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Evaluation of Zr/NH_4ClO_4 and $Zr/KClO_4$ Compositions for Development of Igniter for Ammonium Perchlorate and Hydroxyl-Terminated Polybutadiene Based Base Bleed System

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Abstract : To achieve an enhanced range of large calibre artillery a base bleed unit equipped with ammonium perchlorate and hydroxyl-terminated polybutadiene (AP/HTPB) based composite propellant grain is installed at the bottom of a projectile which produces jet of hot gasses and reduces base drag during flight of the projectile. Upon leaving the muzzle at very high muzzle velocity, due to sudden pressure drop, the propellant grain gets quenched. Therefore, base-bleed unit is equipped with an igniter to ensure ignition as well as reignition of the propellant grain. Pyrotechnic compositions based on Zr/NH_4ClO_4 and $Zr/KClO_4$ mixtures have been studied for the effect of fuel/oxidizer ratio and oxidizer type on ballistic properties. Calorific values of mixtures were investigated by bomb calorimeter, the average burning rate was measured by fuse wire technique at ambient conditions, and high-pressure closed vessel was used to record pressure-time profile, maximum pressure achieved (Pmax), time to achieve Pmax and differential pressure (dP/dt). It was observed that the 30, 40, 50 and 60 wt.% of Zr has a very significant effect on ballistic properties of mixtures. Compositions with NH_4ClO_4 produced higher values of Pmax, dP/dt and Calorific value as compared to $Zr/KClO_4$ based mixtures. Composition containing $KClO_4$ comparatively produced higher burning rate and maximum burning rate was recorded at 8.30 mm/s with 60 wt.% Zr in $Zr/KClO_4$ pyrotechnic mixture. $Zr/KClO_4$ with 50 wt. % of Zr was tests fired in igniter assembly by electric initiation method. Igniter assembly was test fired several times and average burning time of 3.5 sec with igniter mass burning rate of 6.85 g/sec was recorded. Igniter was finally fired on static and dynamic level with base bleed unit which gave successful ignition to the base bleed grain and extended range was achieved with 155 mm artillery projectile.

Keywords : base bleed, closed vessel, igniter, zirconium
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