IC2 Webinar: Evaluating Product Performance during Alternatives Assessment

December 1, 2016
Evaluation of Flame Retardant Alternatives to Decabromodiphenyl ether

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Washington State Department of Ecology

1 December 2016
**WA Legislation**

- PBDE Chemical Action Plan issued in 2006
- Ban legislation passed and signed into law in 2007
  - Banned the use of Penta- and Octa-BDE mixtures
  - Prohibited sale of mattresses containing Deca
  - Ban possible on Deca contained in electronic enclosures and residential upholstered furniture
    - **IF** Fire Safety Maintained
    - **IF** safer and technically feasible alternative(s) identified
WA Legislation

- Ecology conducted an alternatives assessment for Deca in these applications
- Alternative Assessment report completed Jan. 2009
- Ban on use of Deca in electronic enclosures and residential furniture became effective in Jan. 2011
- Ecology tests products to guarantee compliance
Deca Alternatives

- Built upon work done in PBDE Chemical Action Plan & subsequent work around the world

- Evaluated Deca Assessments
  - What products/plastics included
  - What criteria used to evaluate alternatives
  - What alternatives evaluated
  - Conclusions
  - Strengths/weaknesses
‘Safer’ Considerations used in Deca Assessment

1. Market and Technical Analysis
   • Do alternatives exist?
   • Do they meet the same need?

2. Toxicity Evaluation
   • If toxicity worse or equivalent, no further consideration
   • Used Clean Production Action’s Green Screen™

3. Exposure Evaluation
   • Are there substantive differences in exposure?
   • Are the same amounts used?
   • Are the physicochemical properties substantively different?
‘Safer’ Considerations (cont.)

4. **Performance**
   - Can an alternative be used without changing process?
   - Can process be changed to use alternative?
   - Are there other viable alternatives (redesign product so chemical is not needed, etc.)?
   - Can fire safety be maintained?
   - Is more or less of the alternative needed?

5. **Availability**
   - Are alternatives currently being sold for intended application?
   - Are alternatives currently being used in similar products?

6. **Cost**
   - Is more or less of the alternative needed?
   - What impact does switch have upon cost of final product?
   - Is it cost prohibitive?
Performance of Alternatives

Three possible alternatives evaluated

1. Use a different flame retardant
2. Change plastic and flame retardant
3. Redesign product to eliminate need for flame retardant
Performance: Use different FR

- High Impact Polystyrene (HIPS) used most often in electronic enclosures
- Deca and other brominated flame retardants used in HIPS
- Non-brominated flame retardants cannot be used in place of Deca in HIPS
Performance: Change Plastic and FR

- Deca alternatives can be used in other plastic blends
  - HIPS/PPE (polyphenylene ether)
  - PC (polycarbonate)/ABS (acrylonitrile butadiene styrene)

- Fire safety maintained

- Flame retardant manufacturers confirm
Performance: Redesign product to eliminate FR

Options are being explored:

• Some success in Europe separating power supply from display thereby decreasing need for flame retardants in enclosures

• Evaluating options for more inherently flame resistant plastics and/or using other, non-plastic enclosures
Performance: Fire Standards

Two Questions:
1. How does a TV or computer manufacturer prove that his product meets the fire standard?
2. How does Ecology and Health know that Deca alternatives meet this standard?

Information Evaluated
• National Fire Standards
• Lowell Institute Report
• Danish EPA Report
• Karlsruhe Report
Performance: Karlsruhe Report

Evaluated alternatives to Deca using various criteria:

- Processability
- Thermal stability
- Mechanical Properties
- Hydrolytic stability
- Recyclability
- RoHS and WEE directives
Performance: Karlsruhe Report (cont.)

Evaluated PC/ABS and HIPS/PPO

Tested plastics to evaluate fire safety rating

Various results about TPP, RDP and BDP in PC/ABS blends are presented in Table 4 to Table 6.

