Module 6:
Chemical Resistance
### Viton® versus Other Elastomers

**classification according to ASTM 2000D — Service temperature versus Oil No.3**

<table>
<thead>
<tr>
<th>Service Temperature (°C)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</table>

Oil Resistance Class (% volume swell in ASTM No. 3 Oil after 70 hours)

- **A** Not required
- **B** 140
- **C** 120
- **D** 100
- **E** 80
- **F** 60
- **G** 40
- **H** 30
- **J** 20
- **K** 10

- **Acsium®**
- **FVMQ**
- **VMQ**
- **SBR**
- **Natural Rubber**
- **IIR EPDM**
- **Neoprene (CR)**
- **ACM**
- **ECO**
- **NBR**
- **HNBR**
- **AEM (Vamac®)**
- **AM (FFKM)**
- **Kalrez® (FFKM)**
- **Viton® (FKM)**

### Chemical resistance

Viton® is a registered trademark of DuPont Performance Elastomers.
Uniqueness of FKM Fluoroelastomers

High ratio of fluorine-to-hydrogen
Very strong carbon-fluorine bond
Absence of unsaturation (i.e., double bonds)
Specialty monomers

Excellent oil and fluids resistance
Excellent heat (200°C+) resistance
Low temperature flexibility
## Viton® - Chemical Resistance

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Critical</th>
</tr>
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<tbody>
<tr>
<td>☺</td>
<td>☹</td>
</tr>
<tr>
<td>hydrocarbons</td>
<td>strong attack</td>
</tr>
<tr>
<td>(solvents, fuels…)</td>
<td>strong bases</td>
</tr>
<tr>
<td>Very good</td>
<td>strong organic acids, aldehydes</td>
</tr>
<tr>
<td>chlorinated solvents</td>
<td>ammonia and amines</td>
</tr>
<tr>
<td>mineral acids</td>
<td>high volume swell</td>
</tr>
<tr>
<td>aromatic solvents</td>
<td>low molecular weight ether, ester and ketones</td>
</tr>
<tr>
<td>oxidizing fluids</td>
<td></td>
</tr>
<tr>
<td>Fair to good</td>
<td></td>
</tr>
</tbody>
</table>
| hot aqueous fluids like acids and steam | }

Viton® is a registered trademark of DuPont Performance Elastomers.
# Viton® - Relative Performance

<table>
<thead>
<tr>
<th>Standard Products</th>
<th>Specialty Products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Viton® product</strong></td>
<td>A</td>
</tr>
<tr>
<td>Curing system</td>
<td>bi</td>
</tr>
<tr>
<td>Fluorine content</td>
<td>66%</td>
</tr>
</tbody>
</table>

**Heat resistance**

- All Viton® products have outstanding thermal properties

**Chemical resistance**

- Silver gray: **BEST**
- Gray: Good
- Black: Fair
- White: Poor

**Base resistance**

- Silver gray: **BEST**
- Gray: Good
- Black: Fair
- White: Poor

**Low temperature properties**

- Silver gray: **BEST**
- Gray: Good
- Black: Fair
- White: Poor

**Compression set resistance**

- Silver gray: **BEST**
- Gray: Good
- Black: Fair
- White: Poor

**Relative cost of polymer**

- Silver gray: low
- Gray: medium
- Black: high

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*“S” indicates products made with Advanced Polymer Architecture
**Consult the Chemical Resistance Guide at www.dupontelastomers.com or contact your Viton® specialist.*
Viton® - Selection Guide

is available on Internet

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Selection Based on Application Needs

**Base resistance:** Best resistance to aggressive amine based anti-corrosion additives?

- **YES**
  - Hydrocarbon resistance (automotive fuels, etc.)?
    - **YES**
      - ETP-S
    - **NO**
      - TBR-S
  - **GFLT-S**
- **NO**
  - High resistance to oxygenated-fuels (MeOH, MTBE), steam, acids?
    - **YES**
      - Low temperature flexibility better than -20°C?
        - **YES**
          - **GFLT-S**
        - **NO**
          - F
    - **NO**
      - Low temperature flexibility better than -20°C?
        - **YES**
          - **GLT-S**
        - **NO**
          - **GBL-S**

*red* for Viton® made with APA (« -S » for APA technology)

Viton® is a registered trademark of DuPont Performance Elastomers.
Swell in Fuel Mixtures

Influence of oxygenated additives

* 10% level blended with reference ASTM Fuel C
Superior Fluids Resistance

<table>
<thead>
<tr>
<th>Fluid Type</th>
<th>Volume Swell %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A-401C</strong></td>
<td>150</td>
</tr>
<tr>
<td><strong>GF</strong></td>
<td>220</td>
</tr>
<tr>
<td><strong>TBR</strong></td>
<td>250</td>
</tr>
<tr>
<td><strong>ETP</strong></td>
<td>168 hr</td>
</tr>
</tbody>
</table>

- **ATF (150°C)** (transmission fluid)
- **Toluol (40°C)** (aromatic alcohol)
- **MTBE/Toluol (23°C) (92:8)** (ether/aromatic alcohol)
- **MEK (23°C)** (ketone)
- **KOH (100°C) (30%)** (Base)

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Resistance to Methylene Chloride (23°C)

Volume Increase (%) vs. Exposure Time (hrs.)

- Viton® A types
- Viton® GF-S types
- Kalrez®

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Resistance to 95% Sulfuric Acid

2 Months Exposure

![Graph showing volume swell (% vs. temperature (°C) for Viton® A types, Viton® GF-S types, and Kalrez®.](graph.png)
Degradation resulting from Oil Immersion which polymer to choose?

<table>
<thead>
<tr>
<th>Degree of Base Resistance required</th>
<th>Engine</th>
<th>Gear box and Transmission</th>
<th>Axle &amp; Wheel bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>bisphenol cured</td>
<td>B-651C, 500 hrs</td>
<td>B-651C, 500 hrs</td>
<td>B-651C, 1000 hrs</td>
</tr>
<tr>
<td>B-651C un-aged</td>
<td>Shell Helix Ultra</td>
<td>BP Cecilia 20</td>
<td>Mobile Axle lube</td>
</tr>
<tr>
<td></td>
<td>0W40 engine oil</td>
<td>5W40 engine oil</td>
<td></td>
</tr>
</tbody>
</table>

Suggested Polymer

Engine
- Shell Helix Ultra
- BP Cecilia 20
- ESSO Dexron III ATF

Gear box and Transmission
- ESSO Dexron III ATF
- Mobile Axle lube

Axle & Wheel bearing
- ESSO Dexron III ATF
- Mobile Axle lube

Viton® is a registered trademark of DuPont Performance Elastomers.
Chemical Resistance of Elastomers

**Chemical resistance** of elastomers depends on **chemical structure**. Within a class of elastomers such as Viton® fluoroelastomer, chemical resistance within different families will depend on **monomer composition, fluorine content** and **vulcanization system**.

Several factors must be considered when selecting an elastomer for a **rubber part in service**:

- **Service temperature** (the higher the temperature the higher the effect of a given chemical on the polymer)
- **Service conditions** (static vs. dynamic application)
- **Polymer type** (within a class of polymers, several families with different chemical resistances are often available)
- **Compound formulation** (optimization of some properties may adversely affect others such as fluid resistance)
- **Curing system** (bis-phenol or peroxide)
Chemical Resistance Guide on-line

The CRG is a resource to help you choose the best elastomer for your application. Access to our on-line Chemical Resistance Guide (CRG) is available through the DuPont Performance Elastomers web site at www.dupontelastomers.com, where detailed information about our product line may also be found.
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