


IMPROVED IM PROPERTIES OF AN RDX/TPE BASED LOVA PROPELLANT FOR ARTILLERY APPLICATIONS

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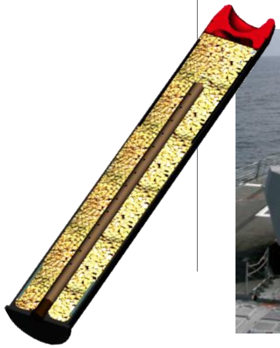
Overview

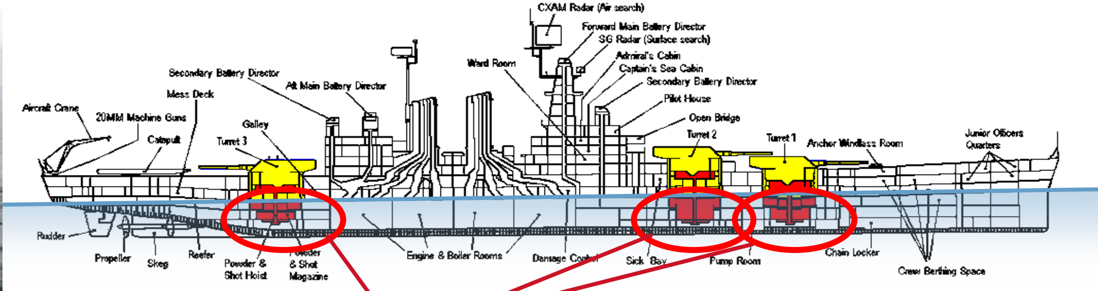
- Introduction
  - LOVA versus IM; IM requirements
    - LOVA characteristics (cook-off, flame temp, ignition, …)
  - Gun propellant developments TNO
- LOVA propellant improvement
  - Aim of the study
  - Experimental
    - Manufacturing
    - Closed vessel test
    - LSP test
- Conclusions

Introduction

Why LOVA propellants?

- IM ammunition components: propellant, igniter/primer, case, charge configuration
- Propellant IM aspects: less sensitive, low energy/explosiveness, high ignition temperatures, high extinguishability (high alpha), low response to shock/fragment impact, good cook-off properties
- LOVA propellants: **cook-off OK**, **bullet/fragment impact ?**
- LOVA propellants often applied in Naval ammunition





Ammo magazines below waterline: low risk of bullet/fragment impact

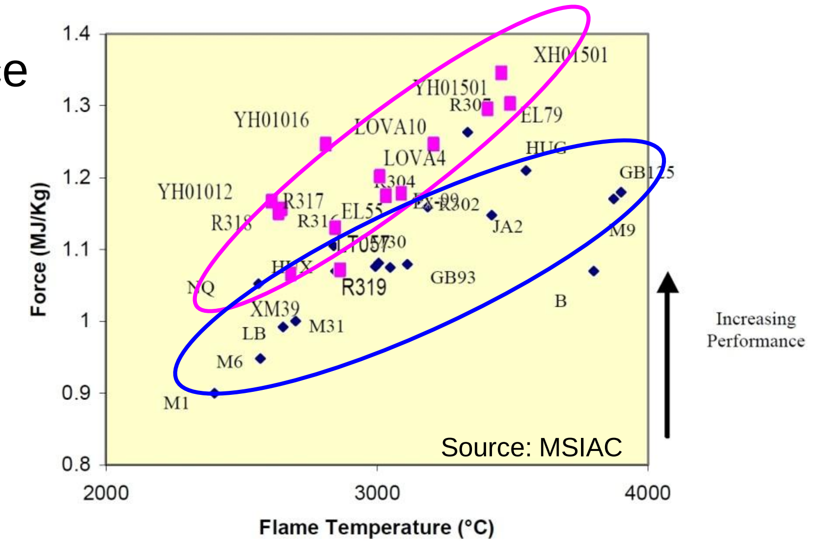
Introduction

What are LOVA propellants?

