Innovation ... Delivered.

Development Toward the Large Scale Synthesis of TEX

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Background

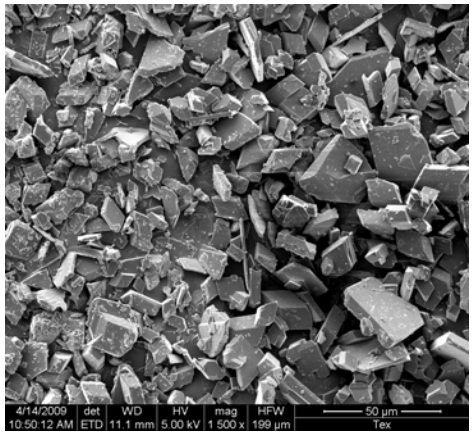
- Development of novel Insensitive Munitions (IM) is a top priority for the US government
  - IM materials respond only when specifically initiated
- IM materials are targeted to replace legacy materials such as RDX
  - RDX is not IM
  - RDX is environmentally unfriendly
- Novel IM material is TEX
  - Low solubility = environmentally friendly
  - Easily synthesized from inexpensive starting materials
    - Simple, two step process provides high producibility and low cost
  - Energy resultant mainly from caged chemical structure
    - High energy with low sensitivity

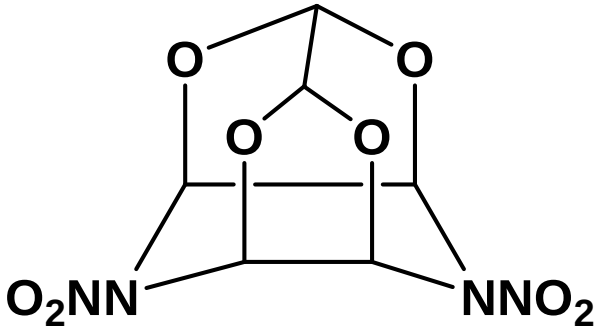
TEX is inexpensive, producible IM material of the future

TEX

	RDX	NTO	TEX
Density (g/cc)	1.82	1.91	1.99
VOD (ms/@TMD)	9045	8328	8683 (calc)*
Impact (ABL, cm)	3.5	N/A	33
Friction (lb@8 ft/sec)	324	N/A	800
ESD (Joules)	0.22	0.91	0.43
Onset (ºC)	234	270	300

