Large-Diameter Seals and Moldings
Materials and Special Manufacturing Aspects
In addition to developing and producing sealing solutions of average and particularly small dimensions, seal manufacturers have to cover a growing demand for large-diameter seals today. Parker Prädifa offers an extensive portfolio of polymeric materials such as NBR, EPDM, FKM, PTFE and PEEK, as well as metals, using respective specialized manufacturing technologies.

Average sealing systems rarely have diameters larger than 100 mm. However, in many sectors such as manufacturing plant and equipment, buildings and pipelines, tunnel construction and mining, energy, high-tech medicine and aerospace, etc., diameters of several meters are not uncommon.

Manufacturing Process Technology

Special Aspects

Applications in the fields mentioned above typically make exacting demands in terms of resistances (pressure, fluids, temperature, mechanical loads...), reliability and service life. As with all seals and sealing systems, these demands initially must be met by selecting the right material and geometry and subsequently producing the seals using suitable manufacturing methods.

However, producing large-diameter seals is not simply a matter of converting small dimensions into large ones. Instead the production of large-diameter seals can only be accomplished with special, complex manufacturing technology and involves a considerably greater handling effort in the production process – a challenge that only experienced, highly capable manufacturers such as Parker Prädifa are able to master with specific manufacturing know-how and the requisite technology and equipment.
Manufacturable Sizes and Manufacturing Methods

Elastomer Seals

Elastomer seals which are suitable for vulcanization can be produced in practically any diameter: Here Parker Prädifa’s innovative continuous vulcanization technology – unlike joint vulcanization or spliced round cord technology which are cost-efficient but entail numerous disadvantages – now makes it possible to economically produce large-diameter O-rings and profile seals in precision quality as well. As a result, these precision large-diameter seals produced at reasonable costs are suitable for use even in safety-critical applications.

Polymer Seals Made from Machinable Materials

Polymer seals made from machinable materials – such as PTFE, PEEK or TPU – can currently be produced at Parker Prädifa in diameters of up to 4.5 m. Due to the continuous further development of machining technology, even larger dimensions are supposed to be possible in the foreseeable future.

Metal Seals

Metal seals (spring-energized C-rings) can currently be produced at Parker Prädifa in diameters of up to 7.6 m and up to 2.3 m for non-rotationally symmetric E-, O-, and C-seals. To manufacture large-diameter metal seals, Parker Prädifa uses special technologies including purpose-developed forming machines and patented welding techniques, as well as appropriate coating and plating technologies.
Elastomeric materials, particularly rubber compounds, are some of the most typical sealing materials found in the chemical process industry. EPDM, NBR, FKM and FFKM are the most commonly used types of rubber compounds. Their diverse advantages such as good long-term and chemical resistance in a wide temperature range, high wear and pressure resistance, rubber-elastic behavior and ready availability make rubber compounds the top choice among sealing materials.

### Standard Compounds

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Compound</th>
<th>Hardness (Shore A)</th>
<th>Temperature Range (°C)</th>
<th>Color</th>
<th>Range of Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>NBR</td>
<td>N0674</td>
<td>70</td>
<td>-35 / 100</td>
<td>Black</td>
<td>Standard compound for hydraulics and pneumatics. Good resistance in hydraulic oils and water glycols, against mineral oil products, animal and vegetable fats.</td>
</tr>
<tr>
<td>EPDM</td>
<td>E0540</td>
<td>80</td>
<td>-50 / 150</td>
<td>Black</td>
<td>Good hot water resistance. Suitable for hot air up to 150 °C and steam up to 200 °C.</td>
</tr>
<tr>
<td>FKM</td>
<td>V0747</td>
<td>75</td>
<td>-25 / 200</td>
<td>Black</td>
<td>Standard compound for the general chemical industry. Suitable for flame-resistant liquids and chlorinated hydrocarbons.</td>
</tr>
</tbody>
</table>

### Available Cross Sections for Standard Compounds [mm]

<table>
<thead>
<tr>
<th>2,62</th>
<th>4,50</th>
<th>5,70</th>
<th>7,00</th>
<th>8,50</th>
<th>10,82</th>
<th>13,00</th>
<th>16,00</th>
<th>20,00</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,00</td>
<td>5,00</td>
<td>6,00</td>
<td>7,50</td>
<td>9,00</td>
<td>11,00</td>
<td>14,00</td>
<td>17,00</td>
<td>22,00</td>
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<tr>
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<td>5,33</td>
<td>6,35</td>
<td>8,00</td>
<td>9,50</td>
<td>12,00</td>
<td>14,40</td>
<td>18,00</td>
<td>24,00</td>
</tr>
<tr>
<td>4,00</td>
<td>5,50</td>
<td>6,50</td>
<td>8,40</td>
<td>10,00</td>
<td>12,70</td>
<td>15,00</td>
<td>19,00</td>
<td>22,00</td>
</tr>
</tbody>
</table>

### Special Compounds

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Compound</th>
<th>Hardness (Shore A)</th>
<th>Temperature Range (°C)</th>
<th>Color</th>
<th>Range of Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>C0557</td>
<td>70</td>
<td>-40 / 100</td>
<td>Black</td>
<td>Frequently used in refrigerants. Good weather and salt water resistance.</td>
</tr>
<tr>
<td>HNBR</td>
<td>KA193</td>
<td>85</td>
<td>-50 / 150</td>
<td>Black</td>
<td>Special compound for oil and gas applications with very good sour gas resistance.</td>
</tr>
<tr>
<td>HiFluor® FB (FKM)</td>
<td>V8991</td>
<td>75</td>
<td>-25 / 200</td>
<td>Ocher</td>
<td>Challenging hygienic and aseptic applications in the chemical, food, cosmetics, pharma and medical device industries with all required approvals.</td>
</tr>
<tr>
<td>Parfluor® (FFKM)</td>
<td>V8910</td>
<td>75</td>
<td>-20 / 220</td>
<td>Black</td>
<td>Very good chemical resistance, very good solvent and paint resistance.</td>
</tr>
<tr>
<td>Parfluor® (FKM)</td>
<td>V8545</td>
<td>75</td>
<td>-15 / 300</td>
<td>Black</td>
<td>Very good chemical resistance including hot water and steam, etc.</td>
</tr>
<tr>
<td>Parfluor® (FFKM)</td>
<td>V8800</td>
<td>75</td>
<td>-15 / 320</td>
<td>Black</td>
<td>High-temperature compound with very good chemical resistance.</td>
</tr>
</tbody>
</table>

