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HIGH PERFORMANCE MELT-CAST PLASTIC-BONDED EXPLOSIVES

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Canada

line

- Introduction
  - IM melt-cast explosives
- Processability
- Performance
- Shock sensitivity
- Vulnerability
- Conclusion

Introduction

- Most new IM explosives were PBXs
- Recent interest for IM melt-cast explosives
  - Based on DNAN (USA)
  - TNT/NTO (France, Australia, USA)
  - Based on wax (USA)
- Retain the advantages of the melt-cast process
  - Processing
  - Demilitarization
  - Absence of a curing period

Introduction

- Our solution for IM melt-cast explosives
  - Polymer added to existing melt-cast compositions
    - TNT is used as a solvent for the polymer

ETPE in ethyl acetate

TNT

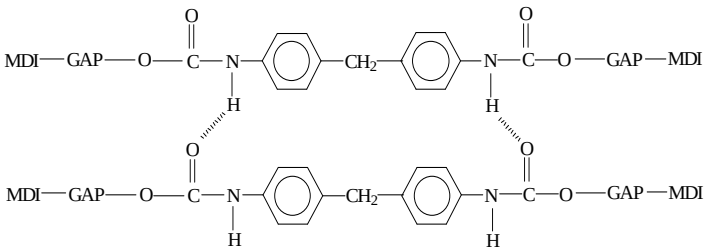
- TNT is
  - Inexpensive
  - Well-known
  - Stable, ages well
  - Has a good performance
  - Available in large quantities from various sources
  - Available from demil. activities
  - Does not harm the environment as much as we thought
  - *Was not produced through environmentally-friendly processes*

IM Melt-Cast Explosive

Comp. B

90 %

+



ETPE

10 %

IM Melt-Cast

Melt-cast mixer →

XRT-10%

High Performance Melt-Cast Explosive

- Use the same ingredients
  - TNT, ETPE, RDX or HMX
- Raise the % nitramines
  - Find the maximum amount of RDX/HMX
- Use PBX equipment to process
  - High viscosity

