FOX-7 based Insensitive Cast PBX

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Introduction (1/2)

- EURENCO and the French Research Centre of SNPE Group are working together to manufacture new cast Plastic Bonded eXplosives (PBXs):
  - More and more powerful
  - Less and less sensitive
  - And cost effective, of course!

- FOX-7 is known for:
  - its detonation properties close to the ones of RDX
  - its low sensitivity on raw material and in pressed and melt poured High Explosives

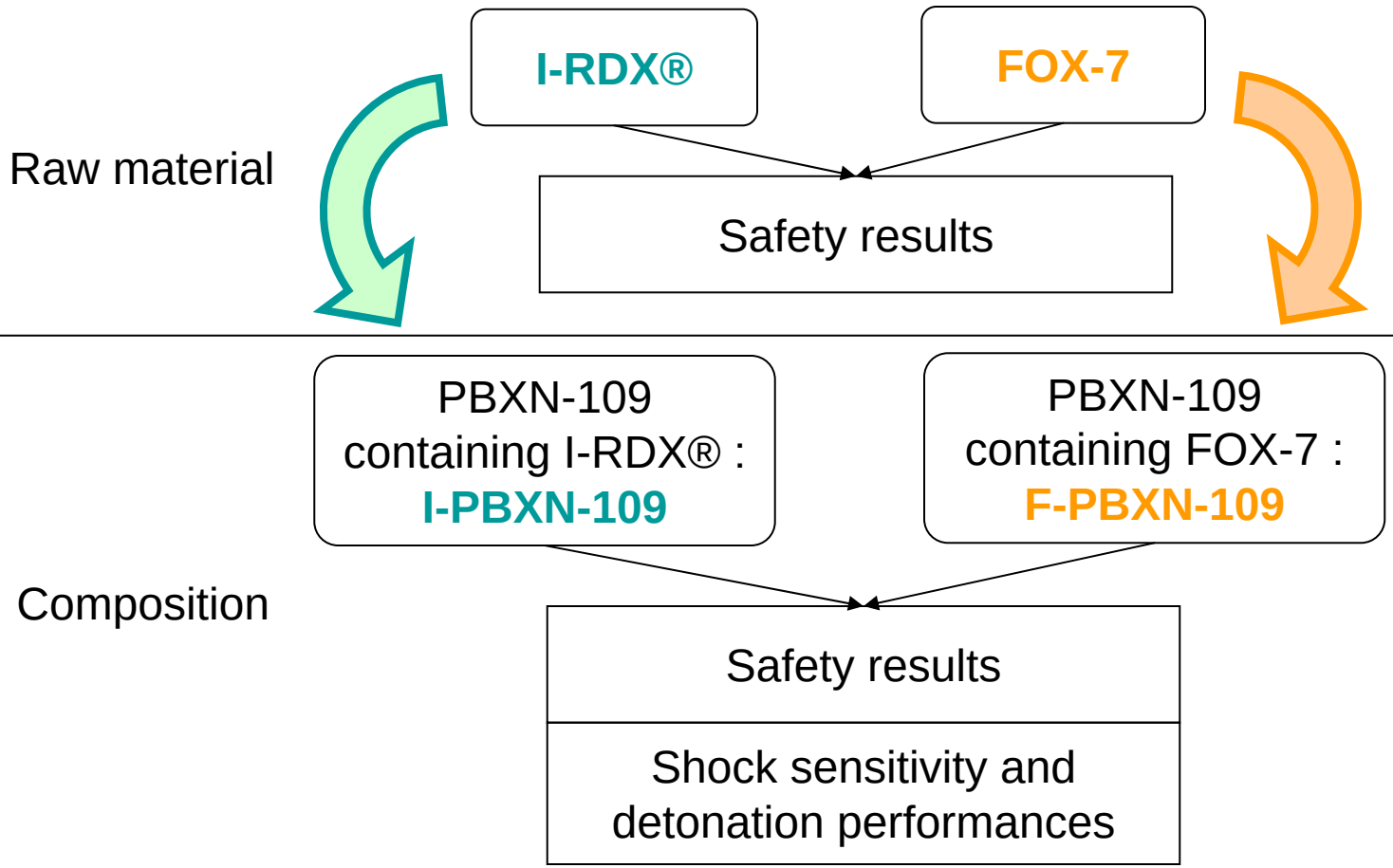
- QUESTION: what would be the result of introducing FOX-7 in a cast PBX ?