***Calculated using Cheetah 3.0**





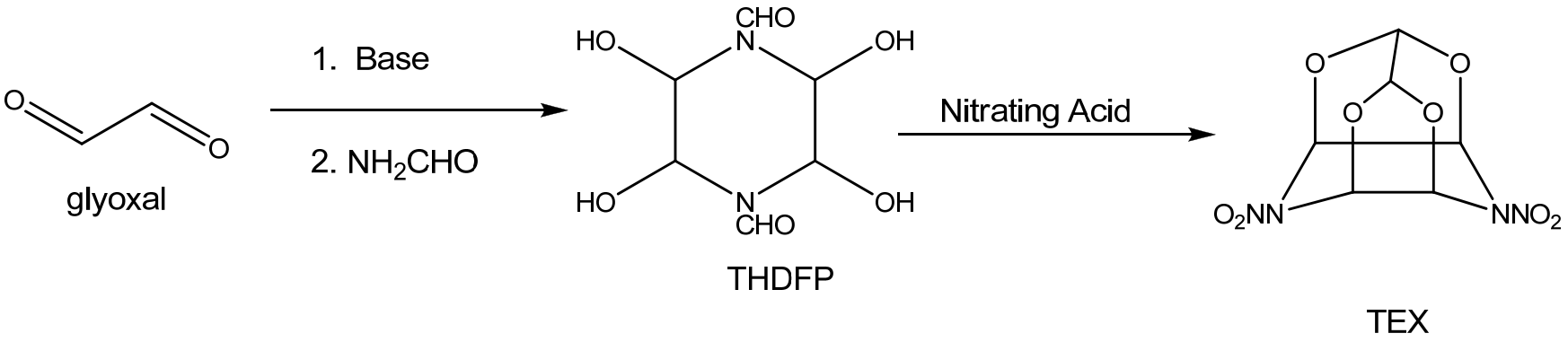
Excellent IM improvement over RDX

Synthesis of TEX

Two step synthesis from glyoxal

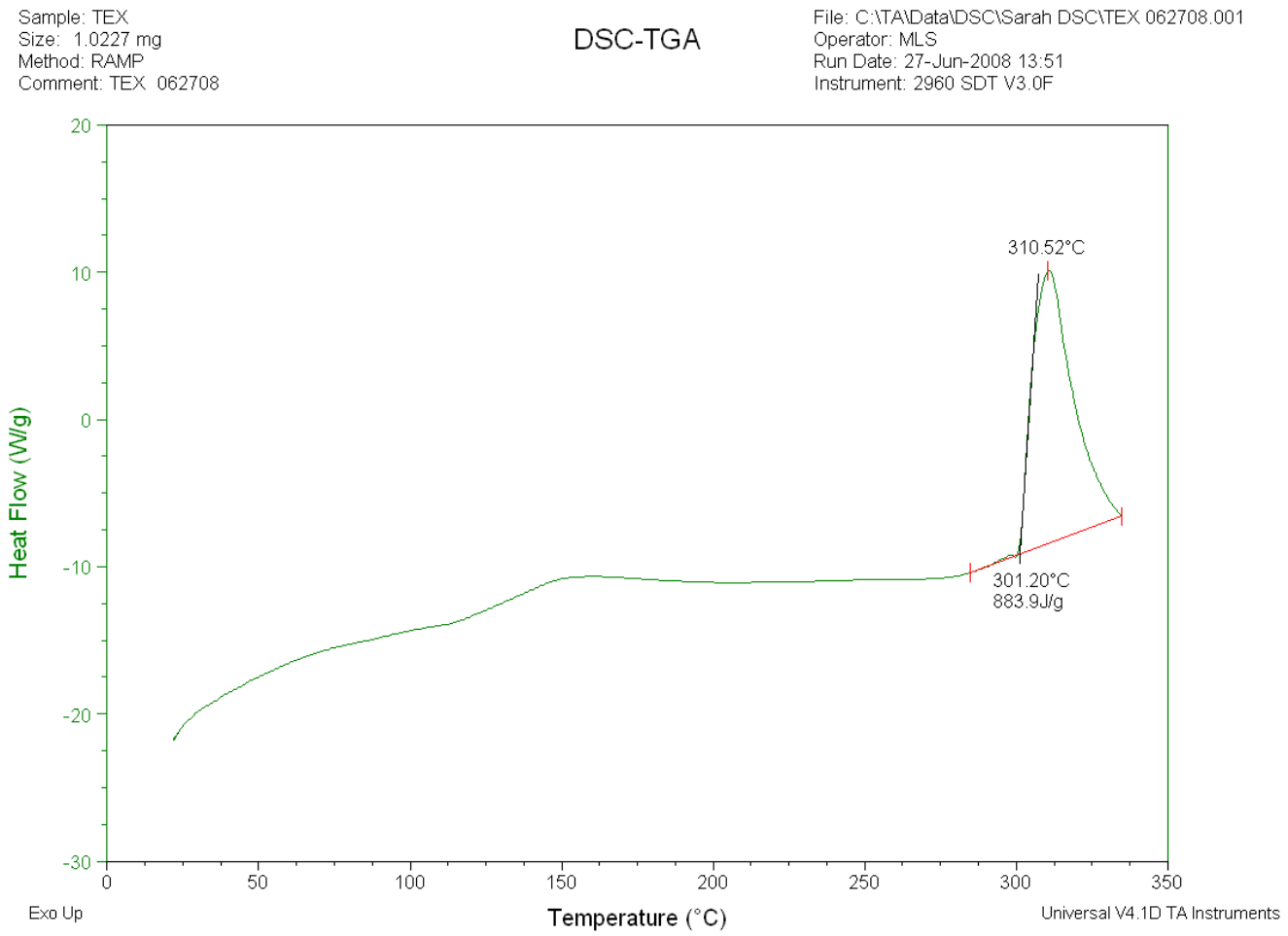
- Completed on 2 and 10 g scale at AES
- Material hazards tested and characterized via DSC