New High-Performance Melt-Cast Explosive

TNT

17-22 %

+

RDX/HMX

70-75 %

+

ETPE

7.5-10 %

PBX mixer →

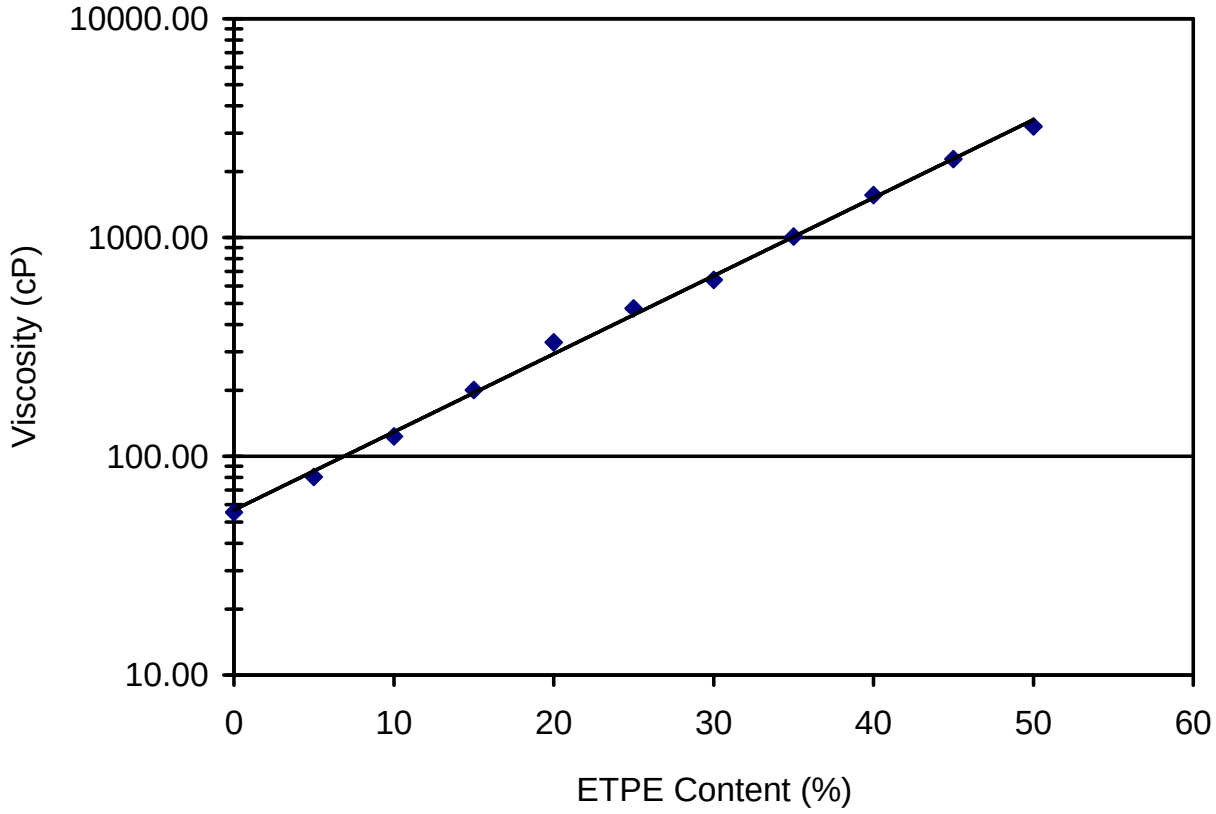
Explosive

Different Explosive

- High performance
  - Possible to beat the performance of Comp. B
    - TNT is a powerful binder
- Melt-cast
  - The mixture of TNT and ETPE is meltable at T° around 75-80 °C
- Plastic-bonded explosive
  - ETPE protects the nitramines
  - Structure from hydrogen bonds

