Tailored PBX formulations for IM 155mm artillery shells

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EURENCO-France
SUMMARY

1 - State of the art
  11 - process
  12 - formulations

2 – PBX formulations for IM 155 mm shells
  21 - objectives
  22 - method and criteria
  23 - first results
  24 - final selection

3 - Conclusions
Tailored PBX formulations for IM 155mm artillery shells

1 - STATE OF THE ART

11 - PROCESS

Bicomponent process for cast cured explosives (worldwide patented)

Composition is split up in 2 components
A - polymer – additives – explosives filler
B - plasticizer – curing agent
Both components are mixed through a static mixer

Advantages
no pot life limitation
all items are casted at same viscosity
possibility to reduce curing time to less than 24 hours
1 - STATE OF THE ART

Full scale production line commissioned in 2006 – Eurenco Sorgues plant

capacity: 50 000 items 155 mm shells per year
100 000 items 120 mm shells per year

production on line:
- shell preparation
- casting
- curing
- control
- final assembly
- X-ray control
- packing

in the same workshop
1 - STATE OF THE ART

Tailored PBX formulations for IM 155mm artillery shells

Conveyor
Handling robot
X-ray control
X-ray control
Curing oven
Bi component filling machine
1 - STATE OF THE ART

12 – COMPOSITIONS

HBU88B (I-RDX ®)
qualified in 120 mm M934A2 mortar

RH26-2 (I-RDX ®)
qualified in 120 mm tank
qualified in 155 mm artillery
2 – PBX FORMULATION FOR IM 155 mm SHELLS

21 – Objectives

- low level of shock sensitivity to meet sympathetic detonation requirements without any shielding in 155 mm shell pallets
- high level of performances
- feasibility compatible with bi component process
22 – Method and criteria

Formulation
- binder: HTPB
- insensitives fillers: I-RDX and NTO
- total solid fillers: 84 and 86%

Shock sensitivity
- ISGT – Stanag 4488, annex B: $\leq 100$ cellulose acetate cards
- ELSGT – Stanag 4488, annex C: $\leq 50$ mm PMMA thickness

Performances
- Detonation velocity: $\geq 7500$ m/s
- Critical diameter: $\leq 50$ mm
2 – PBX FORMULATION FOR IM 155 mm SHELLS

23 – first results

<table>
<thead>
<tr>
<th>Loading (%)</th>
<th>NTO (%)</th>
<th>I-RDX® (%)</th>
<th>NTO/I-RDX®</th>
<th>ISGT (cards)</th>
<th>ELSGT (mm PMMA)</th>
<th>Critical Diameter (mm)</th>
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<td>84</td>
<td>44</td>
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<td>19 &lt; φ_c &lt; 25</td>
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</tbody>
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2 - FORMULATION FOR IM 155 mm SHELLS

ISGT – Stanag 4488, annex B:

INTERMEDIATE SCALE GAP TEST

- Donnor RDX/Wax
  2 × Ø40 H80 mm
- Acetate cellulose cards
- Acceptor Explosive to be tested Ø40 H200 mm
- Witness plate
- Detonation
- No propagation
2 – PBX FORMULATION FOR IM 155 mm SHELLS

ELSGT – Stanag 4488, annex C:

EXPANDED LARGE SCALE GAP TEST

Donnor
RDX/Wax
Ø95 H95 mm

PMMA
Attenuator

Acceptor
Explosive
to be tested
Ø75 H280 mm

Witness plate

Detonation

No propagation

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2 – PBX FORMULATION FOR IM 155 mm SHELLS

Critical diameter:

![Critical Diameter Graph]

Fail
2 – PBX FORMULATION FOR IM 155 mm SHELLS

24 – final selection

Formulation
- HTPB Binder : 14 %
- I-RDX® : 22 %
- NTO : 64 %
- NTO/I-RDX®: 2.9

Viscosity
- At casting time: 100 Pas
- After 6 hours : 500 Pas

Density
- 1,670

Mechanical properties (20°C)
- Hardness: 70 Shore A
- Tensile test
  - Smt : 0.7 MPa
  - emt : 7.2 %

Shock sensitivity
- ISGT : 95 cards
- ELSGT : 55 mm PMMA

Performances
- critical diameter : 30 < Øc < 36
- Detonation velocity : 7 570 m/s
  (unconfined cylinder Ø 50 mm)
EURENCO France has designed a PBX formulation based on NTO and I-RDX® to get the best trade-off between detonation performances and very low levels of shock sensitivity in order to meet the sympathetic reaction requirement without any shielding in 155 mm shell pallets.

A final sympathetic detonation test remains to be performed with actual 155 mm projectiles in a pallet configuration (planned at the end of 2007).

After the experimental validation, this tailored formulation will enter the official qualification process.
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THANK YOU FOR YOUR ATTENTION