Hazards Test	TEX
Impact	51 cm
ABL Friction	210 lbs @ 8 ft/sec
ESD	0.025 J



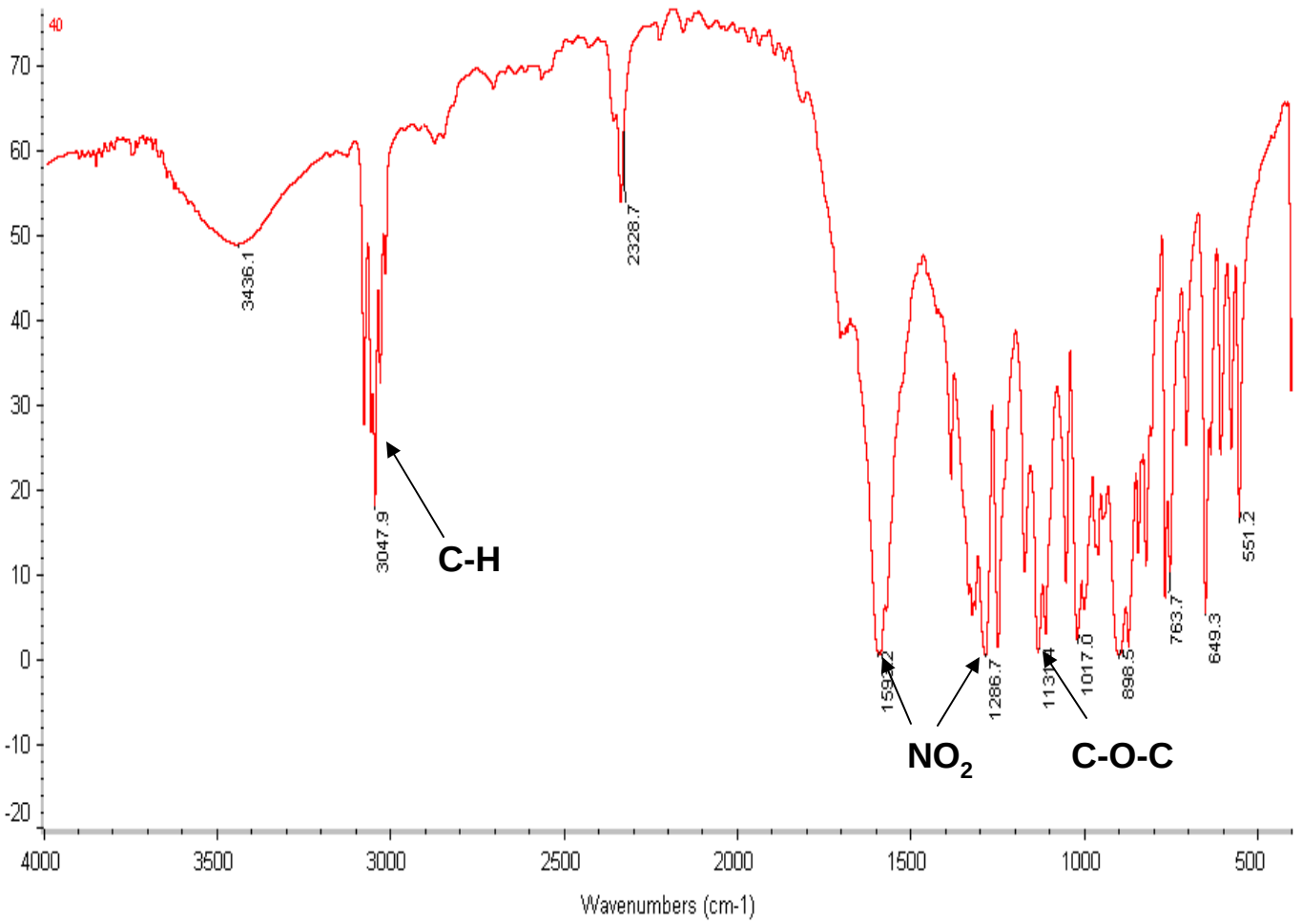
TEX from facile, two step process

TEX DSC Trace