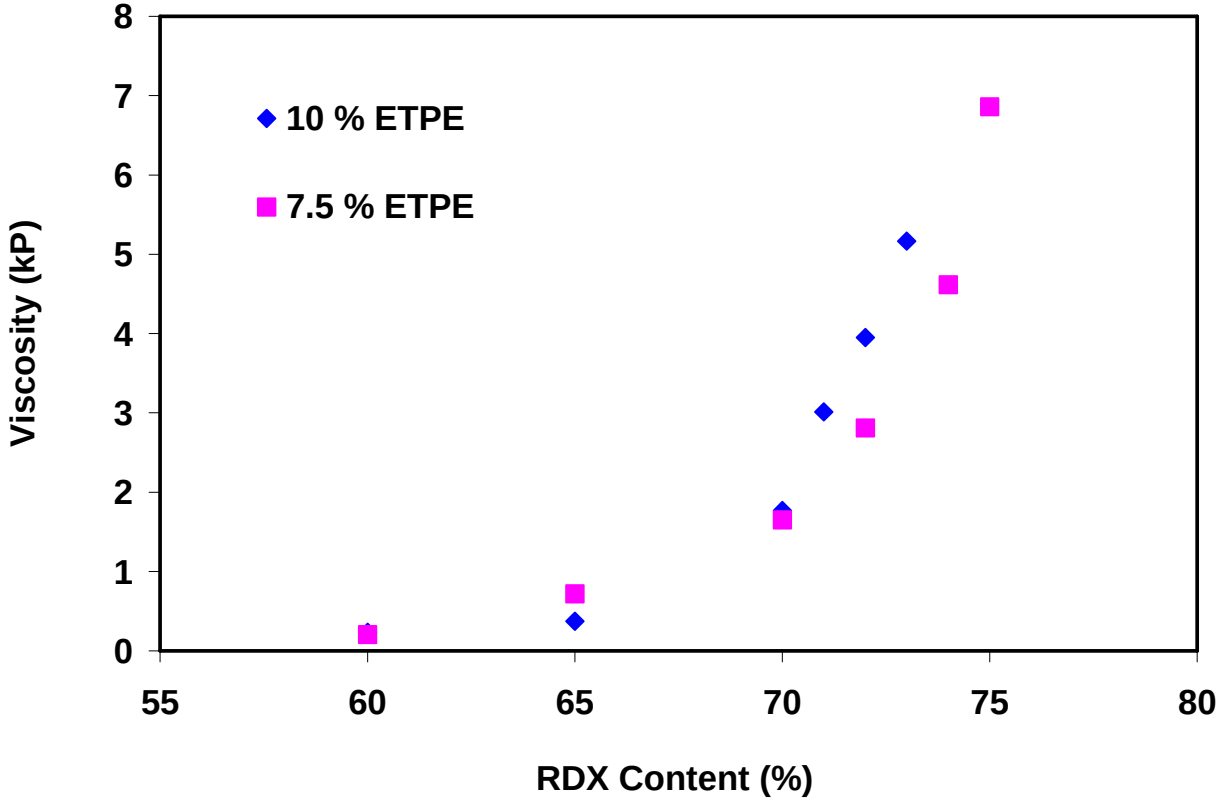
Processability

- Effect of ETPE on the viscosity of TNT



Processability

- Processing limits



Formulations

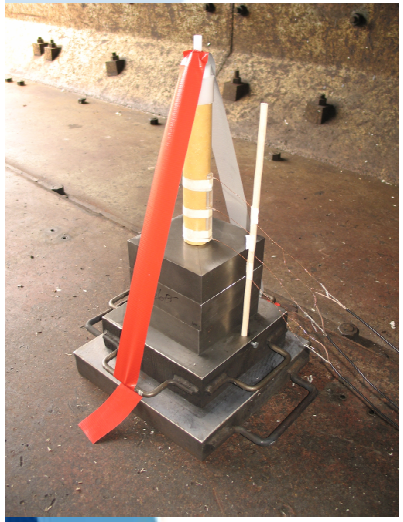
- Selected formulations

Formulation	RDX (%)	HMX (%)	TNT (%)	ETPE (%)	TMD[1] (g/cm^3)	VoD[2] (m/s)	P_{CJ}[3] (GPa)
HV-XRT 1	75		17.5	7.5	1.73	8217	28.8
HV-XRT 2		70	22.5	7,5	1.78	8311	30.4
HV-XRT 3		69.5	20.5	10	1.77	8249	29.7
Comp. B	60		40		1.74	8047	28.1

1. Theoretical maximum density
2. Detonation velocity calculated using CHEETAH 2.0 from LLNL
3. Chapman-Jouguet pressure, calculated

Performance Measurements

- Plate dent tests coupled with VoD measurements



	Exp. density (g/cm^3)	VoD (measured) (m/s)	Plate dent (cm)	Relative performance (% Comp. B)
HV-XRT 1	**1.70**	**8107**	**0.820**	**104.9**
HV-XRT 2	**1.76**	**8160**	**0.841**	**107.5**
HV-XRT 3	**1.73**	**8064**	**0.826**	**105.6**
Comp. B	**1.69**	**7885**	**0.782**	**100**

Shock Sensitivity

- Card GAP tests
  - Less sensitive than Composition B
  - TNT/ETPE ratio has an effect

Composition	Nitramine content (%)	Number of cards
HV-XRT 1	75	203-204
HV-XRT 2	70	171-172
HV-XRT 3	69.5	167
Composition B	60	216
XRT-10%	54	167

Bullet Impact Tests

- On test cylinders
  - 650g explosive
  - Same metal and thickness as a 105mm M1
- 0.5 AP bullets
- 850 m/s

Bullet Impact Tests

- Results
  - Composition with 10% ETPE passed the test
  - Other compositions are borderline

Composition	Reaction Level		
	Sample 1	Sample 2	Sample 3
HV-XRT 1	Type II-III	No reaction	No reaction
HV-XRT 2	No reaction	No reaction	Type II-III
HV-XRT 3	Burning	Burning	Burning
XRT-10%	No reaction	No reaction	Burning

HV-XRT 3

- Processed in standard cast-cured explosive equipment under vacuum
- No curing, 3 hours riser
- 69.5% HMX, 20.5% TNT, 10% ETPE
- Cast density 1.73 g/cm^3
- VoD measured 8064 m/s
- ¼ ρD^2 = 28.12 GPa (1.07 x Comp. B)
- Plate dent = 1.056 x Comp. B
- NOL Card GAP = 167 cards
- Passes the bullet impact test in cylinders

Competing Products

- Cast-cured
  - Life-cycle considerations
    - Melt-cast is re-meltable, recyclable
  - HTPB-HMX
    - High HMX content
      - >86% vs 69.5%
    - Low density of HTPB vs higher density of TNT
- Comparable sensitivity and vulnerability?

Conclusion

- New type of explosive
  - Based on TNT
  - Containing polymers
  - Meltable
  - Processed in PBX equipment
  - Performance better than Comp. B
  - Less sensitive and vulnerable than Comp. B