromium vs. MAT1, where the former is widely used in the military, while the latter is a newer coating material that is currently under development. When the gun is fired, the barrel is subjected to extreme temperatures and high-pressure, turbulent propellant gas flow during the interior ballistics process, introducing transient thermal and mechanical effects. These rapid changes in temperature and pressure lead to an intricate coating-substrate interaction, due to a strong thermal gradient in the radial direction of the barrel. This phenomenon induces a substantial amount of thermal stress, which would affect the overall performance of the howitzer. In order to examine the structural performance of the barrel during firing, the interior ballistic output parameters such as gas pressure, temperature, projectile velocity, position, and the mass fraction of unburned propellants were obtained using IBHVG2, a lumped-parameter computer code, developed by the US Army Ballistic Research Laboratory. These output parameters are then integrated into the numerical model to simulate transient heat transfer and thermo-mechanical stress response in the ANSYS engineering simulation software. The results of thermomechanical behavior of both coating materials (Chromium vs. MAT1) subjected to identical interior ballistics loading conditions will be presented.

REFERENCES

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