PA6.6 vs. PA6

Understanding polyamide basics
PA6.6 vs. PA6

- history of Polyamide
- typical properties
- typical applications
History of PA66

PA66 was discovered in 1931 by H.W. Carothers
History of PA66

Production started in 1938 at DuPont
History of PA6

PA6 was discovered in 1936 by P. Schlack in Germany at former I.G. Farben.
PA66 was discovered in 1931 by H.W. Carothers

Production started in 1938 at DuPont

PA6 was discovered in 1936 by P. Schlack in Germany

Production started in 1941 at ICI

1992 DuPont took over the Maranyl-business from ICI
Polymerisation of PA66

Polycondensation:

Hexamethylenediamine       Adipinacid

\[ H_2N-(CH_2)_6-NH_2 + HOOC-(CH_2)_4-COOH \]

\[ \rightarrow \]

\[ - H_2O \]

\[ H-[NH-(CH_2)_6-NH-CO-(CH_2)_4-CO]_n-OH \]
Polymerisation of PA6

Polymerisation of Caprolactame:
### Comparison of Properties

<table>
<thead>
<tr>
<th>Material</th>
<th>Tm (°C)</th>
<th>Tg (°C)</th>
<th>Water Absorption</th>
<th>Percentage of Crystallisation</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PA 6</strong></td>
<td>~ 223°C</td>
<td>40°C</td>
<td>3.2% at 50% rH</td>
<td>30%</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11% at 100% rH</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PA6.6</strong></td>
<td>~ 263°C</td>
<td>50°C</td>
<td>2.8% at 50% rH</td>
<td>40%</td>
<td>1.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8.5% at 100% rH</td>
<td></td>
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</tr>
</tbody>
</table>
comparison of properties

PA6
- stiffness ➔
- mechanical strength ➔
- impact resistance ➔
- surface ➔

PA6.6
- stiffness ➔
- mechanical strength ➔
- impact resistance ➔
- surface ➔
comparison of long-term properties

**PA6**
- UV-aging ≈
- heat aging ≈
- aging from water ↑
- dimension stability ↓
- creeping ↑

**PA6.6**
- UV-aging ≈
- heat aging ≈
- aging from water ↓
- dimension stability ↑
- creeping ↓
comparison of all PA types

<table>
<thead>
<tr>
<th>Nylon type</th>
<th>MPt &amp; HDT °C</th>
<th>Moisture Absorption/ Effect on Properties</th>
<th>Impact Strength (conditioned)</th>
<th>Chemical Resistance</th>
<th>Modulus (Conditioned)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>185°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>180°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.12</td>
<td>218°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td>223°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td>263°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>295°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPA 51Series</td>
<td>300°C</td>
<td></td>
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</tr>
</tbody>
</table>
## Comparison of Processing

<table>
<thead>
<tr>
<th></th>
<th>PA6</th>
<th>PA6.6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Melt temperature:</strong></td>
<td>260 - 290°C</td>
<td>275 - 300°C</td>
</tr>
<tr>
<td><strong>Mould temperature:</strong></td>
<td>60 - 90°C</td>
<td>80 - 120°C</td>
</tr>
<tr>
<td><strong>Viscosity:</strong></td>
<td>≈</td>
<td>≈</td>
</tr>
<tr>
<td><strong>Cycle time:</strong></td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Mould shrinkage:</strong></td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td><strong>Warpage:</strong></td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td><strong>Surface:</strong></td>
<td>↑</td>
<td>↓</td>
</tr>
</tbody>
</table>

Drying-time for PA generally 2-4h at 80°
Generally for applications where processability, surface quality and low warpage on one hand and/or a good overall toughness on the other hand is required, as well as that the higher creeping and the absorption is not a problem.

For applications which are constantly exposed to high temperatures (dry applications) predominantly PA6 is used also because of its price-advantage.
typical applications for PA66

Generally for applications, where less creeping and less absorption has high priority.

Also for applications where short term temperature can reach 220°C.

For applications where in the long run the part is exposed alternately to high temperature and absorbable substances.