NTO FOR INSENSITIVE COMPOSITIONS

G. ECK, C. SONGY, L. MINGUET
• Introduction

• NTO based compositions for pressed application

• NTO based compositions for melt cast application

• Conclusion
NTO FOR INSENTITIVE COMPOSITIONS

INTRODUCTION

- Intrinsic reduced sensitivity
- Ease of access to complex geometry
- Good mechanical properties
- Wide usable thermal operational range

CAST CURED COMPOSITIONS

Reduction of sensitivity
INTRODUCTION

CAST CURED COMPOSITIONS

PRESSED COMPOSITIONS

MELT CAST COMPOSITIONS

Reduction of sensitivity
Insensitive Munitions (IM) are to be considered as a whole

INTRODUCTION

Explosive

Composition

Ammunition (Design, venting...)

Packaging

Storage

Source MSiAC
Insensitive compositions may be based on:

- TATB
- GUDN or FOX 12
- NTO
- DADNE or FOX 7
• **Introduction**

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NTO FOR INSENTITIVE COMPOSITIONS

PRODUCTION OF NTO BASED COMPOSITIONS

FIRST CHARACTERIZATIONS
Safety, performance, behaviour towards shock, functional

CHOICE OF A COMPOSITION
To be fully characterized
NTO FOR INSENSITIVE
COMPOSITIONS

PRESSED APPLICATION
Production of compositions

![Bar chart showing the production of compositions]
NTO FOR INSENSITIVE COMPOSITIONS

PRESSED APPLICATION Performance

DETONATION VELOCITY

CRITICAL DIAMETER

<table>
<thead>
<tr>
<th>Critical diameter (mm)</th>
<th>A3</th>
<th>RDX0</th>
<th>RDX20</th>
<th>RDX30</th>
<th>RDX50</th>
<th>RDX65</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td></td>
<td></td>
<td>2.2</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>RDX0</td>
<td></td>
<td></td>
<td>&gt; 20</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>RDX20</td>
<td></td>
<td></td>
<td>5-7</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>RDX30</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 5</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>RDX50</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 5</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>RDX65</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 5</td>
<td>&lt; 5</td>
<td>&lt; 5</td>
</tr>
</tbody>
</table>
**NSSWGT**

<table>
<thead>
<tr>
<th>SSWGT (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
</tr>
<tr>
<td>RDX0</td>
</tr>
<tr>
<td>RDX20</td>
</tr>
<tr>
<td>RDX30</td>
</tr>
<tr>
<td>RDX50</td>
</tr>
<tr>
<td>RDX65</td>
</tr>
</tbody>
</table>

**Behaviour towards shock**

- **ELECTRIC DETONATOR**
- **PLEXIGLAS TUBE “B”**
- **DONOR CHARGE**
- **WATER GAP**
- **PLEXIGLAS TUBE “A”**
- **ACCEPTOR CHARGE**
- **PAPER SHEET**
- **WITNESS PLATE**
- **DETONATING CORD**

**Graph:**

- **A3**
- **RDX20**
- **RDX30**
- **RDX50**
- **RDX65**

**Labels:**

- **25 mm**
- **20 SSWGT (mm)**
- **A3 RDX20 RDX30 RDX50 RDX65**

**Legend:**

- **No go**
- **≈ 20**
The mechanical properties are comparable

<table>
<thead>
<tr>
<th></th>
<th>Stress (MPa)</th>
<th>Strain (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>7.0</td>
<td>6.0</td>
</tr>
<tr>
<td>RDX20</td>
<td>8.6</td>
<td>5.2</td>
</tr>
<tr>
<td>RDX30</td>
<td>7.9</td>
<td>6.9</td>
</tr>
<tr>
<td>RDX50</td>
<td>7.3</td>
<td>6.6</td>
</tr>
<tr>
<td>RDX65</td>
<td>6.5</td>
<td>6.3</td>
</tr>
</tbody>
</table>
Compressibility of RDX20

- Max density : 1.84
- % TMD : 98
**RDX20 = The best compromise between insensitiveness and performance**

