Material testing and fire-testing of family tent

Daniël Verstraete, Guy Buyle

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Fire safe shelter
“FR scale”
Outline

- **Background**
- FR Tent test results
- FR Treatment of fabric
- Summary
Centexbel

- Collective research and technical centre

- Membership organisation:
  - Belgian textile producing companies
  - Associated member companies and organisations

- Staff:
  - 150 skilled and highly educated men and women
Testing of emergency relief items

- CENTEXBEL is recognised test body by UNHCR, IFRC, MSF,…

Experimental setup to simulate rain conditions
Relief tent specs

SPECIFICATIONS

- outer roof canvas
- outer wall canvas
- inner tent canvas
- mud flaps
- ground sheet
- mosquito nets
- guying lines
- hammer

Tests on fabric samples of the different tent parts

- tensile strength (ISO 13934-1)
- tear strength (ISO 9073-4)
- breathability (ISO 17229)
- water penetration resistance (ISO 811)
- weight & composition
Artificial ageing:
Weatherometer & UV ageing

Measurement of: Strength loss after artificial ageing

QUV
ASTM G53/94 (UVB 313 nm peak)

Weatherometer
WOM (ISO 4892-2)
Artificial ageing: Soil Burial

Measurement of: Strength loss after soil burial
Rain test

Measurement of: Rain penetration resistance

ISO 5912 - 5.6
What about FR?
Outline

- Background
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FR project Relief Tent
Goal and scope

- **Aim of the study:**
  - Assess flammability behaviour of UNHCR family tent
  - Proposal for improvement of FR properties

- **Parts of study:**
  - Review & discussion of available FR methods
  - Burn test on complete tent
  - FR testing of polycotton materials of existing tent
  - FR treatment of textile samples + testing
Burn test complete tent
Experimental set-up

- Ignition source: sand bed burner with a power output of 6 kW
Burn test complete tent
Time lapse pictures during 18 (!) seconds
Burn test complete tent
Afterwards…
Burn test complete tent
Maximum temperature ...
Tent fabric testing

<table>
<thead>
<tr>
<th>sample</th>
<th>EN ISO 6940</th>
<th>EN ISO 6941</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean ignition time (s)</td>
<td>Mean flame spread velocity (mm/s)</td>
</tr>
<tr>
<td></td>
<td>Length direction</td>
<td>Width direction</td>
</tr>
<tr>
<td>Outer roof canvas</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Outer wall canvas</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Inner tent canvas</td>
<td>2</td>
<td>2</td>
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</tbody>
</table>

→ Quite problematic … solutions?
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- Background
- FR Tent test results
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Behaviour of other fabrics?

- Method: flame spreading (EN ISO 15025)

- Various components of tent tested:
  - Outer wall and roof
  - Inner wall
  - Shade nets: synthetic / natural

- Result: …

Illustration of edge ignition (ISO 15025)
<table>
<thead>
<tr>
<th>Material</th>
<th>Afterflame time (s)</th>
<th>Afterglow Time (s)</th>
<th>Flaming debris</th>
<th>Molten debris</th>
<th>Flame on edge</th>
<th>Holes?</th>
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</thead>
<tbody>
<tr>
<td>Polycotton 200</td>
<td>80</td>
<td>60</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Polycotton 350</td>
<td>120</td>
<td>50</td>
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<td>No</td>
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<td>no</td>
</tr>
<tr>
<td>Polycotton 440</td>
<td>120</td>
<td>4</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>no</td>
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<tr>
<td>PE-sheet</td>
<td>70</td>
<td>0</td>
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<td>Yes</td>
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<td>yes</td>
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<tr>
<td>PVC/PES B8103</td>
<td>0</td>
<td>0</td>
<td>No</td>
<td>No</td>
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<td>yes</td>
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<tr>
<td>PVC/PES B8125</td>
<td>0</td>
<td>0</td>
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<tr>
<td>PVC/PES C2260</td>
<td>80</td>
<td>0</td>
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<td>yes</td>
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<tr>
<td>PVC/PES C2357*</td>
<td>75</td>
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<td>PVC/PES C7458</td>
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<tr>
<td>PU/PES</td>
<td>35</td>
<td>0</td>
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<tr>
<td>Silicone/PA</td>
<td>55</td>
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</tr>
</tbody>
</table>
Behaviour of other fabrics?

- Method: flame spreading (EN ISO 15025)

- Various components of tent tested:
  - Outer wall and roof
  - Inner wall
  - Shade nets: synthetic / natural

- Result: none of the common fabrics has intrinsic FR properties → FR treatment required
What and how to treat?

- **What?**
  - Outer fabric (wall, roof):
    - Water repellency -> no option for a water-based treatment
  - Inner fabric (inner tent):
    - More feasible to treat
    - Most vulnerable for ignition

- **How?**
  - Focus on non-halogenated solutions: organic and inorganic phosphorous compound
  - Water based
Results

- Ignition test:
  - Treated inner fabric: no ignition after 20 sec (maximum waiting time required by test)

- Ignition time:
  - Treated inner fabric: no ignition after 20 sec (maximum waiting time required by test)
  - Comparison:
    - Untreated outer roof: 4 sec
    - Untreated inner fabric: 2 sec
Impact of FR treatment

- **Benefit:**
  - Increase of ignition time:
    - Less risk to burn whole tent
    - Create time slot to leave
    - Possibility to extinguish
  - Inner tent is shielded → no leaching
  - No influence on breathability

- **“Add-on”:**
  - Weight: *measured* 20% on fabric weight
    → ca 1 kg for whole inner tent
  - Price: *estimate* ca 5% of cost of whole tent
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Summary

Potential solution:
FR treatment of polycotton inner tent
- No ignition (after 20 sec)
- Remains breathable
- Reasonable add-on of cost and weight
Contact

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