Pilot plant synthesis of triaminotrinitrobenzene (TATB)

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Abstract

1,3,5-Triamino-2,4,6-trinitrobenzene (TATB) is an extremely insensitive high explosive used in a variety of DOD and DOE applications. This paper describes the scale-up of TATB to the pilot plant level from an innovative baseline route that starts from commonly available reagents and does not involve harsh conditions, chlorides, or halogenated or otherwise environmentally unfriendly reagents. Also discussed will be some challenges that have been encountered at the pilot plant, which required substantial route development to yield a safer and more production efficient process. The TATB produced from this pilot plant effort will be evaluated against material produced through the traditional method, which utilizes trichlorobenzene as starting material.

Introduction

Previous presentations detailed the scale-up synthesis, from lab to pilot plant, of TATB from a novel route.[1] This effort, which was funded by the United States Navy, sought a process to replace the current production of TATB from 1,3,5-trichlorobenzene. Starting from 1,3,5-trihydroxybenzene (phloroglucinol), the current route circumvents the use of reagents and production of by-products (1,3,5-trichlorobenzene and associated chlorinated nitroaromatics) with undesirable environmental consequences. In addition, reaction conditions are much milder than the conventional production conditions (no high temperature or pressure). The waste streams from the phloroglucinol route are readily amenable to remediation by conventional waste treatment options (biodegradation), and overall process yields are high (>81%). The current report will detail the transition of the process to the pilot plant, the significant process changes that have been made in light of an incident with a key TATB intermediate, and the results of the production scale runs.

Discussion

As initially reported, a route to TATB from phloroglucinol was advanced from the bench top to pilot plant scale.[1] This route followed a method first described by Bellamy and co-workers, and later extensively developed at ATK Thiokol.[2] It involved a three-step, three-reactor process that sequentially transformed phloroglucinol to trinitrophloroglucinol (TNPG), 1,3,5-triethoxy-2,4,6-trinitrobenzene (TETNB), and TATB (Figure 1).

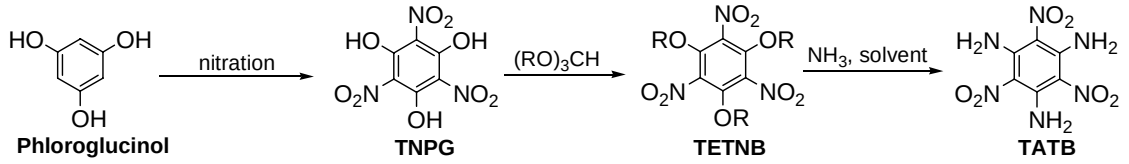

Figure 1. TATB reaction sequence

Each step and all products had been carefully evaluated to ensure that the process as developed would be suited to production in the existing energetic material pilot plant facility. The first two intermediates, TNPG and TETNB, had been successfully transitioned to the production facility when an incident involving the transfer and handling of TETNB brought the effort to a standstill. At 10:45 p.m. on February 14, 2005, a fire occurred in the R&D pilot facility as two technicians were transferring TETNB from a filter tray into 5-gallon plastic buckets. The fire claimed the life of one technician and left the other severely burned. Extensive damage was done to the bay where the transfer operation was taking place, but the building as a whole was left intact and relatively unharmed.

As a result of this incident, several actions were undertaken to enhance the safety of both the process and the facility. This presentation will cover the phloroglucinol to TATB process as originally developed, provide a brief summary of the incident, address the

actions taken in response to the incident, and describe how these actions have been implemented to increase the safety and efficiency of this TATB production process.

References

1. Dressen, S., Merrill, D., Sanderson, A., Velarde, S. “Pilot plant synthesis of triaminotrinitrobenzene (TATB) from a novel process” *2004 IM & EM Conference*, San Francisco, CA.
2. Bellamy, A. J.; Golding, P.; Ward, S. J. UK Patent Applications GB 2355713 (“Synthesis of Diamino- or Triamino-2,4,6-trinitrobenzene”), GB 2355714 (“Ammonium 3,5-diaminopicrate”), GB 2355715 (“Synthesis of Diamino- or triamino-2,4,6-trinitrobenzene”).