- Composite gun propellants (not NC-based)
  - Energetic filler: RDX, FOX-7, FOX-12
  - Non- or low energetic binder system: CAB, TPE, plasticizer, …
  - Examples: XM39, M43, NL0XX / NL1XX / NL2XX

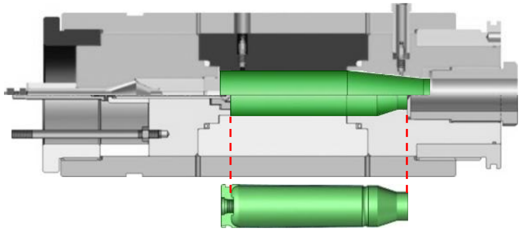
    → good cook-off behaviour
- Low flame temperature / good force
- Ignition difficulties
- Problems related to mechanical properties, especially at cold

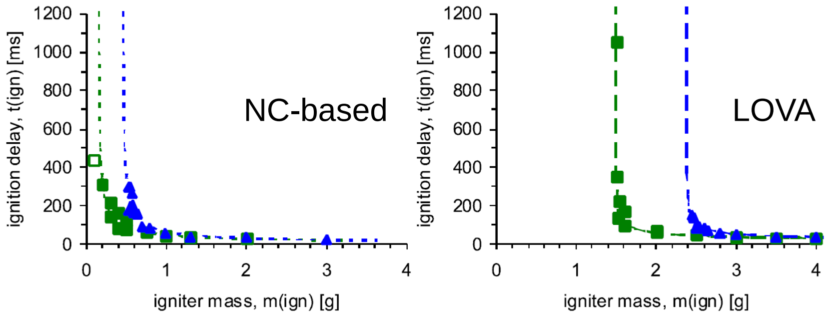
  → affect bullet/fragment impact sensitivity



Gun propellant developments TNO

- Solventless extrusion
  - LOVA propellants: early HTPB, CAB, TPE
  - Also NC-based propellants
- Safety and ballistic properties
  - Thermal safety: stability, ageing, …
  - Ballistic stability/safety: burning behaviour, mechanical properties (bed) compression, 40mm/35mm gun simulator, gun firings
- IM properties
- Propellant ignition
  - New primer comp. for LOVA
  - Plasma primer development (fully IM, T-compensation, green)





[NDIA Joint Armaments Conference 2012, Seattle]

Investigated LOVA gun propellants

Propellants (IBK1000 family)

- Fillers:
  - ~ 75% RDX (bi-modal size distribution)
  - 0 – 10% additional compounds
- Binder systems:
  - CAB / NC / inert plasticizer
  - Non-energetic TPE systems

Thermodynamic properties

- HoE / Force: 4010 – 4050 kJ/kg / 1040 – 1060 kJ/kg
- T_{flame}: 2475 – 2530 K

Geometry

- 19-perf, D = 6.7 mm, web = 0.7 mm, L/D = 1.5

Improvement mechanical properties

Aims

- To improve mechanical properties at low temperature
  - burning properties → prevent high vivacity due to brittleness at cold
  - IM properties (extend suitability for land systems)
- To improve processing properties (solventless)

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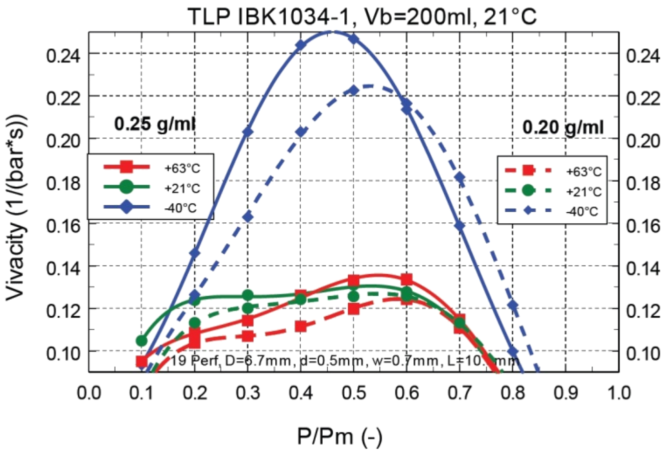