<table>
<thead>
<tr>
<th>PC/ABS 4/1</th>
<th>% FR Additive</th>
<th>UL 94* (1.6 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDP</td>
<td>9.0</td>
<td>V0 (1.5)</td>
</tr>
<tr>
<td>BDP</td>
<td>12.3</td>
<td>V0 (1.5)</td>
</tr>
<tr>
<td>TPP</td>
<td>14.0</td>
<td>V0 (1.7)</td>
</tr>
</tbody>
</table>

* avg. flame time

Table 4: UL 94 flammability in FR-PC/ABS (4/1)
Enclosures Performance Conclusions

1. Changing to HIPS blends allow use of alternatives
2. Alternatives used in same amounts and ways
3. Performance requirements met by alternatives
4. Fire safety protected
5. Industry is already moving in this direction
Furniture Performance Conclusions

1. Furniture can be made without FRs
2. Barrier fabrics and other techniques provide fire safety
3. Preferred alternative is to produce furniture without FRs
More Information

Alternatives to Deca-BDE in Televisions and Computers and Residential Upholstered Furniture
That's all Folks!
Contact Information

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Safer Chemical Alternative Chemist
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Product Performance and Alternatives Assessments

TURI Cleaning Lab
TURI Cleaning Lab

• Providing technical assistance since 1993
  • SSL has helped hundreds of companies find safer alternatives to hazardous cleaning solvents
  • The implementation rate for clients of the lab is many times higher than the national average (10%) for technical assistant providers
    • From 1993-2007 - Over one-third of the companies fully adopt the lab’s recommendations
    • From 2008 – More than three-quarters adoption rate
Want to Know How? Of Course You Do

• Process is challenging
  – Thousands of products
  – Different information from different vendors
  – What is right for some may not work for others

• Need for an easier selection method
  – Independent analysis of products
  – Objective operating conditions
  – Process specific final evaluations
How Have We Done It?

• Safety Screening
  – CleanerSolutions

• Performance Testing
  – Customized evaluations

• EHS Assessment
  – P2OASys
Questions to Ask

• What is the purpose of cleaning
• What are the problems with present cleaning system
• What are you trying to remove (soils)
• What is being cleaned (substrates)
• How are you cleaning it (equipment)
• How do you determine how clean is clean
Review Current System

- Contacted by company with cleaning related issue
- Gather background information on process
  - Cleaning Lab Test Request form
    - Material of parts to be cleaned
    - Contaminants
    - Current Solvent or other alternatives tested
    - Available Equipment
    - Operating conditions (time, temp, conc.)
Review Current System

• Site visit
  – Complete Test Request form
  – Gather samples and MSDS
    • Contaminants
    • Current Solvent
    • Dirty Parts
  – Identify possible adjustments to process
Keys to Success

I. Product Selection Process
Helps to scope project more efficiently
- Determine substrate/surface/chemical cleaner reactivity
- Review lab safety screening scores
- Using TURI’s CleanerSolutions Database for cleaning alternatives (www.cleanersolutions.org)
- Database selection process based on past performance and safety considerations

II. Temperature and Concentration Trials
Chemical field may be narrowed/changed from Phase I
- Follow chemical manufacturer’s recommendations for both parameters
- Equalize time
- Minimize same-source agitation*

*chemical comparison tool; minimal use of mechanical energy; first round of scientific trials; gravimetric analysis

III. Mechanical Energy Trials
Number of chemical cleaner candidates further decreases from Phase II
- Application-specific
- Economically-sensitive
- Space-limiting
- Conduct comprehensive EHS profiles of top performing products

IV. Actual Product Cleaning Trials
Geometries and sizes of parts important to cleaning efficiency
- Duplicate optimal Phase III cleaning conditions
- Duplicate optimal Phase III cleanliness testing

V. Pilot Plant / Scale-up Feasibility Trials
Obtain input from employees that will be working on new process
- Identify areas concerns
- Arrange for lab loaning of equipment for further on-site testing
- Follow up lab work based on client feedback
Testing an Alternative Phase 1

- **TURI Lab Database**
  - Used to identify safer and effective products
    - Safety Screening Scores
      - VOC, ODP, GWP, HMIS/NFPA, pH
    - Matching Performance
      - Contaminant, substrate, equipment, current solvent

www.cleanersolutions.org
Testing an Alternative Phase 2

• Initial laboratory evaluation of alternatives
  – Using basic operating conditions
    • Minimal concentration
    • Short times
    • Little agitation
  – Using coupons matching part substrate
  – Using supplied contaminants
  – Compare with current solvent (if possible)
Testing an Alternative Phase 3

