Safe Transportation and Storage of Ammonium Nitrate

A US Explosives Industry Perspective

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Topics

- AN Chemistry
  - Synthesis
  - Decomposition
  - Stimuli for explosion
- AN Incidents
- Regulations and Guidelines
AN Synthesis and Use

Natural Gas → Ammonia (Water) → Air (Water) → Nitric Acid → AN Solution → AN Solids

Water

High Density

Low Density
Stimuli for Explosion

- Shock
- Heat*
- Contamination

AN

Explosion

* Primary concern in transportation
**Effect of Heat**

- **Solid**
  - 25°C (77°F)
  - 100°C (212°F)

- **Liquid**
  - 170°C (338°F)

- **Decomposing Liquid**
  - 210°C (410°F)

- **Violently Decomposing Liquid**
  - 300°C (572°F)

**Nitrous Oxide + Heat**

Gases + Heat

Chemical reactions and heats of reaction:

1. \( \text{NH}_2\text{NO}_3 \rightarrow \text{NH}_3 + \text{HNO}_3 \) \( \Delta H = +44.6 \text{ kcal/mol} \)
2. \( \text{NH}_4\text{NO}_3 \rightarrow \text{N}_2 + \text{H}_2\text{O} \) \( \Delta H = -8.8 \)
3. \( 2\text{NH}_2\text{NO}_3 \rightarrow 2\text{N}_2 + 2\text{O}_2 + 4\text{H}_2\text{O} \) \( \Delta H = -28.2 \)
4. \( 2\text{NH}_4\text{NO}_3 \rightarrow 2\text{N}_2 + 2\text{NO} + 2\text{H}_2\text{O} \) \( \Delta H = -6.6 \)
5. \( 3\text{NH}_2\text{NO}_3 \rightarrow 3\text{N}_2 + 2\text{H}_2\text{O} + \text{H}_2\text{NO}_3 \) \( \Delta H = -22.2 \)
6. \( 2\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2 + \text{NO}_2 + 4\text{H}_2\text{O} \) \( \Delta H = -29.4 \)
AN Incidents (Fire)

- No Explosion

  - Australia (2014)
  - USA (2009)
  - USA (2013)

- Explosion

  - France (2003)
  - USA (1947)
Controls (Storage & Transportation)

Heat

Materials of construction

Hazard Awareness

Fire Detection & Suppression

Separation

Emergency Response Plan

Evacuation

Alarms

Community Notification

Explosion

Fire Involving AN
AN Regulations and Guidelines

**Regulatory**
- Department of Transportation
- Department of Labor
- Environmental Protection Agency
- Department of Justice
- U.S. Coast Guard
- Department of Homeland Security

**Non-Regulatory**
- National Fire Protection Association
- Institute of Makers of Explosives (IME)
谢谢

Thank You

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