Bad burning properties of RDX/TPE based propellant at low temperature

Manufacturing

- Up to kg-scale production by mixing and ram extrusion
- RDX/CAB based compositions require too high pressures for solventless processing
  - Improvement processing properties by variation of:
    - CAB type
    - Plasticizer content
    - Temperature
- TPE based compositions are relatively easy to manufacture (websizes for large calibre application)

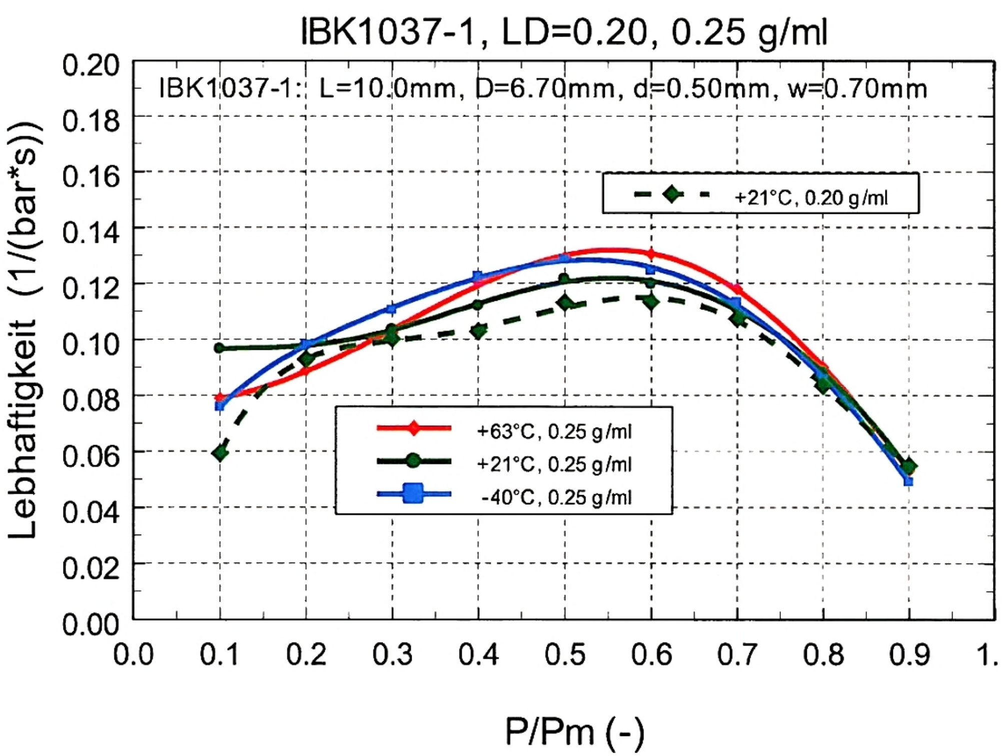

Results

- RDX/CAB based compositions
  - Too high viscosity, even at T > 90°C
  - Increasing viscosity at keeping the compositions at the high processing temperatures (not confirmed by measurements)
  - Extrudable compositions lack sufficient mechanical strength
  - RDX/CAB based propellant compositions: not solventless processable

- TPE based compositions
  - Good processability
  - Scale-up to 2 kg scale

Results

- TPE based compositions
  - Burning properties (closed vessel, charge density 0.2 – 0.25 g/cc)



