US ARMY RDECOM

U.S. Army Research, Development and Engineering Command

Malcolm Baldrige National Quality Award 2007 Award Recipient

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER PICATINNY ARSENAL, NJ

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Nitrotriazolone Process Optimization

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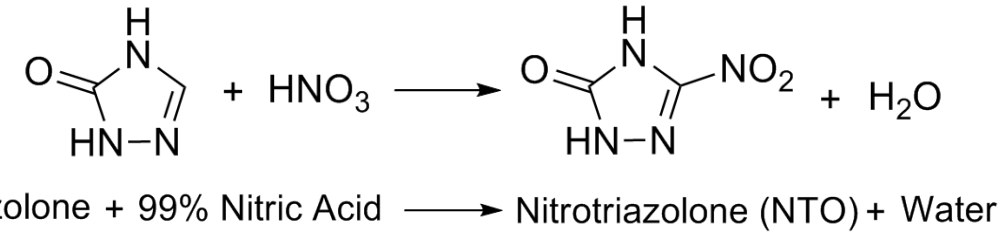
- US ARMY PM-CAS
  - Technology Transfer Customer
- BAE Systems
  - Research & Development Analytical Labs
  - Production / Design Teams

Program Objectives

- Optimize NTO re-crystallization process to increase product yield without affecting quality
  - Identify key process metrics that can be optimized
  - Quantify and verify process parameters in laboratory environment
  - Implement and verify process improvements on manufacturing scale

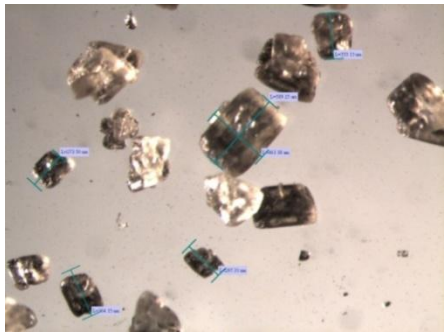
Background

- Nitrotriazolone
  - NTO is a key constituent being integrated into new energetic material formulations (IMX-101 & IMX-104)



Triazolone + 99% Nitric Acid ⟶ Nitrotriazolone (NTO) + Water

  - NTO has similar performance to RDX with improved IM characteristics
  - IMX explosive formulations are the high explosive loads in IM artillery projectiles and mortar cartridges



Background

- Nitrotriazolone
  - Demand for NTO will increase substantially to comply with insensitive munitions requirements
    - IMX-101 Qualified by the U.S. ARMY as main fill explosive in the 155mm M795 Artillery Projectile.
    - 2.1 M lbs annual NTO quantity required for IMX formulations
  - It is anticipated that other munitions which use traditional energetics (Comp B or TNT) will utilize the same or variant compositions containing NTO
  - NTO yield is not fully achieved. As a result, manufacturing costs are high ($15/lb). Current manufacturing technique prevents full recovery of NTO

155mm M795 Projectile

ManTech Solution

- Develop / modify manufacturing techniques to permit full or nearly full recovery of NTO in bench scale environment
- Verify NTO crystal size, shape and morphology meets or exceeds military specifications
- From bench scale, develop design for facility modifications and/or equipment additions to optimize NTO manufacturing process
- Implement and verify process modifications at Holston AAP, G-10 Agile Manufacturing Facility

Benefits

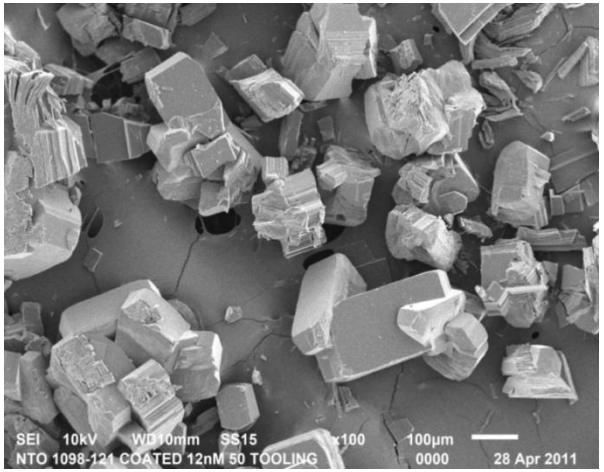
- Optimized NTO manufacturing process
  - Increased NTO yield and recovery
  - Increased yield per batch, lower NTO cost
  - Improved production control to attain consistent NTO yield and recovery

