Non fluorinated water repellent treatments on textiles

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Water repellent fabrics

There are several methods which can be used to obtain water repellent fabrics.

• Coatings
  • Fluoro and non fluoro based

• Densely woven fabrics

• Since only water repellent properties are required fluoro treatments may not be necessary.
## Water repellent polysiloxanes

### Some manufactured intermediates

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Name</th>
<th>CAS no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4</td>
<td>Octamethyl cyclotetrasiloxane</td>
<td>556-67-2</td>
</tr>
<tr>
<td>D5</td>
<td>Decamethyl cyclopentasiloxane</td>
<td>541-02-6</td>
</tr>
<tr>
<td>D6</td>
<td>Dodecamethyl cyclohexasiloxane</td>
<td>540-97-6</td>
</tr>
<tr>
<td>MM (or HMDSO)</td>
<td>Hexamethyl disiloxane</td>
<td>107-46-0</td>
</tr>
<tr>
<td>MDM</td>
<td>Octamethyl trisiloxane</td>
<td>107-51-7</td>
</tr>
<tr>
<td>MD2M</td>
<td>Decamethyl tetrasiloxane</td>
<td>141-62-8</td>
</tr>
<tr>
<td>MD3M</td>
<td>Dodecamethyl pentasiloxane</td>
<td>141-63-9</td>
</tr>
</tbody>
</table>

Polysiloxanes
## POP assessment (Stockholm Convention) of siloxanes

<table>
<thead>
<tr>
<th>Substance</th>
<th>Persistence Annex D 1. (b)</th>
<th>Bioaccumulation Annex D 1 (c)</th>
<th>LRT Annex D 1 (d)</th>
<th>Adverse effects: ecotoxicity Annex D1 (e)</th>
<th>Adverse effects to human health Annex D1 (e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decamethyl cyclopentasiloxane (D5)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Dodecamethyl cyclohexasiloxane (D6)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Decamethyl tetrasiloxane (MD2M)</td>
<td>Equivocal data</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Octamethyl cyclotetrasiloxane (D4)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Octamethyl trisiloxane (MDM)</td>
<td>Equivocal data</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

*Source: UNEP/POPS/POPRC.10/CRP.6*
Water repellent cotton and cotton/PET blends

- A classic cationic textile surfactant is 1-(stearamidomethyl) pyridinium chloride

![Chemical structure of 1-(stearamidomethyl) pyridinium chloride]

SC assessment: No P, B, no T

- The substance reacts with cellulose at elevated temperatures to form a durable water-repellent finish on cotton

- There are also other similar resins used to water repellent cotton

- Sometimes these treatments are addressed as paraffin wax treatments
Superhydrophobic repellents

- Hyperbranched hydrophobic polymers (dendritic, i.e., highly branched polymers) and specifically adjusted comb polymers as active components

- Superhydrophobic means contact angles larger than 150° that can be applied in coatings, textile, leather etc.

- Dendrimers may be in the region of nano sized materials meaning features with an average diameter between 1 to 100 nm

- There are now cationic dendrimers applied to improve bonding to cotton.

Cationic properties needs to be considered concerning cytotoxicity.
“Non chemical” highly dense woven plain fabrics

12.1 Scanning electron micrograph of Ventile fabric.
Membranes

- Membranes are extremely thin films made from polymeric material and engineered in such a way that they have a very high resistance to liquid water penetration, yet allow the passage of water vapour.
- A typical membranes is only 10 μm thick and is laminated to a conventional textile fabric to provide the necessary mechanical strength.
- This is a thin film of polytetrafluoroethylene (PTFE) polymer with 1.4 billion holes per cm².
- These holes are much smaller than the raindrops (2-3 μm compared with 100 μm), yet very much larger than water vapour molecule (0.0004 μm).

PFOA is used as an emulsifier for production of PTFE membranes – observe possible residues
Are non fluoro treated fabrics completely free from fluoro chemicals?

Unfortunately NO.

There may still be traces of stable fluorinated degradation products in the fabric such as

- perfluorinated carboxylic acids (PFCAs) such as PFOA
- perfluorinated sulfonic acids (PFSAs) such as PFOS

Why?
These substances are not used in production, but occur as contaminants through water and food chains and appear everywhere.
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