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DEVELOPMENT OF AN ALTERNATE POLYISOBUTYLENE (PIB) BINDER FOR COMPOSITION C-4

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2007 Insensitive Munitions & Energetic Materials Technology Symposium
Miami, FL
15-18 October 20027

ACKNOWLEDGEMENT

- PM Close Combat Systems
  - Mr. Felix Costa
- RDECOM-ARDEC
  - Mr. Gregory Tremarco
- Co-Authors
  - BAE Systems, Holston AAP
    - **Mrs. Brooke Boggs**
    - **Mr. Brad Smythe**
  - RDECOM-ARDEC
    - **Mr. Paul Vinh**

Outline

- **Background**
- **Objective**
- **Approach**
- **Qualification**
- **Summary**

Background

- **Holston Army Ammunition Plant is the sole qualified producer of Composition C-4 in the U.S.**
- **Composition C-4 is mainly used for demolition purposes**
  - **M112 Demolition Charge**
  - **M183 Demo Kit**
  - **MICLIC**
  - **M18A1 Claymore Mine**
- **Nominal Composition C-4, Cl. 3**
  - **Taggant 1.23%**
  - **Binder 9.88%**
  - **RDX Explosive 88.89%**


Bulk Composition C-4


Bulk C-4 from Boxes

Background

- About 2.3% of the plastic binder in Composition C-4 is polyisobutylene (PIB)
- ExxonMobil has been the only qualified PIB producer - Vistanex MML-120
- ExxonMobil sold the Vistanex trade name to BASF and ceased its PIB production
- Vistanex PIB will not be available in CY08
- BASF will only market its own PIB – Oppanol
- PM-CCS initiated this effort to qualify BASF Oppanol PIB

Objective

- Qualify a new source of polyisobutylene for use as binder in Composition C-4

Approach

- **Completed market survey**
- **Three grades of BASF Oppanol were analyzed for MIL-P-13298, polyisobutylene compliance**

Specification	*MIL-P-13298 PolyIsoButylene Specification*		BASF Oppanol B-100	BASF Oppanol B-150	BASF Oppanol B-200	ExxonMobil Vistanex MML-120
	Min.	*Max.*				
Intrinsic Viscosity	3.15	3.72	3.250	*5.177**	*6.554**	3.62
Iodine No.		1.32	*1.46**	0.7462	0.4048	0.89
Chlorine, %		0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acidity, % AS HCL		0.01	*0.011**	0.005	0.009	0.000
Insoluble Matter		0.20	0.00	0.01	0.00	< 0.20
Color	*</= standard*		< std	< std	< std	< std

* Failed Specification

Approach

- **Five lab-scale batches (2 lb/batch) produced with various Oppanol PIB grades meet MIL-C-45010 for Composition C-4**

Specification	*MIL-C-45010A Comp C-4, Class 3 Specification*		Comp C-4 with B-100	Comp C-4 with B-150	Comp C-4 with B-200	Comp C-4 with 70% B100 & 30% B150	Comp C-4 With MML-120
C-4 Batch #			1039-100	1039-102	1039-103	1039-107	1039-105
	Min.	*Max.*					
% RDX	*89.8*	*91.2*	90.13	90.52	90.48	90.42	90.62
% Binder	*8.8*	*10.2*	9.87	9.48	9.52	9.58	9.38
% Moisture		*0.25*	0.0120	0.0048	0.0047	0.0047	0.0300
USSS 40		*0*	0	0	0	0	0
USSS 60		*5*	0	0	0	0	0
Plasticity	*0.018*		0.052	0.052	0.023	0.037	0.057

Approach

- All 5 C-4 lab samples (4 test samples and 1 control) were rheological tested at the ARDEC Energetic Rheology Lab
- Instron Capillary Rheometer was used
  - Measures the apparent viscosity (Pa*s) versus the apparent shear rate (1/s)
  - Composition C-4 apparent viscosity decreases with increasing apparent shear rate
- Testing of lab samples yielded inconclusive results
  - Typical behavior of Composition C-4 not made on production-scale equipment


Instron Rheometer

Approach

- Rheological testing all 5 lab samples (4 test samples and 1 control) at ARDEC yielded inconclusive results
  - Typical behavior of Composition C-4 not made on production-scale equipment

