Impact of REACh, ITAR and other regulations on Energetic Materials Sustainability

G. ECK, M. EL OTHMANI, J. PERQUEL, D. DRU, B. NOUGUEZ

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• Introduction
• Impact of REACH regulation
• Impact of ITAR / EAR regulation
• Conclusion
Europe has to face different regulations:

- **REACH**: Registration, Evaluation, Authorization and Restriction of Chemicals. Adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals.

- **ITAR**: International Traffic in Arms regulations / Export Administration Regulation. Designed to help ensure that defense related technology does not get into the wrong hands.

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2018 IM & EM Technology Symposium, April 23-26, 2018, Portland, OR
INTRODUCTION

EUROPE has to face different regulations

- Replace the critical component by another one that is supposed to be chemically and/or functionally equivalent

- Find new suppliers of the same component

REACH

ITAR

(US/DoD or US/DoC regulations)

EAR

EUROPEAN CHEMICALS AGENCY
INTRODUCTION

GRANULAR EXPLOSIVE

CATALYSTS

BINDER

SOLVENTS

BONDING AGENT

PLASTICIZER

EXPLOSIVE COMPOSITION
INTRODUCTION

GRANULAR EXPLOSIVE

EXPLOSIVE COMPOSITION

CATALYSTS
TPB
ITAR

SOLVENTS
DCE

PLASTICIZER
DBP

BINDER
HTPB R45HT2
EAR

BONDING AGENT
TEPAN
ITAR

2018 IM & EM Technology symposium, April 23-26, 2018, Portland, OR
• Introduction
• Impact of REACH regulation
• Impact of ITAR / EAR regulation
• Conclusion
### Impact of REACH Regulation

#### List of Critical Compounds

<table>
<thead>
<tr>
<th>Impacted compounds</th>
<th>Use</th>
<th>Regulation Impact</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBP</td>
<td>Plasticizer</td>
<td>Prohibited by REACH since 2015</td>
<td>Replacement</td>
</tr>
<tr>
<td>Dibutyl Phthalate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCE</td>
<td>Polymerization solvent</td>
<td>Not to be in use after 2021</td>
<td>Search for a new polymerization solvent</td>
</tr>
<tr>
<td>Dichloroethane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>Jellification solvent</td>
<td>Prohibited by REACH since 2016</td>
<td>Search for a new solvent</td>
</tr>
</tbody>
</table>

**Notes:**
- DBP was prohibited by REACH since 2015.
- DCE is not to be in use after 2021.
- Tetrachloroethylene is prohibited by REACH since 2016.
IMPACT OF REACH REGULATION

PLASTICIZER in the nitrocellulose varnish used for final coating of MACS and CCC

- Replaced by a plasticizer widely used in the cosmetic industry
- Qualification of this new compound completed
  - Chemical compatibilities
  - Combustion quickness
  - Ash percent
  - Permeability
  - Overall qualification of MACS and CCC

DBP Dibutyl Phthalate

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IMPACT OF REACH REGULATION

DCE
 Dichloroethane

SOLVENT
Polymerization of ECH to get PECH, the intermediate polymer in GAP production

- Middle term replacement by a standard organic solvent
  - Organic solvent not yet impacted by REACH
  - Process file ready for scale up to the industrial workshop

- Long term replacement: Research studies to find new ways to polymerize ECH
• Introduction

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### List of critical compounds

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<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTPB R45HT2</td>
<td>Polymer</td>
<td>• Produced in the USA under EAR licence&lt;br&gt;• Difficulties for renewing the end user statement</td>
<td>Find new suppliers</td>
</tr>
<tr>
<td>Copolymer SBS</td>
<td>Thermoplastic copolymer</td>
<td>• Long period supply&lt;br&gt;• Difficulties due to final use</td>
<td>Find an European source</td>
</tr>
<tr>
<td>TEPAN Tetraethylen pentamine acrylonitrile</td>
<td>Bonding agent</td>
<td>• Impacted by ITAR regulation</td>
<td>Find new suppliers</td>
</tr>
<tr>
<td>BiPhi₃ or TPB Triphenyl bismuth</td>
<td>Polymerization catalyst</td>
<td>• Impacted by ITAR regulation</td>
<td>Find new suppliers</td>
</tr>
</tbody>
</table>

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Supplying oh HTPB from a new source and comparison with the current one

**BINDER**
Most used polymer in EURENCO cast PBX compositions

- **Hydroxyl content**
- **Viscosity**

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Qualification of this new source

- Chemical compatibilities with most important granular products
- Evaluation in cast PBX composition in 8 L. mixer ➔ implementation feasibility
- Evaluation in cast PBX composition in 35 L. mixer ➔ implementation feasibility and composition characterization
- Ageing studies at 60°C
- Evaluation in 135 L. mixer
- Evaluation in the proprietary bi-component process
o Qualification of this new source