• Advanced lab evaluation
  – Using client specific operating conditions
    • Moderate concentration (if necessary)
    • Times
    • Appropriate agitation (match current equipment)
  – Using coupons matching part substrate
  – Using supplied contaminants
  – Compare with current solvent (if possible)
  – Determine if there are any health risks that the screening does not address
    • TURI’s Pollution Prevention Options Analysis System - P2OAYSys
Testing an Alternative Phase 4

• Pilot cleaning in lab setting
  – Using client specific operating conditions
  – Using client supplied parts
  – Compare with current solvent (if possible)
  – Send/bring parts to client for assessment
Testing an Alternative Phase 5

- Pilot testing at facility
  - Using best alternative cleaning products
  - Using operating conditions from lab piloting
    - Modify conditions if necessary
  - Set up piloting off-line from current system
    - Compare pilot cleaned parts with current system for parts from the same manufacturing lot
    - Get end user input for performance
Third Party Certifications

- Green Seal
- EPA Safer Choice
- UL - Ecologo
# Cleaning Standards to Guide Performance Testing

<table>
<thead>
<tr>
<th>Category</th>
<th>Related standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>All purpose – heavy duty</td>
<td>GS 8, 37, CCD 110, ASTM D4488 (WK26967 when developed)</td>
</tr>
<tr>
<td>All purpose – light duty</td>
<td>GS 8, 37, CCD 110</td>
</tr>
<tr>
<td>Glass Cleaning</td>
<td>GS 8, 37, DCC09 &amp;09A, CCD 110</td>
</tr>
<tr>
<td>Bathroom general</td>
<td>GS 8, 37, DCC16 I &amp; II, CCD 110, ASTM D5343</td>
</tr>
<tr>
<td>Bathroom toilet bowl cleaning (hard water removal)</td>
<td>GS 37, DCC16 I &amp; II, CCD 110, Marble block test</td>
</tr>
<tr>
<td>Grease removal from hard surfaces</td>
<td>DCC17</td>
</tr>
<tr>
<td>Automatic Dishwashing</td>
<td>DCC05A; ASTM D3556</td>
</tr>
<tr>
<td>Hand Dishwashing</td>
<td>DCC-10, ASTM D4009</td>
</tr>
<tr>
<td>Oven Cleaners</td>
<td>DCC12</td>
</tr>
<tr>
<td>Flooring and Washable Walls</td>
<td>ASTM D4488; ASTM D5343</td>
</tr>
<tr>
<td>Hand Washing</td>
<td>GS41</td>
</tr>
<tr>
<td>Odor Elimination</td>
<td>ASTM E1593</td>
</tr>
<tr>
<td>Floor stripping</td>
<td>GS 40 - ASTM D 1792-82, ASTM D 3206-92, ASTM D 3207-9</td>
</tr>
<tr>
<td>Oil cleaning – heavy (motor)</td>
<td>ASTM G122</td>
</tr>
<tr>
<td>Oil cleaning – light (cooking)</td>
<td>ASTM G122</td>
</tr>
<tr>
<td>Whiteboard cleaning</td>
<td></td>
</tr>
<tr>
<td>Stainless Steel cleaning/polishing</td>
<td></td>
</tr>
</tbody>
</table>
Alternative Performance Requirements

- Using another objective, scientifically-validated method conducted under controlled and reproducible laboratory conditions, the product performs as well as or better than a conventional, nationally-recognized product in its category and at equivalent product-specific use directions
- Test methodology and results must be documented in sufficient detail for this determination to be made
Performance Evaluation for Alternatives Assessment: Collaboration Model

Greg Morose
Toxics Use Reduction Institute
University of Massachusetts Lowell

December 1, 2016
Industry Collaborative Alternatives Assessment Initiatives

**Lead Reduction for Electronics Industry**
Collaborative performance testing for safer alternatives to lead in electronics.