Clean, sharp exotherm peak indicates purity

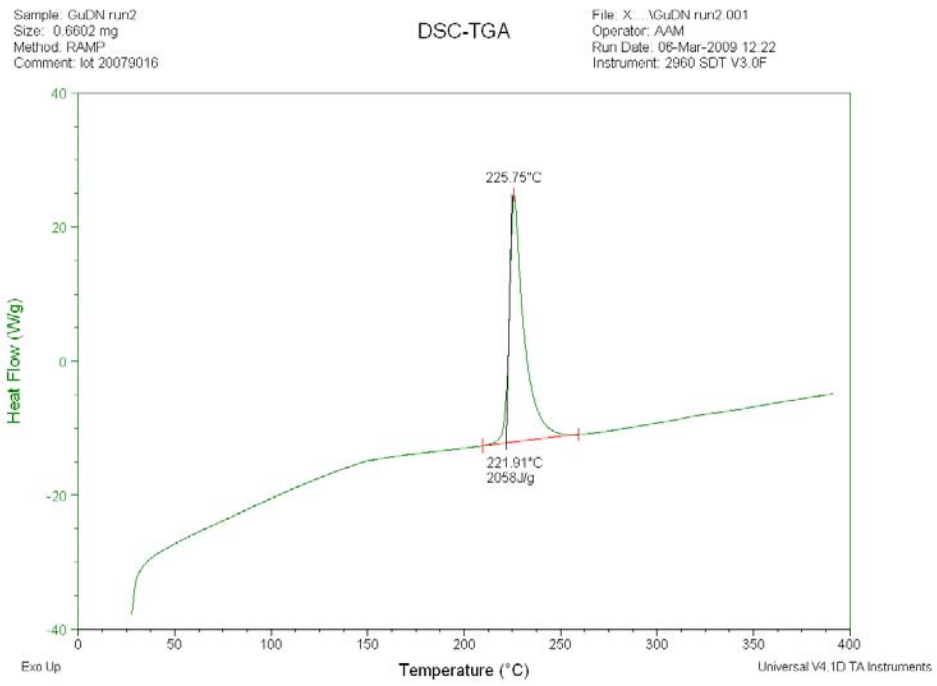
TEX IR Spectrum

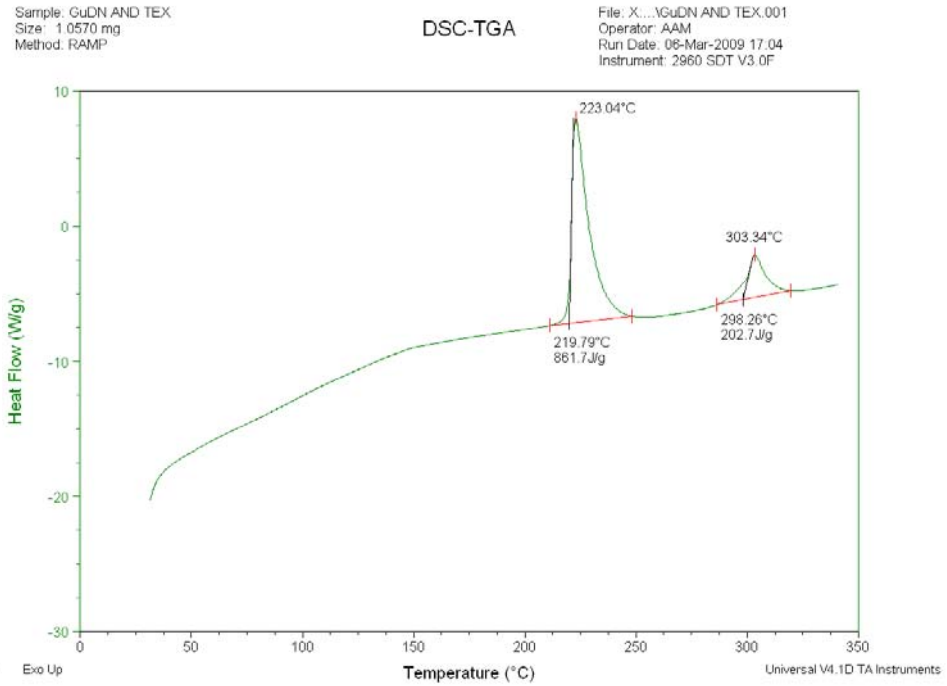


High quality TEX

TEX DSC Compatibilities

