Reclamation and Reformulation of TATB from PBX-9502 and LX-17

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TATB Overview

- TATB (Triaminotrinitrobenzene) is a critical insensitive explosive
- Main component in a number of DoD/DoE booster and fuze weapon assemblies
- Production-scale manufacturing source no longer existed in Western-world countries
- Joint DoD/DoE initiative created to restore U.S. TATB manufacturing capabilities
- BAE Systems at HSAAP downselected as contractor to manufacture TATB
TATB Recovery and Reuse

- TATB Manufacturing Facility recently built at HSAAP (TATB Qualification in 2013)
- As a overall risk mitigation effort to the Facilitization Program, DoD desired alternate source of TATB be pursued
- The US DoE has a surplus of PBX-9502 and LX-17 machine cutting available
- BAE Systems initiated a program with DoD/DoE to recover TATB from surplus DoE machine cuttings for potential reuse in DoD weapons applications

Focus of program at HSAAP

LX-17 Machine Cuttings  PBX-9502 Machine Cuttings

Non-Export Controlled Information- Releasable to Foreign Persons//S2DSEA2013-0502
Machine Cuttings

PBX-9502
95% TATB
5% Kel-F 800 binder

LX-17
92.5% TATB
7.5% Kel-F 800 binder
Red Dye
Program Overview

**Phase 1: Lab-Scale Reclamation Development**
- TATB recovery parameters developed and optimized on the lab-scale
- Novel test methods developed for recovered TATB
- Data assessed by Joint TATB team

**Phase 2: Reclamation and Reformulation Prove-Out**
- Optimized recovery parameters demonstrated on the multi-pound scale
- Recovered TATB formulated into PBXN-7 and PBXW-14 for DOD evaluation

**Phase 3: Production-Scale Reclamation and Reformulation**
- Reclamation and reformulation scaled to production at HSAAP
- Over 12,000 lbs of TATB reclaimed from machine cuttings
- Formulation of PBXN-7 and PBXW-14 with reclaimed TATB
- PBXN-7 and PBXW-14 currently in qualification
Phase 1: Lab-Scale Reclamation

**Reclamation Development**

- TATB recovery parameters developed and optimized on the lab-scale using 3-L still
- Process parameters for reclamation: solvent type, temperature, solvent:PBX ratio, and extraction time
- Key Measurements of reclaimed TATB: Particle Size and Residual Kel-F 800 Binder
  - Process found to be solvent dependant for amount of residual binder
  - Particle size of reclaimed TATB very similar for all reclamation conditions
Size Distribution of TATB from PBX-9502 and LX-17

- Reclaimed TATB from PBX-9502 has smaller particle size than virgin Benziger TATB
- Attrition of crystals is indicative of the TATB crystals being fractured during the PBX processing and pressing.
- TATB from LX-17 smaller than from PBX-9502 (WA-TATB)
Phase 2: TATB Reclamation Scale-Up

- The optimized reclamation parameters were scaled-up in the laboratory to the kilogram scale.

- Two 1-kg samples of TATB were reclaimed at this scale from both PBX-9502 and LX-17 using an 18-liter still.

- Reclaimed TATB particle size similar to Phase I effort. Residual binder on the TATB <0.2%
Phase 2: PBXN-7 / PBXW-14 Formulation

- The reclaimed TATB was formulated into PBXN-7 and PBXW-14 using the standard Holston laboratory procedure and equipment.

- A total of four samples were produced:
  - 1 kg PBXN-7 from PBX-9502 TATB
  - 1 kg PBXN-7 from LX-17 TATB
  - 1 kg PBXW-14 from PBX-9502 TATB
  - 1 kg PBXW-14 from LX-17 TATB

- The formulations processed the same as virgin Benziger TATB.

- All 4 batches passed the standard Mil-Spec testing, including:
  - Composition, granulation, bulk density, pressed density, impact, VTS.
Phase 2: PBXN-7 Formulation

N-7 From Benziger TATB

N-7 From Reclaimed TATB
Phase 2: SSGT Results

- Small scale gap testing (SSGT) was performed on PBXN-7 using reclaimed TATB to compare relative performance with PBXN-7 made with Benziger TATB.

- Testing was performed at Reynolds System Inc (RSI).

- Testing was performed at -60 °C to provide worst case shock initiation data.

- Difference in shock sensitivity is less than 1%, which is well within lot-to-lot variation.

Shock initiation characteristics of both PBXN-7 samples are the same and would perform in initiation systems with the same degree of reliability.
Phase 3: TATB Reclamation in Production

- The reclamation process scaled to the Agile Manufacturing Facility at HSAAP (G-10)
- Reclamation performed in 6,000 gallon still
- Extracted TATB from both PBX-9502 (8,000 lbs) and LX-17 (6,500 lbs)
- Extraction solvent distilled and reused
Phase 3: TATB Reclamation in Production

- TATB reclamation effort in production complete:
  - PBX-9502: 7,000 lbs of TATB recovered (3 Batches)
  - LX-17: 5,200 lbs of TATB recovered (3 Batches)

- All batches met the residual binder specification

- Reclamation solvent distilled after each batch and reused, with no loss or effect on binder removal

- TATB tested by the new military specification, including:
  - Purity Analysis by HPLC, GC
  - Chlorine Content
  - Particle Size/Shape Analysis
  - Safety Data (Impact, Friction, ESD)
  - Thermal Analysis by DSC, VTS
  - BAE Holston Residual Binder Test
Phase 3: PBXN-7 and PBXW-14 Production Formulation

- PBXN-7 and PBXW-14 formulated using reclaimed TATB:
  - Standard production building (G-6) utilized for these products
  - Batches produced using a 500 gallon vacuum still.
  - PBXW-14: 1,500 lbs of material produced (3 batches)
  - PBXN-7: 1,500 lbs of material produced (3 batches)

- Material Qualification:
  - All batches passed acceptance testing and initial FAT Testing
  - Bulk Density, granulation, and pressed density excellent for all of the batches.
  - Finalizing 6-month aging and cold-temperature SSGT

- PBXN-7 and PBXW-14 sent to customer for further evaluation and formal DoD qualification
Summary

- The reclamation process of TATB from PBX-9502 and LX-17 was initially developed and optimized on the lab-scale at HSAAP.

- The process was then scaled to full-scale production. The developed reclamation process was optimized to use existing infrastructure at HSAAP.

- Reclaimed TATB was formulated into PBXN-7 and PBXW-14 using existing procedures and infrastructure. BAE Systems and DOD conducted full qualification testing on both materials.

- Reclaimed TATB is available and can be provided at a reduced cost compared to Benziger TATB. DOD customers have already expressed interest for some applications.
Additional TATB Presentations

Session 6A (10:40 AM Wednesday):
“Establishment of TATB Manufacturing Process at Holston Army Ammunition Plant”
– Mike Ervin (BAE Systems)

Session 7A (1:00 PM Wednesday):
“Manufacture of Wet-Aminated TATB at the Holston Army Ammunition Plant”
- Dr. Jacob Morris (BAE Systems)

Session 7A (1:40 PM Wednesday):
“Comparison of DOTC and Legacy Benziger Dry-Aminated TATB and PBX-9502”
- Dr. Mark Hoffman (LLNL)