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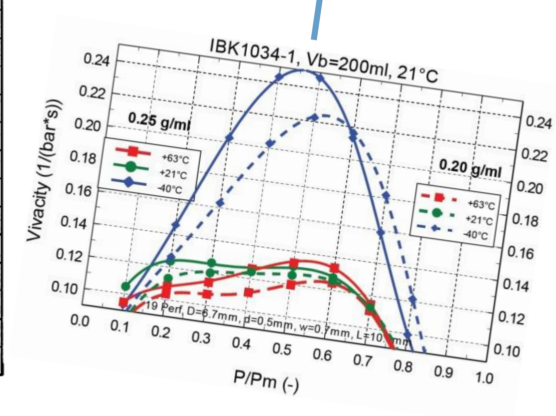
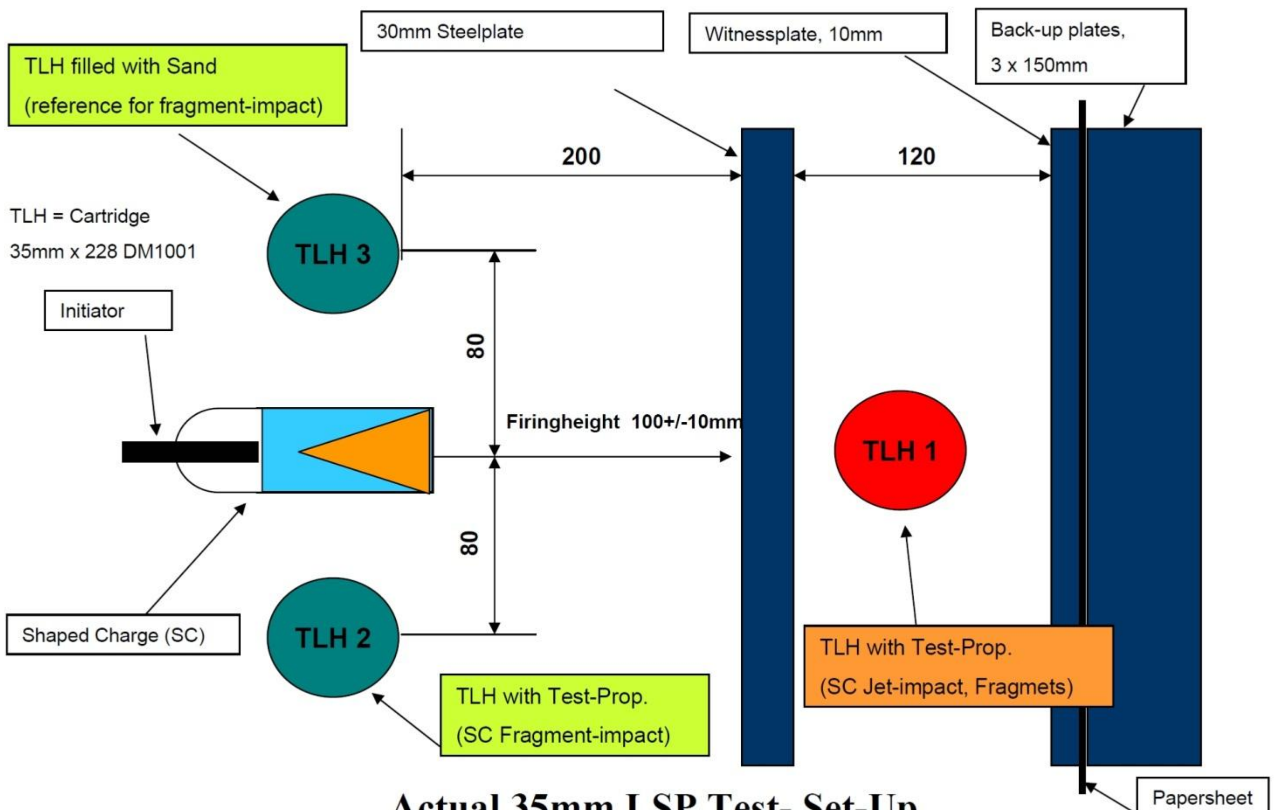


Results

- IM properties: LSP test (Rheinmetall)



Actual 35mm LSP Test- Set-Up

Results

- IM properties: LSP test (Rheinmetall)

Results

- IM properties: LSP test (Rheinmetall)

IBK1037-1

reference (commercially available)

Conclusions

RDX/CAB based LOVA propellant

- No solution found that meets both production and performance requirements

RDX/TPE based LOVA propellant

- Good manufacturing and IM properties
- Improved mechanical properties due to lower glass transition point

Future research

- Improvement die design (smaller websizes for medium calibre)
- Increase burning rate
- RDX replacement

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