A premier aerospace and defense company

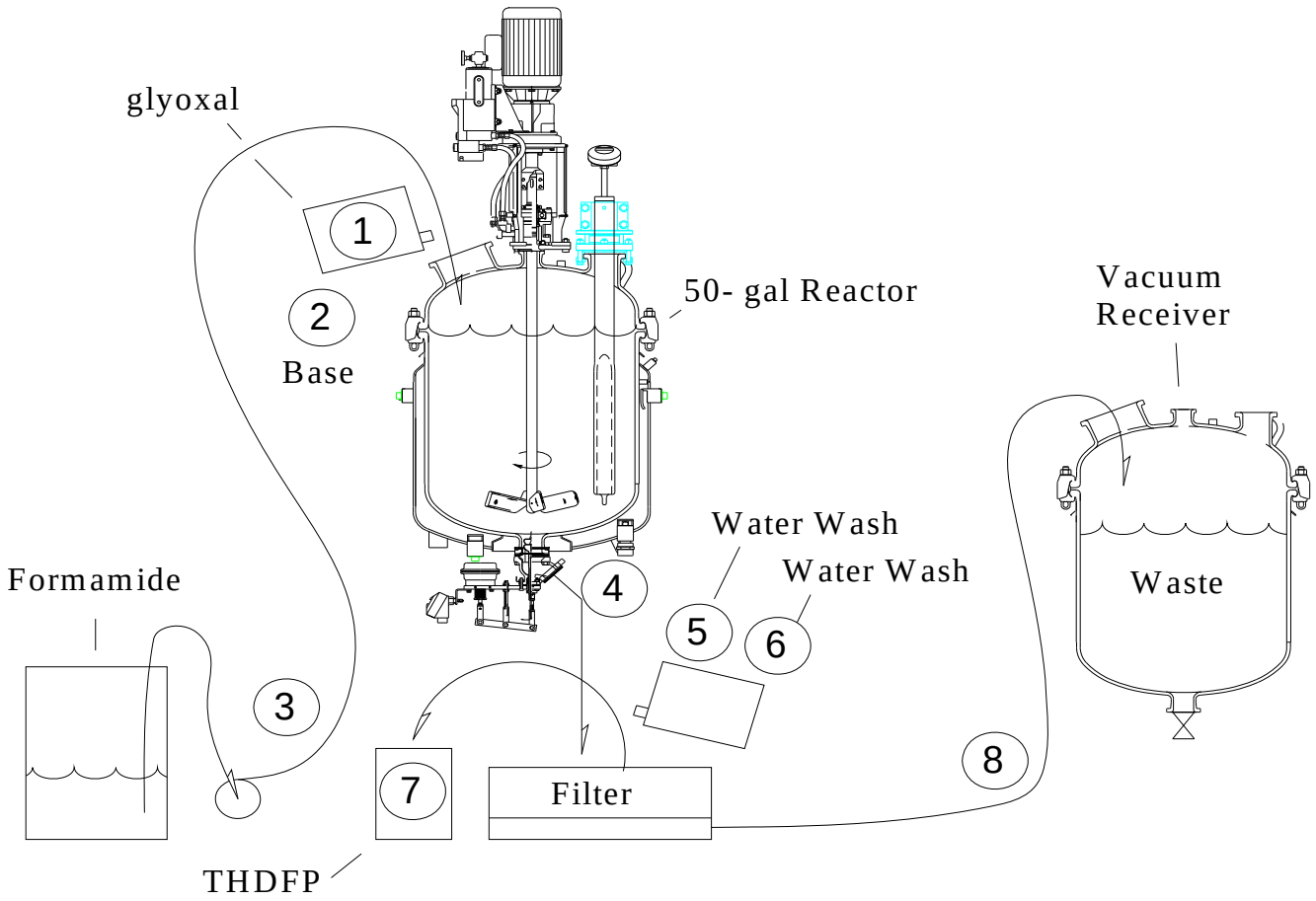




- TEX compatibility tested with NTO, GuDN, NC, NG, RDX and NQ
  - Compatible with all materials

