Permeation Research Update and PPE Virtual Center

Anugrah Shaw, Ph.D.
University of Maryland Eastern Shore
Permeation Research Update
Objective

- Develop a test method to measure permeation of active ingredients in pesticide formulations. Test method would allow evaluation of:
  - ISO 27065 Level 3 materials for whole-body garments and accessories such as apron and headgear
  - Develop performance requirements for gloves used by pesticide operators

A collaborative approach was used for this study. Resources and expertise was leveraged to develop the new method.
Permeation Test Cell Assembly

- A – cell base
- B – collection disc centered on the base
- C – sample placed over collection disc
- D – gasket
- E – cylinder

Side view

Top view
Permeation Through “Chemical Resistant” Materials

Cumulative permeation $\mu g/cm^2$

Sample Number
Permeation through “chemical resistant” materials
Glove Research

- In the United States, glove selection categories (A-H) are based on the breakthrough time of carrier solvent.
  - Selection Category Type
  - Active Ingredient
  - Type of Formulation

<table>
<thead>
<tr>
<th>Carrier Solvent</th>
<th>Selection Category Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>No solvent or aqueous solvent</td>
<td>A</td>
</tr>
<tr>
<td>Ketones</td>
<td>B</td>
</tr>
<tr>
<td>Alcohols</td>
<td>C</td>
</tr>
<tr>
<td>Acetates</td>
<td>D</td>
</tr>
<tr>
<td>Aliphatic Petroleum Distillates</td>
<td>E</td>
</tr>
<tr>
<td>Aromatic petroleum Distillates &lt; 40%</td>
<td>F</td>
</tr>
<tr>
<td>Aromatic petroleum Distillates &gt; 40%</td>
<td>G</td>
</tr>
<tr>
<td>Halogenated Hydrocarbons</td>
<td>H</td>
</tr>
</tbody>
</table>
Formulation Selection

- **Category A** – Eight formulations selected to determine if waterproof can be a criteria for Level 1 gloves.

- **Category B** – Requires use of barrier laminate or butyl rubber gloves. One formulation selected since most gloves cannot be used for this category.

- Categories C and E – No formulations selected as nitrile and neoprene work well for these categories.

- Category D – No formulation was select for Category D since acetate is used in very few formulations.

- **Categories G and H** – require use of barrier laminate or Viton® gloves. Therefore, two formulations were selected for G and one for H. Data for these formulations would be used to determine if Level 3 is required.
Glove Materials

- **Six** disposable and **seven** reusable gloves made of materials listed on the EPA Chemical Resistance Category Selection Chart were used for the study.
- A 12 mil PVC glove was used as ≤14 mil glove with no lining was not available.
- Viton® was not used due to the cost and high resistance to chemicals.
<table>
<thead>
<tr>
<th>Type</th>
<th>Material</th>
<th>Mil</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable</td>
<td>Natural Rubber</td>
<td>5</td>
<td>0.13</td>
</tr>
<tr>
<td>Disposable</td>
<td>Polyethylene</td>
<td>~1</td>
<td>~0.025</td>
</tr>
<tr>
<td>Disposable</td>
<td>PVC</td>
<td>5</td>
<td>0.13</td>
</tr>
<tr>
<td>Disposable</td>
<td>Nitrile</td>
<td>4</td>
<td>0.10</td>
</tr>
<tr>
<td>Disposable</td>
<td>Nitrile</td>
<td>8</td>
<td>0.20</td>
</tr>
<tr>
<td>Disposable</td>
<td>Neoprene</td>
<td>5</td>
<td>0.13</td>
</tr>
<tr>
<td>Reusable</td>
<td>Natural Rubber</td>
<td>18</td>
<td>0.46</td>
</tr>
<tr>
<td>Reusable</td>
<td>PVC</td>
<td>12</td>
<td>0.30</td>
</tr>
<tr>
<td>Reusable</td>
<td>Nitrile</td>
<td>15</td>
<td>0.38</td>
</tr>
<tr>
<td>Reusable</td>
<td>Neoprene</td>
<td>24</td>
<td>0.61</td>
</tr>
<tr>
<td>Reusable</td>
<td>Butyl</td>
<td>7</td>
<td>0.18</td>
</tr>
<tr>
<td>Reusable</td>
<td>Butyl</td>
<td>13</td>
<td>0.33</td>
</tr>
<tr>
<td>Reusable</td>
<td>Barrier Laminate</td>
<td>3</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Result Highlights

Research is still ongoing. The following highlights are based on data obtained to date.

- Confirms that other ingredients in the product affect permeation of active ingredient.

- The active ingredient permeates through thinner gloves; the amount of permeation is considerably lower. Need to work with risk assessors to determine minimum limit.

- For PVC, the amount permeated was consistently higher for the thicker glove. Permeation is based on glove composition and thickness; higher thickness does not always equate to lower permeation.

- Category G and H may not require use of only barrier laminate or Viton® gloves.
The International Center for Personal Protective Equipment

International Center for PPE

University of Maryland Eastern Shore
Overview

- Neutral entity established by University of Maryland Eastern Shore to advance research and outreach activities through partnerships with other institutions and organizations.

- ICPPE will play an important role in establishing linkages and networks with
  - scientists
  - policy makers
  - educators
  - private industry
  - other stakeholders
Rationale

- Harness a global network of expertise
- Coordinate international research activities
- Leverage limited resources

...use research and standards to solve PPE issues at the “local” level.
In 2014 an International Consortium was established.

The Consortium consists of researchers and stakeholders with the shared interest of improving PPE available to protect pesticide operators and re-entry workers.

ICPPE will coordinate the research activities undertaken as part of the Consortium.