New Low-Sensitivity Modular Charge Propellant Based on GUDN

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Introduction

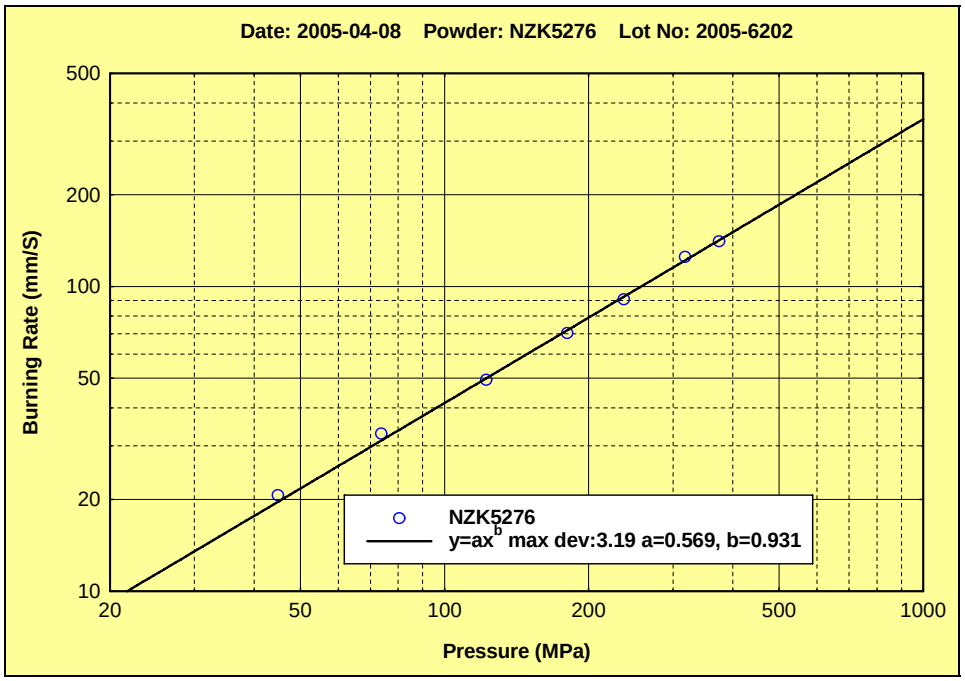
The Swedish effort to develop low-sensitivity propellants took a new turn in 1999 when GUDN started to be produced on a larger scale at EURENCO Bofors. A research program on insensitive gun propellants based on new ingredients was initially included in a government funded program managed by the Swedish MoD (FMV). Preliminary and promising test results in 2002 led to specific funding from FMV and industry for large scale testing. Today GUDN is tested as a main ingredient in a new propellant for the modular charge system, UNIFLEX 2 IM, intended for the BAE-Systems Bofors ARCHER Artillery System 08.

GUDN is a stable salt of dinitramide. In relation to the better known dinitramide (ADN) the properties of GUDN are quite different. GUDN does not melt, is poorly soluble in water has reduced water solubility and is significantly more thermally stable then ADN. This, together with a very low sensitivity, makes it an excellent component for gun-propellant manufacturing. GUDN is often referred to as FOX-12 and was first synthesized and presented by the Swedish FOI. Although GUDN is a fairly new component in gun-propellant formulations, it is not an entirely new explosive. It is already in use in automotive safety devices and is in large scale production by EURENCO Bofors.

ARCHER Artillery System 08

The Propellant Composition

The new propellant for the UNIFLEX 2 IM MCS is based on a mix of GUDN and RDX with a binder system consisting of nitrocellulose and low-sensitivity energetic plasticizers. A typical composition with 60% GUDN/RDX generates a burn rate of approximately 40 mm/s at 100 MPa with burning characteristics over the pressure regime as shown in the burn rate versus pressure diagram below.



Burn rate diagram

Since GUDN generates a large amount of gas at a small energy out-put during combustion, the gun performance of the GUDN-based propellant equals that of a single-base propellant, but burns with a considerably lower flame temperature. The solvent-less manufacturing process for double-base propellants is currently used for the GUDN propellant. The picture to the right shows the kerfed, 19-perforation, rosette-geometry of the GUDN-based propellant necessary to increase the loading density in the modules.

Kerfed propellant stick

UNIFLEX 2 IM performance and utility

The new modular charges system, UNIFLEX 2 IM, with GUDN-based propellant has been tested in BAE-Systems Bofors L/52, 155 mm Howitzer at ambient temperature and at –40 and +63 ^{0}C. The charge system consists of modules of two sizes, one full

length module and one half length, both containing the same propellant. Adding a half module will double the number of increments and thereby increase fire power in terms of Multiple Round Simultaneous Impact (MRSI).

Uniflex 2 MCS

Rounds with 6½ modules down to only 1 module have been fired at the different temperatures. The temperature coefficient is within the requirements and shows normal positive slope behaviour. This means that these modular charges can be used through the entire velocity range, which significantly decreases complexity in a combat situation.

IM capability of UNIFLEX 2 IM

The IM capability of UNIFLEX 2 IM originates from the use of the uniquely insensitive main propellant ingredient GUDN. The sensitivity of the propellant is low in terms of the standard drop-weight and friction tests. Initiation tests show that no sustained detonation could be achieved axially along the 135 mm 19-perforation propellant stick using a standard blasting cap and a 6 gram C4 booster-charge.

The most severe test for the MCS is the shaped charge jet impact test, especially if the propellant sticks are densely packed as is the case with the kerfed stick geometries used. A single module was subjected to a shaped charge attack axially along the stacked propellant sticks. This was done using an 80 mm war-head from the Carl-Gustaf 84 mm anti-tank round. A reference test was conducted using a module of the conventional UNIFLEX 2 MSC containing single-base propellant.

The picture down to the left shows the test set-up with the shaped charge on top and the modular charge standing on a witness plate. Between is a tube to define the stand-off. The pictures down to the right shows the witness plate after the test with the module containing the single-base propellant (2) and the module containing the GUDN based propellant (5). The pictures clearly show the difference in response between the two propellants. In the case of the single-base propellant, the witness plate was heavily fragmented due to the violent reaction. Continued IM-testing will be performed during 2006 to further verify the IM-signature.

Jet-impact test with the CG 80 mm war-head