- Chemical compatibilities with most important granular products
- Evaluation in cast PBX composition in 8 L. mixer ➔ implementation feasibility
- Evaluation in cast PBX composition in 35 L. mixer ➔ implementation feasibility and composition characterization
- Ageing studies at 60°C ➔ In progress
- Evaluation in 135 L. mixer ➔ In progress
- Evaluation in the proprietary bi-component process ➔ In progress
Qualification at 8 L. scale on 6 cast cured compositions

<table>
<thead>
<tr>
<th></th>
<th>B2238B</th>
<th>B2211B</th>
<th>PBXN-109</th>
<th>B2214B</th>
<th>B2263A</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDX</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>HMX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>NTO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>PA</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AI</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTPB</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
- Qualification at 35 L. scale on 3 cast cured compositions

<table>
<thead>
<tr>
<th></th>
<th>B2238B</th>
<th>PBXN-109</th>
<th>B2263A</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDX</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>HMX</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>NTO</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PA</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Al</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>HTPB</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
○ Qualification at 8 L. scale: Characterizations
  • Density
  • Hardness
  • Mechanical properties at +20°C, -45°C, +60°C
  • Sensitivity to friction (ISF) and impact (ISI)

✓ Conform to the specifications
✓ Results equivalent to those for standard industrial compositions

○ Additive characterization at 35 L. scale
  • Friability
B2214 - Stress

B2214 - Strain

B2214 - Hardness

B2214 - Density

• 8 L. scale

IMPACT OF ITAR / EAR REGULATION

HTPB R45HT2

B2214 - Stress

B2214 - Strain

B2214 - Hardness

B2214 - Density

• 8 L. scale

IMPACT OF ITAR / EAR REGULATION

HTPB R45HT2
Supplying of 2 French alternatives (TEPAN N°2 and TEPAN N°3) and comparison with the reference (TEPAN n°1)

<table>
<thead>
<tr>
<th>Characterization</th>
<th>Specification</th>
<th>TEPAN n°1 (Reference)</th>
<th>TEPAN n°2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total amine content</td>
<td>11/15 eq/kg</td>
<td>13.7</td>
<td>13.7</td>
</tr>
<tr>
<td>Water content</td>
<td>≤ 0.50 %</td>
<td>0.28</td>
<td>0.28</td>
</tr>
</tbody>
</table>
Validation in composition

<table>
<thead>
<tr>
<th>Formulation tested</th>
<th>B2238</th>
<th>B2214B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>Compliant with industrial scale</td>
<td>Compliant with industrial scale</td>
</tr>
<tr>
<td>Density</td>
<td>1.572</td>
<td>1.636</td>
</tr>
<tr>
<td>Mechanical properties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Smt (MPa)</td>
<td>0.96</td>
<td>0.60</td>
</tr>
<tr>
<td>- Emt (%)</td>
<td>9.3</td>
<td>10.6</td>
</tr>
</tbody>
</table>
**Supplying of TPB N°2 (Non European supplier)**

**Validation in composition PBXN-109**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>PBXN-109 with US TPB&lt;sup&gt;a&lt;/sup&gt;</th>
<th>PBXN-109 with TPB n°2&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>1669/1683</td>
<td>1669</td>
</tr>
<tr>
<td>Mechanical properties at 20°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sm (MPa)</td>
<td>0.33/0.76</td>
<td>0.61</td>
</tr>
<tr>
<td>- Em (%)</td>
<td>19/55</td>
<td>19</td>
</tr>
<tr>
<td>Shore hardness</td>
<td>44/64</td>
<td>62</td>
</tr>
</tbody>
</table>

<sup>a</sup> Industrial results (36 mixes)

<sup>b</sup> Results at 8 L. scale

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# CONCLUSION

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<tr>
<th>Impacted compounds</th>
<th>Regulation impacts on the supply</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBP / Dibutyl Phthalate</td>
<td>REACH</td>
<td>✔️</td>
</tr>
<tr>
<td>DCE / Dichloroethane</td>
<td>REACH</td>
<td>Long term research studies needed</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>REACH</td>
<td>✔️</td>
</tr>
<tr>
<td>HTPB R45HT2</td>
<td>EAR</td>
<td>Long term program to be completed</td>
</tr>
<tr>
<td>TEPAN</td>
<td>ITAR</td>
<td>✔️</td>
</tr>
<tr>
<td>Copolymer SBS</td>
<td>« Reluctant » supplier</td>
<td>✔️</td>
</tr>
<tr>
<td>BiPhi(_3) / TPB / Triphenyl bismuth</td>
<td>ITAR</td>
<td>✔️</td>
</tr>
</tbody>
</table>
Most of the issues encountered by EURENCO

😊 have been solved (DBP, TCE, TEPAN, SBS, TPB)

😊 or are about to be solved (HTPB)

Of course these regulations cost money

But

➡️ They force us to find alternative solutions sometimes very innovative (DCE)

➡️ They can significantly reduce the exposure of workers to dangerous substances

Overall they are cost effective
• J. PEROUEL, D. DRU, M. EL OTHMANI and B. NOUGUEZ who coauthored this work
• Process team and laboratory team who performed and characterized the compositions
• Bergerac team for MACS and CCC related inputs
Thank you for your attention

Questions?