- The composition chosen to support this study is the PBXN-109, well known for its low shock sensitivity : 140 acetate cards at French Large Scale Gap Test

- The French version of PBXN-109 contains :
  - I-RDX® : 64 %
  - Aluminum : 20 %
  - Inert binder : 16 %

Introduction (2/2)

❑ Methodology of this study



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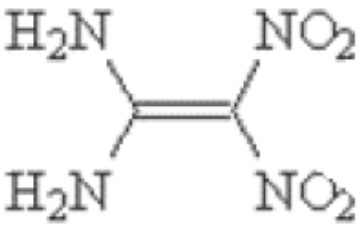
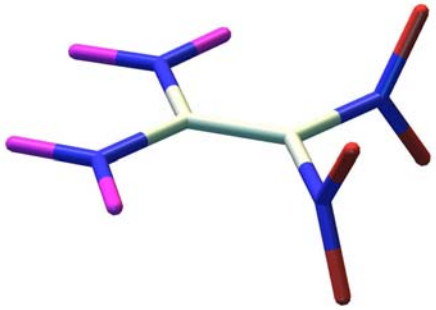
FOX-7 Characteristics

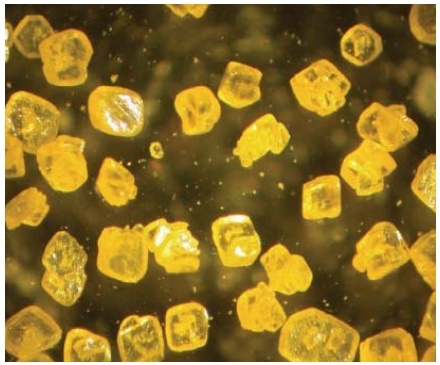
❑ Chemical Formula of FOX-7 molecule



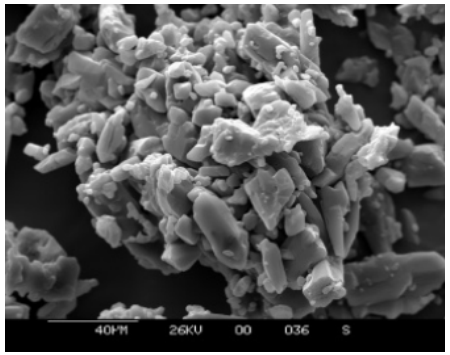


❑ Aspect of FOX-7 crystals

FOX-7 powder



Microscopy picture



SEM picture

FOX-7 Characteristics

❑ Thermochemical and Detonation properties

	FOX-7	RDX
Crystal density (g/cc)	1.885	1.806
Heat of Formation (kcal/mol)	-32.0	-16.5
Activation Energy (kcal/mol)	58	40
Theoretical Det. Velocity (m/s)*	8849	8940
Theoretical Det. Pressure (GPa)*	33.7	34.6

* from CHEETAH v2.0 calculations

The detonation properties of raw FOX-7 are expected to be very close to the ones of raw RDX

FOX-7 Characteristics

❑ Safety Results on raw material

	FOX-7	RDX
Friction Sensitivity (ISF*)	> 350 N	120 N
Impact Sensitivity (ISI)**	20 - 40 J	4 - 5 J
Sensitivity to ElectroStatic Discharge (ESD)	Not sensitive	Not sensitive
Auto Ignition Temperature	215°C	223°C

* corresponding to the French norm AFNOR NF T70-503
** corresponding to the French norm AFNOR NF T70-500

FOX-7 clearly appears less sensitive than RDX at impact and friction

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Preliminary Study

- Estimation of Detonation properties for both compositions with the help of CHEETAH v2.0

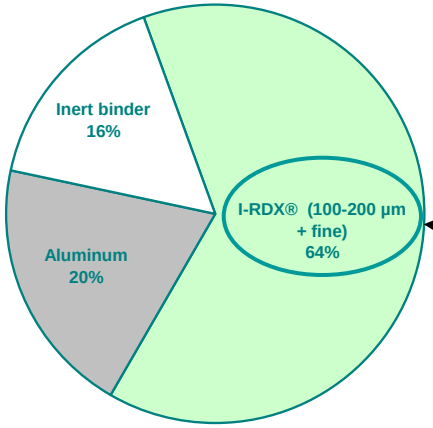
	F-PBXN-109	I-PBXN-109
Density (g/cc)	1.703	1.665
Detonation Velocity (m/s)	7018	7074
Detonation Pressure (GPa)	18.85	19.38
Energy @ V/V0 = 2 (GPa cm^3 / cm^3)	4.30	4.63
Energy @ V/V0 = 7 (GPa cm^3 / cm^3)	6.63	7.11

