Thin-Layer Chromatography
a Field Technique for Propellant Stabilizers and Explosives Analysis

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Lawrence Livermore National Laboratory UCRL-PRES-230934
Agenda

Propellant Stability Analysis in the Field with TLC

TLC Explosives Module

Future Developments
Project Inception -- 1996

- R & D Effort to Develop TLC for Propellant Stability
- From Screening to Quantification
- Fieldable Kit Development
- Validation Trips – 2000, 2002
- Validation testing – 2004
- PSSB Endorsement – 7/06
- Fielding & Commercialization - 2006
Propellant Stability Analysis in the Field with Thin-Layer Chromatography

Commercialized to:

Pelatron Inc. – Honolulu, HI
(808) 543-5290

TLC Sales and Support
(866) 460-1356
www.pelatron.com/tlc

PIKA International – Houston, TX
(281) 340-5523
Explosive Analysis Module

- Typical Military Explosives
  - TNT, NG, RDX, Picric Acid, Exp. D, CL-20, HMX, Tetryl, & PETN

- Other Explosives
  - Urea, Urea Nitrate
  - Ammonium perchlorate & nitrate, Sodium nitrate, chlorate, & bromate

- Areas of Use
  - Trace & Bulk analysis, Environmental Clean-up, etc.
The TLC Kit

TLC system
Imaging
Filtration
Chromatography Solution #1

- View with UV light
- Color
- View with white light
- Develop and view with UV light

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Chromatography Solution #2

- Order of explosives reversed
- Same type plate used with both solvents
- Not all explosives appear in each view
- Second method confirms results
### RF values

<table>
<thead>
<tr>
<th>Explosive</th>
<th>Syst. #1</th>
<th>Syst. #2</th>
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<tbody>
<tr>
<td>picric acid</td>
<td>0.09</td>
<td>0.76</td>
</tr>
<tr>
<td>Exp D</td>
<td>0.09</td>
<td>0.76</td>
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<tr>
<td>HMX</td>
<td>0.31</td>
<td>0.41</td>
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<tr>
<td>RDX</td>
<td>0.39</td>
<td>0.44</td>
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<tr>
<td>Tetryl</td>
<td>0.61</td>
<td>0.16</td>
</tr>
<tr>
<td>NG</td>
<td>0.73</td>
<td>0.28</td>
</tr>
<tr>
<td>CL-20</td>
<td>0.28</td>
<td>0.01</td>
</tr>
<tr>
<td>PETN</td>
<td>0.78</td>
<td>0.08</td>
</tr>
<tr>
<td>TNT</td>
<td>0.86</td>
<td>0.23</td>
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</tbody>
</table>

* Non-Polar  
** Polar

### Visualization

<table>
<thead>
<tr>
<th>Explosive</th>
<th>UV</th>
<th>Coloring Sol’n</th>
<th>Coloring + UV</th>
<th>DL (ng)</th>
</tr>
</thead>
<tbody>
<tr>
<td>picric acid</td>
<td>+</td>
<td></td>
<td>+</td>
<td>25</td>
</tr>
<tr>
<td>Exp D</td>
<td>+</td>
<td></td>
<td>+</td>
<td>25</td>
</tr>
<tr>
<td>HMX</td>
<td>+</td>
<td></td>
<td>+</td>
<td>50</td>
</tr>
<tr>
<td>RDX</td>
<td>+</td>
<td></td>
<td>+</td>
<td>50</td>
</tr>
<tr>
<td>Tetryl</td>
<td>+</td>
<td></td>
<td>+</td>
<td>50</td>
</tr>
<tr>
<td>NG</td>
<td>+</td>
<td></td>
<td>+</td>
<td>100</td>
</tr>
<tr>
<td>CL-20</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>50</td>
</tr>
<tr>
<td>PETN</td>
<td>+</td>
<td></td>
<td>+</td>
<td>100</td>
</tr>
<tr>
<td>TNT</td>
<td>+</td>
<td></td>
<td>+</td>
<td>100</td>
</tr>
</tbody>
</table>
Urea and Urea Nitrate TLC

Lane
1  urea nitrate, 0.2 μg
2  urea nitrate, 0.5 μg
3  urea nitrate, 1.0 μg
4  urea nitrate, 2.0 μg
5  urea, 0.2 μg
6  urea, 0.5 μg
7  urea, 1.0 μg
8  urea, 2.0 μg

Solvent front

Rf = 0.6
Ions of interest

Lane
1 NH₄ perchlorate, 2 μg
2 NH₄ perchlorate, 5 μg
3 Na nitrite, 2 μg
4 Na nitrite, 5 μg
5 NH₄ nitrate, 2 μg
6 NH₄ nitrate, 5 μg
7 Na chlorate, 2 μg
8 Na chlorate, 5 μg
9 Na bromate, 2 μg
10 Na bromate, 5 μg
Common Tools

- Sampling Tools
- Filtration Syringe
- Light Box
- TLC Process Tank
- Dip Tank
- TLC Plate – Explosives and Urea Nitrate
Expanding Capabilities

- Add quantification to explosives module
- Additional modules – CW, TIC, Street Drugs
- High Throughput Screening for Propellant Stability
  - Pre-Screen for strong Cat A Unknowns
High Throughput Screening for Propellant Stability

- Rapidly screen 50 propellant samples
- Each spot contains all the components in the standard
- Determine strong Category A’s
- Samples prepared for TLC analysis
- Spotted and colored with no separation
- Uses same software and camera
Conclusion

- Propellant analysis with TLC is commercialized
- Fielded at TEAD, HWAD, APG, YPG
- Explosive Module being added
- Expand propellant analysis
- Expand kit capabilities
Acknowledgements

Defense Ammunition Center

Pelatron Inc.

PIKA International Inc.

Picatinny Arsenal