Other compounds available on request

### Available Cross Sections for Special Compounds [mm]

<table>
<thead>
<tr>
<th>3,53</th>
<th>4,00</th>
<th>5,00</th>
<th>5,33</th>
<th>6,00</th>
<th>6,99</th>
<th>8,00</th>
<th>10,00</th>
<th>12,00</th>
</tr>
</thead>
</table>

Other cord thicknesses available on request
Machinable Materials

Fluoropolymers – PTFE

PTFE and its wide range of available compounds is no doubt the most frequently used fluoropolymer in challenging sealing applications. In addition to the homopolymer PTFE, a growing number of modified PTFE polymer versions are used, all of which have specific advantages.

PTFE seals are utilized where other sealing materials (such as rubber elastomers, polyurethanes, fabrics, etc.) reach their limits in terms of demands like temperature range, chemical, abrasion and wear resistance.

The molecular structure of PTFE is based on a linear chain of carbon atoms that is completely surrounded by fluorine atoms.

Carbon-fluorine bonds are among the strongest found in organic compounds. That is why PTFE exhibits outstanding properties:

- **Thermal stability across a wide temperature range.** The high melting point (342 °C) and the morphological characteristics of PTFE make it possible to produce components for permanent use in operating temperatures of up to 260 °C. Above this temperature, the physical properties of the components tend to degrade, resulting in heat aging and deterioration of the material’s properties. In cryogenic temperatures, PTFE is used to seal against critical fluids such as liquid nitrogen (-196 °C), liquid hydrogen (-253 °C) and liquid helium (-269 °C). In alternating temperature loads, PTFE exhibits unique resistance against heat aging, material degradation and change in physical properties.

- **Outstanding tribological properties**
PTFE has the lowest friction coefficient of all known solids. The material is self-lubricating and thus permanently usable in dry-running, dynamic sealing applications. In addition, PTFE has very low stick-slip tendency and thus ensures smooth running.

- **Extreme chemical resistance**
The strengths of the intropolymeric chain bonds of PTFE preclude a reaction with most chemicals. As a result, they are chemically inert in applications with practically all industrially used chemicals and solvents at higher temperatures and pressures. Only few media are known to react with PTFE: alkali metals, fluorine and some fluorochemicals such as chlorine trifluoride and oxygen difluoride. PTFE is suitable for applications in contact with foodstuffs and meets FDA requirements.

- **Unlimited shelf life**
PTFE does not age over time and is not affected by UV light either.

- **No explosive decompression**
PTFE is not susceptible to saturation with high-pressure gases that may heavily expand and cause the material to explode in the event of a sudden pressure drop.
For application conditions in which even fluoropolymers – especially with increasing temperatures – reach their limits in terms of strength and mechanical resistance, other materials are available. The most frequently used high-end material for particularly challenging application conditions is polyether ether ketone (PEEK). At Parker Prädifa, PEEK is used in its unfilled quality (virgin PEEK) and in the form of various compounds with specifically selected fillers. PEEK and PEEK compounds are typically used to produce back-up elements (e.g. back-up rings) within a sealing design or stand-alone sealing elements. Other possible materials in these areas include PAI and PI.

**High-End Materials (PEEK, PAI, PI, …)**

Where the utilization of high-end polymers is not imperative, lower-priced, equally machinable materials may be used as well. Here Parker Prädifa, for instance, offers POM, PE and diverse polyurethanes and elastomers. Particularly for large diameters, machining of these materials compared with traditional methods such as compression molding and injection molding often provides an economically attractive alternative because smaller batch sizes or prototypes can be produced without costly molds.

**Other Machinable Polymers (POM, PE, Polyurethanes and Elastomers)**

- No swelling due to absorption of liquids
- Safe for use in vacuum conditions
- **Excellent electric properties**
  High dielectric strength, low dielectric constant and very high electric resistivity (depending on fillers).
Metal

Stainless Steel and Nickel Alloys

Operating conditions in some areas – such as large-scale chemical plants or the energy sector – include temperatures above 300 °C or below -50 °C – which exceed the capacities of even the most powerful among the aforementioned “classic” sealing materials. Since the components to be sealed in these applications typically consist of metal, metal – in the form of stainless steel or nickel alloys – is suitable as a sealing material here as well. As the base material Parker Prädifa uses special nickel alloys – cobalt-nickel-chromium-tungsten or heat-treatable nickel-super alloys. These materials are used to manufacture spring-energized seals in C, E and other designs with high preloading force and considerable resilience.

Coatings/Plating

For wear protection, corrosion resistance and enhanced sealing properties, various types of coatings/plating – gold, silver, nickel or TriCom® – are available, depending on the requirements.

Summary

The growing importance of manufacturing large-diameter seals and other large-size engineered components requires a particularly high level of materials and manufacturing technology know-how. Through continuous refinement of existing and development of new products and the materials used in them, as well as their manufacturing technologies and related technical equipment, Parker Prädifa ensures that even large seals in rather small volumes can be economically produced at the required level of quality.