Recent developments in the formulation of high explosives

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Leader in energetic materials, EURENCO has for many years been producing a complete range of high explosives as well as the compositions based thereof. Thus, EURENCO has a wide knowledge in the field of granulation and coating of explosives and in the formulation of explosives.

To be able to supply customer with less sensitive products, EURENCO works both to improve conventional coating techniques and to develop complete new methods for particle coating in order have efficient IM solutions, matching both melt cast and pressed applications. EURENCO is also involved in formulation improvement studies in the field of melt cast composition as well as cast cured PBX compositions. This paper will present the most recent relevant results in the coating and formulation studies.

1 Coating and granulation studies

Coating is a technique widely used to modify characteristics and to create particles with desired properties. Coating technology is commonly used e.g. in pharmaceutical industry to produce drugs with controlled release speed. In high explosives processing, coating is an important tool to lower sensitivity and to improve pressability.
In most conventional coating processes, the coating material (often some kind of wax or binder) is added (pure or dissolved in an appropriate solvent) to a suspension of liquid (often water) and particles of explosives at elevated temperature. When this mix is cooled down, the wax solidifies at the surface of the explosive.
To be able to supply customer with safer, less sensitive products, better adapted for downstream processing, EURENCO works to improve conventional coating techniques.

1.1 Under-water coating process for production of compositions based on NTO

In the recent years, EURENCO has developed new IM compositions as well as for pressed application than for melt cast application [1][2]. Most of these compositions are based on NTO. Due to the solubility of NTO in water, the conventional coating process is not suitable.

Thus EURENCO has developed under-water coating processes suitable for the compositions based on NTO. These processes have been successfully applied to different compositions such as P16945 (pressed application) and an Ontalite (melt cast application).

1.1.1 P16945

The composition P16945 (RDX/NTO/Binder) is the best compromise between insensitiveness and performance. It is comparable to composition A3 in terms of performance and functional requirements (See Table 1). Due to its characteristics, P16945 is a good candidate for booster application.

Composition P16945 is manufactured according to an under-water coating process. The coating has been transferred from lab scale to pilot scale and to industrial scale (See Figure 1).

Characterization	*Composition A3*	*P16945*
Critical diameter (mm)	2.2	5/7
Detonation velocity (m/s)	8470	8350
PCJ (GPa)	29.9	29.7
SSWGT (mm)	≈ 20	14
Mechanical properties Stress (MPa) Strain (%)	 7.0 6.0	 8.6 5.2

Table 1: Comparative data between composition A3 and P16945

1.1.2 Ontalite (NTO / TNT / RDX)

As for P16945 an under-water coating process has been developed at lab scale for the preparation of IM melt cast compositions based on NTO, TNT and RDX. The transfer to pilot scale is in progress. Thanks to this process EURENCO would be able to offer a well granulated composition to the customer instead of the separate ingredients (See Figure 1).

P16945 Ontalite

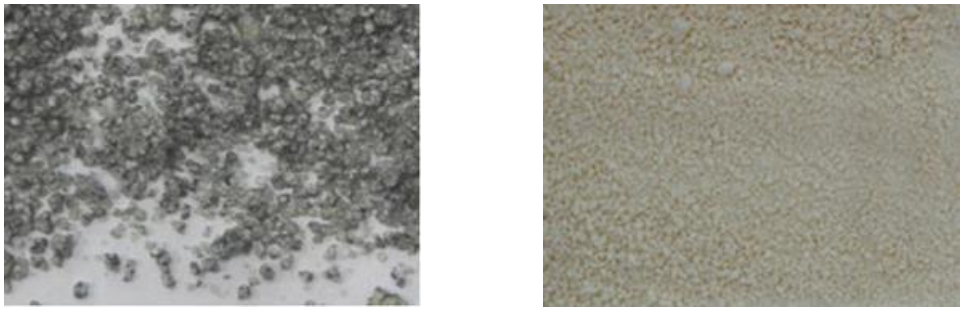


Figure 1: Granulated compositions based on NTO

1.2 New method for particle coating

Microscopic studies of coated material produced by the conventional way often show free crystals of explosives mixed with small lumps of coating material. Despite that, the "coated" material often has significantly reduced sensitivity and better pressing properties than the original material. EURENCO now has developed a completely new process for coating explosive particles. This new technique results in evenly coated particles without any signs of lumps (See Figure 2 and Figure 3). The particles are also significantly less sensitive than conventional, despite less inert material, see Table 2.