The use of FOX-7 in PBXN-109 leads to equivalent detonation performances than standard PBXN-109 containing RDX

Formulation Works

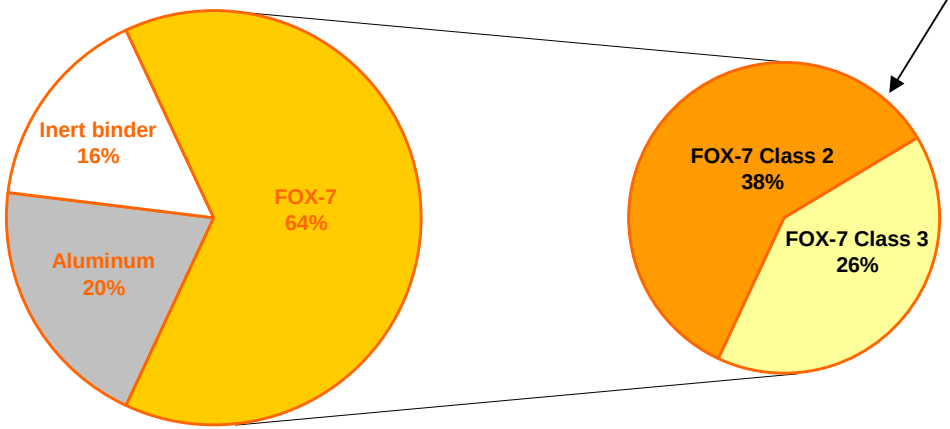
- The total mass of RDX in PBXN-109 (64 wt%) has been substituted by the same mass of FOX-7:

I-PBXN-109:



N.B: 2 qualities of FOX-7 have been used in F-PBXN-109 to comply with the RDX PSD in I-PBXN-109

F-PBXN-109:



Formulation Works

❑ Safety Results

Back to safety res. on raw material

	F-PBXN-109	I-PBXN-109
Friction Sensitivity (ISF)	> 353 N	> 353 N
Impact Sensitivity (ISI)	> 50 J	26 J

→ No more sensitivity difference at friction

→ F-PBXN-109 is less sensitive than I-PBXN-109 at impact

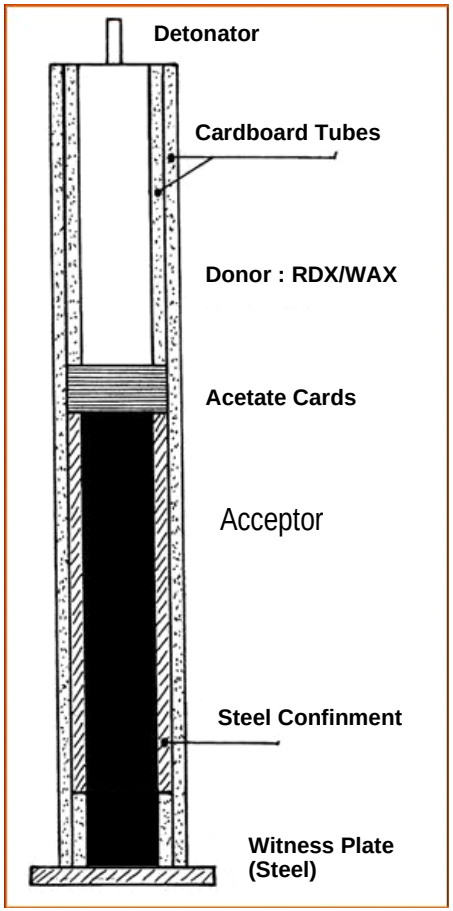
❑ 5 cylinders ∅ 40 H 200 mm of F-PBXN-109 were cured to evaluate:

- Shock Sensitivity at Large Scale Gap test (LSGT)
- Detonation Velocity

Contents

Experimental set up for LSGT

- Description of French Large Scale Gap Test (LSGT) according to STANAG 4488 annex B



Donor: RDX/Wax ∅ 40 mm

Barrier: acetate cards 0.19 mm thick. The result is the number of cards which **does not transmit** the detonation to the acceptor

Acceptor: ∅ 40 H 200 mm in a steel confinement 4 mm thick

Results

- F-PBXN-109 results and comparison with I-PBXN-109:

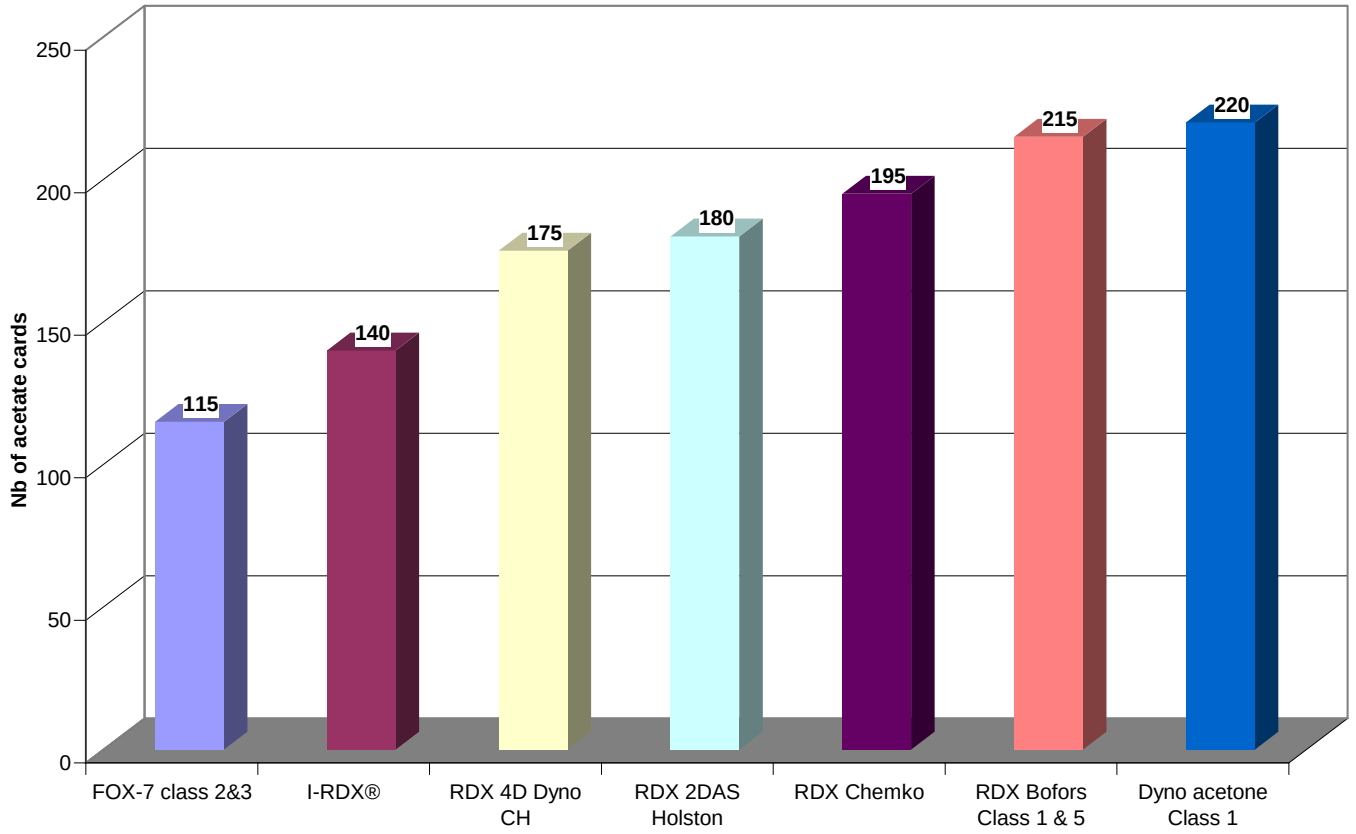
	F-PBXN-109	I-PBXN-109
Crystal quality	FOX-7 class 2&3	I-RDX®
Detonation Velocity (m/s)	7300 ± 50	7527 ± 38
LSGT Result	115	140 ± 5
Pressure in acetate (kbar)	68.2	53.7

→ The Det. Velocity of F-PBXN-109 is 3% lower …

→ … but the initiation pressure is **27 % higher**

Results

- Comparison with PBXN-109s containing miscellaneous qualities of RDX



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  - Chemical and basic properties
  - Safety results on raw material
- Formulation Works
  - Preliminary Study
  - Feasibility and Safety Results
- Experimentations
- Conclusion

Conclusion

- A cast Plastic Bonded eXplosive containing FOX-7 has been successfully realized

- Comparing to regular PBXN-109, the “PBXN-109 like” composition containing FOX-7 exhibits:
  - Equivalent or lower sensitivities to standard safety tests
  - Equivalent detonation properties
  - A significant improvement of shock sensitivity

- These first results concerning the introduction of FOX-7 in a cast PBX are very promising for the industrial development of new Extremely Insensitive Detonable Substances (EIDS)