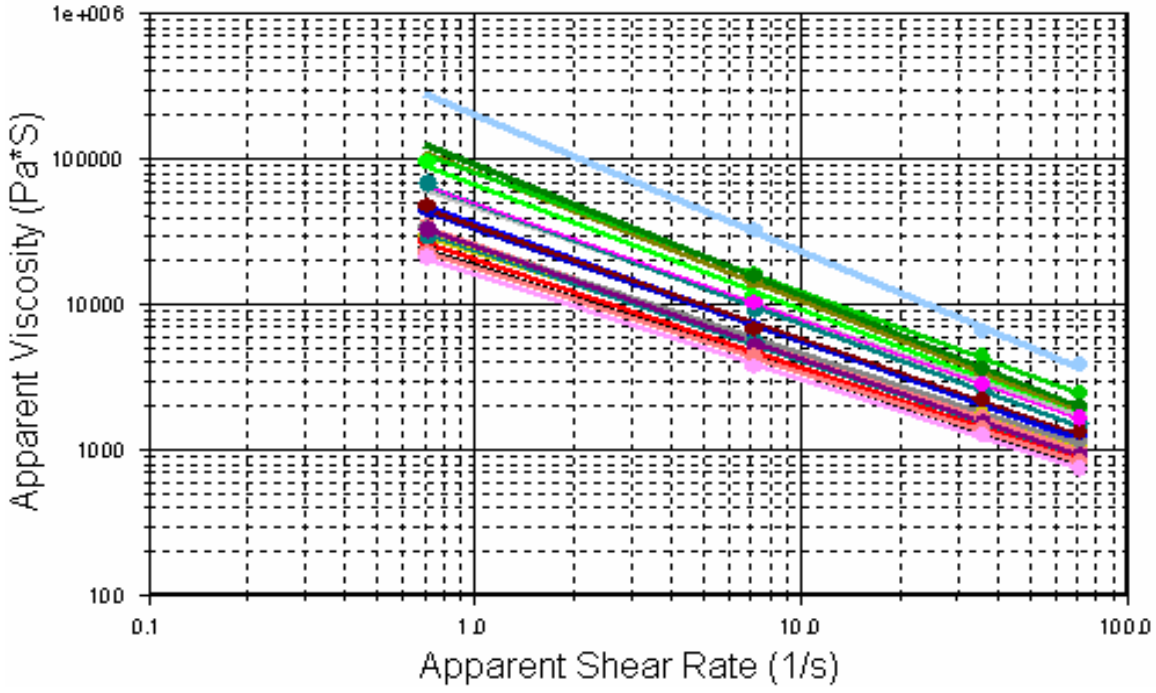

Figure 1: Typical Rheology Results of C-4 Production Batches

Qualification

- Oppanol B-150 and B-200 were selected for qualification:
  - B-100 fails 2 specification requirements on chemical properties
  - B-150 and B-200 fail on viscosity which may only affect their processing
  - Intrinsic Viscosity
    - Current specification for PIB appears to have been derived from the ExxonMobil own product specification
    - B-150 and B-200 have higher intrinsic viscosities
    - Intrinsic viscosity affects flow, i.e., the higher value, the more viscous is the product
  - Higher molecular weight PIB
    - More elastic
    - Higher recovery after extension

Qualification

- Composition C-4 production batches have been produced
  - Three 4,000 lb batches with Oppanol B-150
  - Three 4,000 lb batches with Oppanol B-200
  - C-4 from a standard PIB Vistanex MML-120 production lot
  - All batches have been tested for MIL-C-45010A compliance
- Did not produce Composition C-4 batches having a blend of B-150 and B-200 (70% B-100/30% B-150)
  - No blending among the various PIB grades
  - Cross-blending may create potential complication due to the possibility that one of the product grades may be discontinued
  - PIB will be procured from a single source with two different grades

Qualification

- **All 6 Composition C-4 production batches produced with Oppanol PIB meets MIL-C-45010 specification requirements**

Specification	*MIL-C-45010A Comp C-4, Class 3 Specification*		Comp C-4 with B-150	Comp C-4 with B-150	Comp C-4 with B-150	Comp C-4 with B-200	Comp C-4 with B-200	Comp C-4 With B-200
C-4 Batch #			C403-7577	C403-7578	C403-7579	C403-7580	C403-7581	C403-7582
	Min.	*Max.*						
% RDX	*89.8*	*91.2*	90.6	90.5	90.6	90.2	90.2	90.2
% Binder	*8.8*	*10.2*	9.4	9.5	9.4	9.8	9.8	9.8
% Moisture		*0.25*	0.03	0.02	0.01	0.07	0.04	0.05
USSS 40		*0*	0	0	0	0	0	0
USSS 60		*5*	0	0	0	0	0	0
Plasticity	*0.018*		0.176	0.131	0.142	0.140	0.167	0.117
% DMDMB	*1.00*	*1.50*	1.14	1.30	1.40	1.38	1.18	1.16

Path Forward

- All Composition C-4 batches will be shipped to a Load/Assemble/Pack facility, either Crane Army Ammunition Activity and/or Milan Army Ammunition Plant for extrusion
  - Test IAW MIL-DTL-50523, M112 Demolition Charge
  - Evaluate extrusion performance with standard Composition C-4
- Complete qualification of Oppanol B-150 and B-200 at ARDEC with testing of thermal, sensitivity, performance, rheology characteristics, and aging evaluation of Composition C-4 with both PIBs

Summary

- Vistanex MML-120 polyisobutylene has been qualified for use in Composition C-4
- ExxonMobil, Vistanex MML-120 producer, will no longer manufacture PIB
- Vistanex will not be available in CY08
- BASF produces a similar PIB product named Oppanol
- Two grades of BASF Oppanol are being qualified for use in Composition C-4
  - Production test batches have been manufactured
  - Testing will soon be initiated