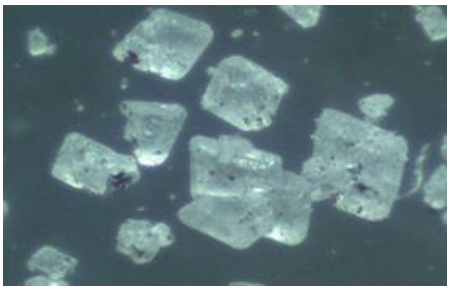
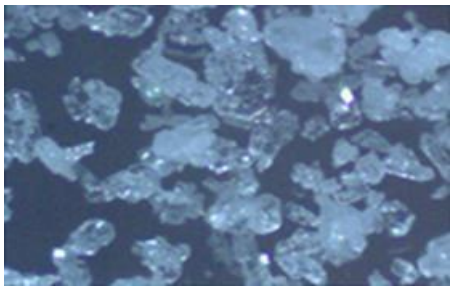


Figure 2: Wax coated HMX *HMX coated with new process (PE)*



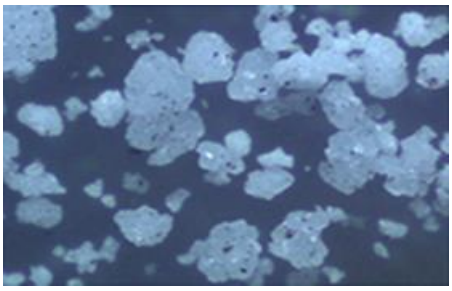


Figure 3: PETN + 7% wax *PETN + 1,5 % PE*

	HMX / wax	HMX / PE	PETN / wax	PETN / PE
Coating mtrl	7	1,5	7	1,5
Vacuum stab. 2 h [ml/g]	0,2	0,135		
Drop hammer D50 [cm]	39,1	74,1	15-20	36-

Table 2*: Comparison between particles coated with conventional technique and new one.*

The new coating technique is so far tested for HMX, RDX PETN and FOX-7 and is now scaled up to pilot scale. Except for better coating and lower impact sensitivity it also gives product with enhanced flowability as well as better work environment.

3 Formulation studies and their applications

As a producer of high energetic materials, EURENCO is also involved in formulation improvement studies in the field of melt cast composition as well as cast cured PBX compositions. A comprehensive presentation was already given in Kishem-2 Symposium dealing with high performance RDX and HMX formulations [3]. Examples in both technologies are proposed hereafter.

3.1 New TNT/FOX-12 composition with good casting performance.

Guntols is a family of high explosive compositions for melt cast applications with TNT as the melting ingredient and the relatively new explosive FOX-12 as crystalline filler. FOX-12 is one of the most insensitive explosives described in the open literature that has a detonating pressure matching military explosives and the performance for Guntol has been found to match or be better than alternative IM fills. The properties for Guntol have been presented at several occasions.

EURENCO has now further improved the Guntol compositions with respect to processability and casting properties. Guntol can easily be casted, using conventional equipment. The process is fast, adhesion good and there are no signs of cracks or voids in the resulting castings (See Figure 4.

Figure 4*: Casted Guntol*

3.2 NTO based insensitive cast PBX for warheads and bombs

Two examples of NTO based cast PBX, fine-tuned by EURENCO, are given in Table 3 with their main characteristics [3]. B2268A was proven to survive shaped charge jet impact in 155mm shell configuration [4], as well as Sympathetic Reaction in full scale Mk82 pallet configuration [5].

Topic	B2267A	B2268A
- Formulation (%)		
HTPB binder	14	13
I-RDX®	22	15
NTO	64	52
Al	/	20
- Viscosity (Pa.s)		
at casting time	100	300
6 hours after casting	250	600
- Density	1.65	1.76
- Mechanical properties (at 20°C)		
Max tensile stress (MPa)	0.72	0.72
Max tensile strain (%)	7.2	8.6
- Hardness (Shore A)	70	71
- Detonation velocity ($m.s^{-1}$)		
Unconfined cylinder Ø50 mm	7570	/
Computed	7680	7440
- ISGT (cards)	95	<1
- ELSGT (mm PMMA)	55	40
- Critical diameter (mm)	$30 < \Phi_c < 36$	$\Phi_c > 50$

Table 3*: NTO based Cast PBX Formulations*

4 Conclusions

EURENCO is mastering the full range of Energetic Materials technologies, from new molecules syntheses to advanced processes such as coating, as well as fine tuning formulations to survive the most stringent stimuli relevant to Insensitive Munition policies.

Based on its knowledge on coating and formulation, EURENCO can also offer to customers:

- Ready to use IM compositions based on NTO or FOX 12.
- HMX, RDX, PETN and FOX 7 coated with PE according to a very new process that gives evenly coated particles without any sign of lumps and with enhanced flowability.

5- Bibliography

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