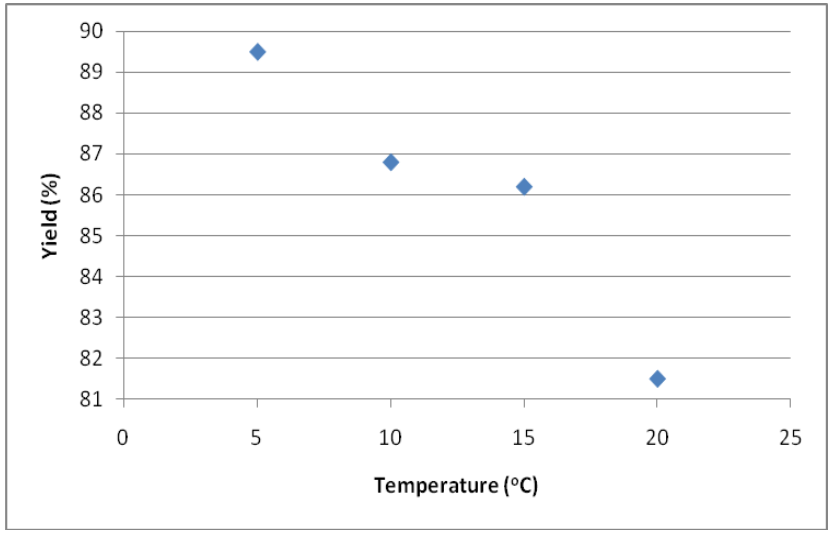
Achievements

- Analytical Analysis
  - Equipment
    - 2-L Mettler-Toledo Reaction Calorimeter
    - Fully automated, integrated with PC for data collection
- Design of Experiments
  - DOE Variables: Final Temperature, Cooling Rate, NTO Concentration, Agitation, Hold Temperature
  - Experiments were set up so that each time a variable was changed (i.e. cooling rate, NTO concentration, etc), the yield and quality of NTO produced was looked at each of the four final temperatures (20, 15, 10, 5 °C)

Achievements

- DOE Results/ Conclusions
  - Lowering the final temperature has the most noticeable impact on yield.
    - Changing the baseline parameters rarely changed the crystal size & morphology
    - Verified crystal structure and morphology using optical and scanning electron microscopes
    - NTO purity verified thru HPLC
  - Lowering NTO temperature down to 5deg C has no little affect in quality
  - An increase as high as 10% NTO yield
  - DOE results fed into the process design





Achievements

- Completed Process Design
  - Incorporating chiller / refrigeration system
    - Due to the energy consumption in the chiller, the design incorporates river water to initially cool during re-crystallization.
    - “Chilled” water will then cool to desired temperature
  - Integrating new chiller controls with existing control system
- Implementation
  - Procured long lead process equipment
  - Anticipated equipment arrival April - May 2012

Upcoming Milestones

- NTO production facility scheduled for 6-month shut down
- Install, integrate, and prove-out facility improvements
- Verify NTO production yield and quality
- Transition to production by end of CY2012

Summary

- Decreasing NTO re-crystallization temperature increases NTO product yield
  - At 5 deg C, NTO yield increases by 10%
  - Low re-crystallization temperature does not affect the overall quality of NTO
- FY12 milestones include procuring, installing, and integrating refrigeration / chiller system. As well as, prove-out process improvements and verify program metrics.

Questions