2001 to 2009
http://www.turi.org/Our_Work/Business/Industry_Sectors/Electronics

**Hex Chrome Reduction for Aerospace/Defense Industry**
Collaborative performance testing for safer alternatives to hex chrome free in aerospace/defense applications.

2012 – ongoing
http://www.turi.org/Our_Work/Business/Industry_Sectors/Aerospace_Defense
TURI Collaboration Approach

1. Use of a toxic chemical(s) of concern is pervasive in an industry sector

2. Toxic chemical is not used for competitive advantage

3. Strong market and/or regulatory drivers to reduce the use of the toxic chemical

4. Significant research required to switch to the use of safer alternatives

5. Time and cost intensive for companies to individually conduct research

6. Independent third party available to manage and coordinate the effort

7. Voluntary participation by government, academic, and industry collaborators

8. Participants provide either in-kind contributions (production equipment, technical expertise, materials, supplies, testing, etc.) or direct funding

9. Intent of participants is to adopt the safer alternative solutions identified

10. All results made public so that other companies can adopt solutions identified
# Lead in Electronics Products

<table>
<thead>
<tr>
<th>Toxic Chemical of Concern</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Solder, solder paste, board surface finish, component surface finish</td>
</tr>
<tr>
<td>Quantity Used (prior to project start)</td>
<td>80 – 90 million pounds used globally on an annual basis</td>
</tr>
<tr>
<td>Driver</td>
<td>EU Directive: Restriction on the Use of Certain Hazardous Substances (RoHS)</td>
</tr>
<tr>
<td>Research Required</td>
<td>Technical performance of alternatives for assembly, rework, and long term reliability</td>
</tr>
<tr>
<td>Collaborative Research Approach</td>
<td>Formation of the New England Lead-free Electronics Consortium</td>
</tr>
<tr>
<td>Alternative Materials</td>
<td>Tin, copper, silver, gold</td>
</tr>
</tbody>
</table>
New England Lead-free Electronics Consortium

$1.5 million total in direct funding and in-kind contributions

**Government**
- Funding
- Outreach

**Academia**
- Pull testing
- Statistical analysis
- Project management

**Industry**
- Technical expertise
- Funding
- In-kind contributions

2001 – 2009
Four Phases of Research

20+ companies in the electronics industry

DRAFT
# Hex Chrome in Aerospace/Defense

<table>
<thead>
<tr>
<th>Toxic Chemical of Concern</th>
<th>Hexavalent chromium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Phases</td>
<td>1) Primers/sealants, 2) sealants, 3) structural adhesive coatings</td>
</tr>
<tr>
<td>Driver</td>
<td>Defense Federal Acquisition Regulation Supplement (DFARS), May 2011</td>
</tr>
<tr>
<td>Research Required</td>
<td>Technical performance (corrosion resistance) of alternatives for long term reliability</td>
</tr>
<tr>
<td>Collaborative Research Approach</td>
<td>Formation of the Hex Chrome Free Sealant Evaluation Team for Phases 1, 2, and NASA TEERM Project for Phase 3</td>
</tr>
<tr>
<td>Alternative Materials</td>
<td>zinc phosphate, ammonium phosphite, molybdates</td>
</tr>
</tbody>
</table>
Hex Chrome Free Sealant Evaluation Team

**Government**
- Customer requirements

**Academia**
- Statistical analysis
- Project mgmt

**Industry**
- Technical expertise
- Funding, and In-kind contributions
Phase I Test Vehicle

Aluminum plates:
2” x 4.5” x 0.25”
(alloys 6061 and 7075)

8 stainless steel fasteners (4 with 100 degree countersunk heads, and 4 with socket heads)
Phase I - Research Process

Test plan development
All participants

Test vehicle CAD design
Raytheon

Stress Analysis
Northrop Grumman

Aluminum plate machining
UMass Lowell
Phase I - Research Process

Conversion Coating (HC)
- Metalast

Conversion Coating (HCF)
- Northrop Grumman

Test Vehicle Assembly
- Raytheon

Test Vehicle Preconditioning
- U.S. Navy
Phase I - Research Process

Accelerated Corrosion Test  
Lockheed Martin

Long-term Corrosion Test  
NASA

Statistical Analysis & Write Paper  
TURI
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