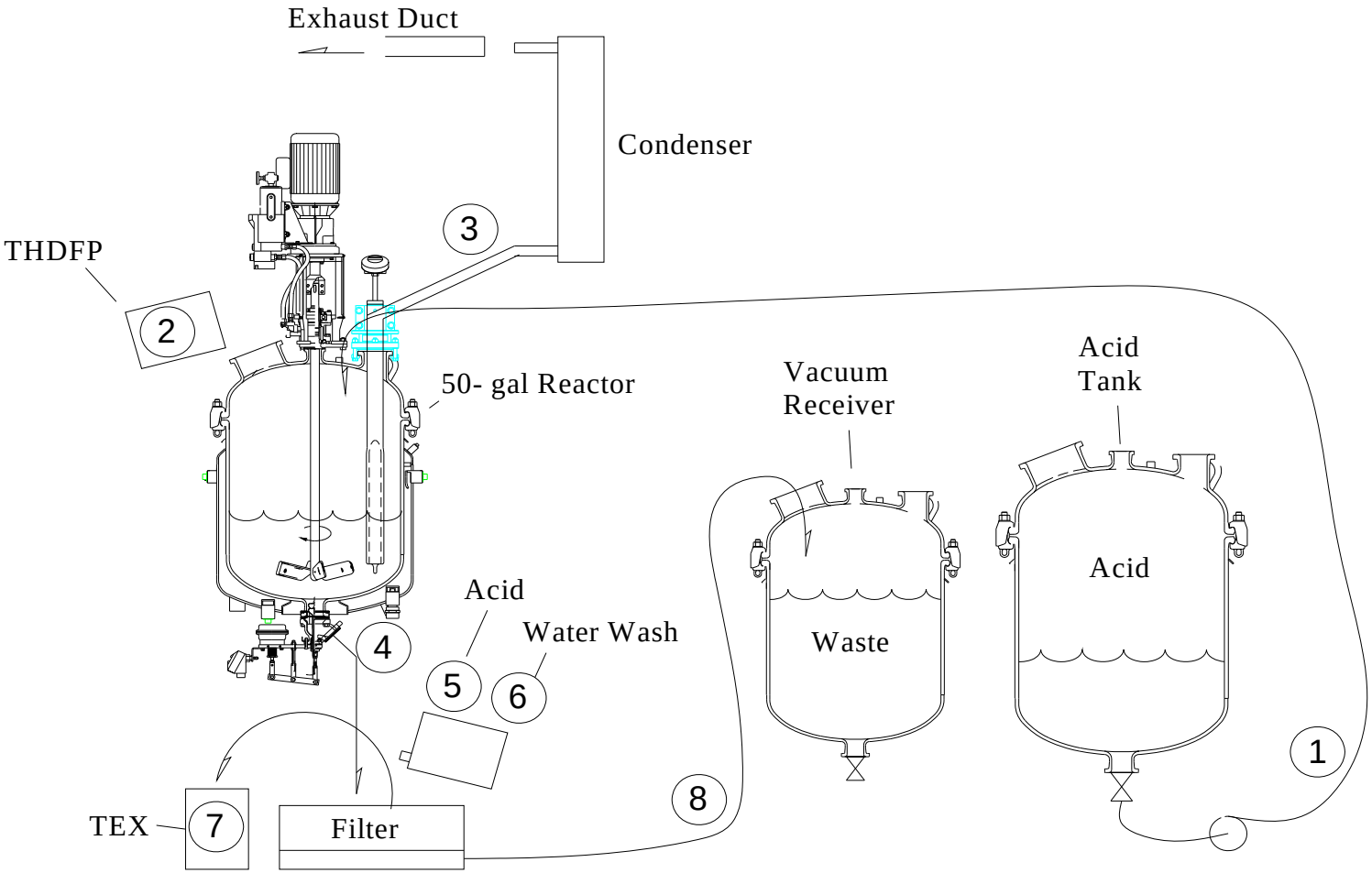
TEX has exceptional compatibility

Pilot Scale THDFP Flow Diagram



Predictable, inert reaction

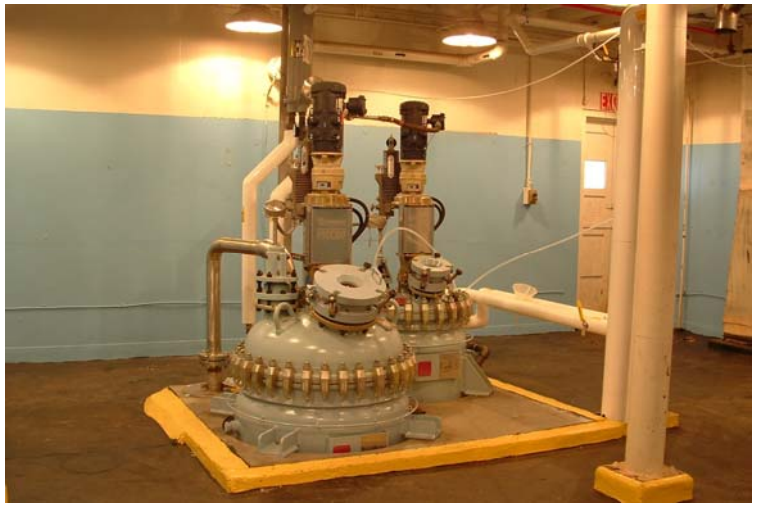
Pilot Scale TEX Flow Diagram



Easy, fast nitration

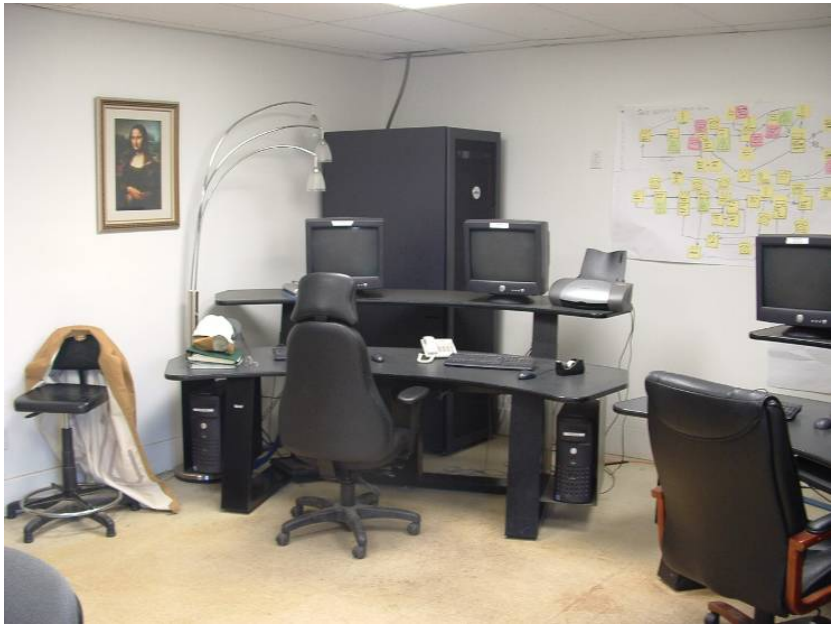
Future Pilot Scale Synthesis

- TEX to be synthesized in AES's new pilot plant
  - Built in 2008
  - Designed for manufacture of specialty materials
    - Explosive and inert
  - Air permitted
  - Sited for 10,000 lbs of explosive
  - 2 L to 100 gallon capacity reactors
    - Flexible configuration
  - Support buildings for additional storage
  - Conductive flooring throughout



Pilot Plant open and ready for business

Pilot Plant Safety Features



Separate control room allows for remote capability

- State of the art PLC system including 7 cameras
- Remote control of pumps, stirrers, heating, cooling, dump valves and two electrical outlets

- **Loading dock for transporting materials**
  - Provides minimal movement for sensitive materials
  - Eliminates need for heavy lifting

Necessary safety features in place

Flexible Facility

Small scale reactors move in and out

  – Medium scale (10 and 20 L) on rolling stands

- **Multiple heating, cooling, steam, vacuum, compressed air and ventilation connections**
- **Easily changes configuration**
- **Permitted for all kinds of processes**

Flexible to fulfill customer needs

Support Utilities

- Large capacity storage
  - Acid storage tank
  - Vacuum receiver tank
  - Acid neutralization tank

- Glycol heating and cooling system
- Drown tank available for exotherms

All necessary utilities provided

Technical Results

TEX has been synthesized on small scale

- Quick, two step process
- Material characterized by DSC
- Material DSC compatibility tested with several materials
  - Compatible with those tested

- **Future work to complete pilot scale synthesis of TEX**
  - To be performed in AES new pilot plant
    - Construction completed in 2008
    - Fully equipped for energetic and non-energetic reactions (TEX and THDFP)

AES has manufacturing capability for excellent IM material

Conclusions

TEX is a novel IM material

- Inexpensive to produce
- Simple chemistry yields high producibility
- Quick reaction times yields fast manufacturing of production quantities

- **AES Energetics Pilot Plant**
  - Fully constructed
  - Exceeds all necessary industry safety standards
  - Fully flexible for various operations
  - All necessary utility support included

AES Pilot Plant open and ready for business