Elimination of Perchlorate Oxidizers from Pyrotechnic Flare Compositions

Weapons Systems and Platforms
WP-1280

Background:

Most in-service colored signal flares and spectrally balanced decoy flares contain perchlorate oxidizers. Perchlorate, a type of salt in its solid form, dissolves and moves rapidly in groundwater and surface water. Even in low concentrations in drinking water supplies, perchlorate is known to inhibit the uptake of iodine by the thyroid gland. While there are currently no federal drinking water standards for perchlorate, some states have established public health goals, or action levels, and some are in the process of establishing state maximum contaminant levels. Accordingly, there is an urgent need to develop perchlorate-free compositions for pyrotechnic flare devices.

Objective:

The objective of this project was to formulate and test pyrotechnic compositions that contain non-perchlorate oxidizers. As appropriate to the pyrotechnic application, the new compositions must produce equal or superior emission intensities in the visible or infrared regions.

Process/Technology Description:

Perchlorate oxidizers, currently used in both spectrally balanced decoy and colored flare compositions, were substituted with nitrate or oxide oxidizers. Because nitrate oxidizers are less reactive than perchlorate oxidizers, high-energy fuels were used to compensate for this energy shortfall. Some of these high-energy fuels were produced by the New Jersey Institute of Technology using Mechanical Alloying (MA) technology. The new compositions have been tested at the Naval Surface Warfare Center Crane Division at laboratory-scale to determine their performance and possible safety concerns. Compositions meeting acceptance criteria are being scaled up to their prototypes, and performance of the prototypes is being tested.

Results:

Laboratory-scale testing has led to the identification of perchlorate-free red, green, and yellow signal flare compositions. Based on performance test results, these compositions have the potential to meet or exceed performance specifications for the in-service perchlorate-containing flares. The red candidate compositions contain a mixture of calcium nitrate and strontium nitrate and no halogen-containing ingredients. The green compositions contain a mixture of three fuels, together with barium nitrate oxidizer and polyvinyl chloride color enhancer. The yellow compositions contain a mixture of the currently used barium nitrate and polyvinyl chloride ingredients, but eliminate both the potassium perchlorate and the sodium oxalate. Instead, sodium nitrate is used as the source of the intense sodium emission at 589 nm. This substitution has the added benefit of eliminating the production of low levels of toxic cyanide salts. Prototype perchlorate-free red compositions have been successfully tested using the red flare candle in the Mk 124 Mod 0 Marine Smoke and Illumination Signal. Scale-up efforts with the green and yellow compositions are ongoing. Formulation qualification testing is under way. A number of perchlorate-free spectrally balanced decoy flare compositions also have been tested at laboratory-scale. Both high energy metal/alloy and organic fuel ingredients have been evaluated. Tests of the most successful candidates have shown performance characteristics similar to the older of two types of in-service perchlorate-containing spectrally balanced decoy compositions.

F/A-18 Hornet firing a decoy flare.

Benefits/Implications:

The successful development of perchlorate-free pyrotechnic compositions will reduce future contamination of groundwater during the manufacturing, storage, and use of these pyrotechnic devices. Such reductions will decrease the number of costly perchlorate remediation efforts and result in devices that have significantly lower life-cycle costs. Moreover, the identification of new high-energy metal and alloy fuels will benefit the energetics community as a whole, since these fuels may have uses in other pyrotechnic and propellant devices. (Project Completed – 2006)

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