EURENCO COMPOSITION P16945

<table>
<thead>
<tr>
<th></th>
<th>Composition A3</th>
<th>P16945 = RDX20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical diameter (mm)</td>
<td>2.2</td>
<td>5-7</td>
</tr>
<tr>
<td>Detonation velocity (m/s.)</td>
<td>8470</td>
<td>8350</td>
</tr>
<tr>
<td>PCJ (GPa)</td>
<td>29.9</td>
<td>29.7</td>
</tr>
<tr>
<td>SSWGT</td>
<td>≈ 20</td>
<td>14</td>
</tr>
<tr>
<td>Stress (MPa) Strain (%)</td>
<td>7.0</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>5.2</td>
</tr>
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MELT CAST APPLICATION
Introduction

NTO BASED MELT CAST COMPOSITIONS

NON ALUMINIZED COMPOSITIONS

ALUMINIZED COMPOSITIONS

<table>
<thead>
<tr>
<th>Composition</th>
<th>Density</th>
<th>Detonation Velocity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTO/TNT 50/50</td>
<td>1.654</td>
<td>7370</td>
</tr>
<tr>
<td>NTO/TNT 60/40</td>
<td>1.78</td>
<td>7427</td>
</tr>
<tr>
<td>NTO/TNT 65/35</td>
<td>1.80</td>
<td>7810</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composition</th>
<th>Density</th>
<th>Detonation Velocity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFX 644</td>
<td>1.71</td>
<td>6820</td>
</tr>
<tr>
<td>XF 13333</td>
<td>1.754</td>
<td>7150</td>
</tr>
</tbody>
</table>

Viscosity problem with high NTO contents
STANDARD NTO

- Crystallized NTO: Coarse
- Air milled NTO: Fine

HIGH QUALITY GRADE NTO

- Crystallized according to a controlled crystallization process
- Bulk density and morphology fully controled from the pilot scale to the industrial scale
BULK DENSITY

Pilot scale
- Average: 934 kg/m³
- Standard deviation: 17

Industrial scale
- Average: 935 kg/m³
- Standard deviation: 18

High quality grade of NTO

NTO FOR INSENSITIVE COMPOSITIONS

MELT CAST APPLICATION
NTO FOR INSENSITIVE COMPOSITIONS

MELT CAST APPLICATION
High quality grade of NTO

MORPHOLOGY
• Viscosity is very dependant on the ratio between the coarse and fine fraction
• Best ratio Coarse/fine = 65/35
MELT CAST APPLICATION
Use of NTO CF in Ontalite 65/35

- If NTO CF is replaced by Standard NTO, the viscosity is more than twice higher

<table>
<thead>
<tr>
<th>Fine NTO content (% by weight)</th>
<th>Viscosity (s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard NTO</td>
<td></td>
</tr>
<tr>
<td>NTO CF</td>
<td></td>
</tr>
</tbody>
</table>

- 30 32 34 36 38 40 42 44
Efflux viscosity measurement on aluminized Ontalite NTO/TNT/Al/Wax : 40/30/20/10

Comparison of results obtained with standard NTO and NTO CF
MELT CAST APPLICATION
Use of NTO CF in aluminized Ontalite

Coarse grade 100%

Coarse/fine 70/30

NTO CF 100%

Standard NTO

NTO CF
MELT CAST APPLICATION
Use of NTO CF in aluminized Ontalite

Standard NTO

NTO CF

Viscosity (s.)

Coarse grade 100%

Coarse/fine 70/30

Lab scale

Pilot scale

Industrial scale

NTO CF produced at
EURENCO produces a new high grade of NTO, NTO CF

NTO CF has been proved to be suitable for melt cast application as well as for compositions based on NTO and TNT or compositions based on NTO, TNT and aluminum
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**NTO FOR INSENSITIVE COMPOSITIONS**

**GENERAL CONCLUSION**

**PRESSED APPLICATION**

**COMPOSITION P 16945**

- Based on NTO, RDX and a binder
- Best compromise between insensitiveness and performance
- Performance equivalent to composition A3

**MELT CAST APPLICATION**

**NTO CF a new high grade of NTO**

- High bulk density NTO
- Control morphology of NTO
- Significant improvement of the viscosity of Ontalite
- Suitable as well as for aluminized or non aluminized Ontalites
A special thank for their contribution to:

- C. SONGY and L. MINGUET who coauthored this work
- D. LEGEAY and his team
- S. MOREAU and S. POUDENX for the industrial scale