Flammability and Strength of Various Welding Workwear Materials
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Abstract
The typical welding gear has historically been made from split cowhide. However, the impact of the tanning process that allows split cowhide to be so durable is detrimental to environmental health. There are multiple market alternatives that are more sustainable and accessible to the general public that also meet OSHA regulations.

Purpose
- To assess the flammability and tear strength of various welding gear.
- To determine the most protective and sustainable alternatives to traditional welding workwear made of split cowhide.

Background
- Tanning is bad for the environment causing toxic, chromium saturated water pollution.
- Welding gear must be heat and spark resistant, comfortable, allow for dexterity, durable, and breathable.
- Typical Welding temperatures are between 6500°F and 10,000°F

Methods
- The fabric weight of each specimen was found.
- The breaking strength was tested using ASTM Test Method D-5043 and the tearing strength using the ASTM Test Method D-1424 for the cowhide, denim, and canvas. Both tests were performed on the CRT Instron. It was not possible to directly test the Kevlar, so the information provided by the manufacturer was used.
- The flammability was tested using a modified standard based off of ASTM Test Method D-1230. This was tested by holding the specimen 2 inches above a Bunsen burner and observing the amount of time the specimen took to catch and if it self extinguished.
- The dimensional stability was tested using the Sussman Curing Oven. The dimensional stability and hand after exposure to excess heat was tested using the Sussman Curing Oven and observing after intervals of 1 hour, 5 hours, and 10 hours.
- Fabric Weight
<table>
<thead>
<tr>
<th>Fabric</th>
<th>Weight (oz/yd² square)</th>
<th>Original Size (in)</th>
<th>Size After 1 Hour (in)</th>
<th>Size After 5 Hours (in)</th>
<th>% Shrinkage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowhide</td>
<td>37.9</td>
<td>Cowhide 6 x 6</td>
<td>5.5 x 5.5</td>
<td>5 x 5</td>
<td>17%</td>
</tr>
<tr>
<td>Kevlar</td>
<td>13.3</td>
<td>Kevlar 6 x 6</td>
<td>6 x 6</td>
<td>6 x 6</td>
<td>0%</td>
</tr>
<tr>
<td>Denim</td>
<td>12.75</td>
<td>Denim 6 x 6</td>
<td>6 x 6</td>
<td>6 x 6</td>
<td>0%</td>
</tr>
<tr>
<td>Canvas</td>
<td>10.8</td>
<td>Canvas 6 x 6</td>
<td>6 x 6</td>
<td>6 x 6</td>
<td>0%</td>
</tr>
</tbody>
</table>

Results
- Kevlar was the strongest when it came to tensile strength, as it would have been with tearing strength if tested. The cowhide and kevlar performed similarly when burned: they both self extinguished. However, the cowhide shrunk 17% when exposed to high temperatures. The denim was notably strong, but did ignite when forced.

Sustainability
- Kevlar
  - Kevlar is 100% recyclable and can be re-spun into yarn
  - Kevlar is a natural biopolymer of collagen- making it sensitive to natural environmental conditions causing it to deteriorate faster.
  - Current methods of tanning have exhaustion levels of 40-70% due to limited access to reactive sites and/or presence of low affinity species in tanning materials.
  - Such poor exhaustion levels lead to a discharge of chromium equivalent to nearly 160,000 tonnes of tanning salts annually if not managed effectively.
  - These salts infiltrate waterways and cause immense pollution.
- Cotton
  - Cotton is water-intensive crop.
  - It takes 10,000-20,000 liters of water to produce one kilogram of cotton.

Conclusion and Implications
The most protective and sustainable fiber for welding workwear is Kevlar. Kevlar was the stronger fabric and performed equally well with cowhide. In addition to this, the kevlar fabric did not shrink when exposed to high temperatures for a prolonged period. It is also more lightweight than the cowhide. Kevlar is an aramid fiber which also makes it naturally cut resistant. It is also a 100% recyclable material.

Kevlar, however, is not an affordable material. A way to further this study would be to test kevlar blends. Some fibers that kevlar can be blended with are organic cotton and recycled nylon. This would allow for the properties of the blended fibers to be combined: the strength and protection of kevlar and the breathability, lightweight, and wicking capabilities of cotton and nylon. It would also allow for products made of these blends to be accessible.