PolTolerances -
Tolerances for plastic moulded parts (according to ISO 20457 / DIN 16742)
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PolTolerances - preface

It is important for the manufacturer of plastic moulded parts and for the customer to agree meaningful dimensional tolerances. Too high accuracy requirements lead to high costs, e.g. for tools, in the production of moulded parts and thus in quality assurance. The dimensional, shape and position deviations in the application and production of plastic moulded parts cannot be compared with those of metal parts, as the properties of plastics and metals may differ considerably in application and production. The application of the new ISO 20457/DIN 16742 is recommended in order to take the technically feasible accuracies into account during the development of moulded parts.

Quick start

The following procedure is only a suggestion. The order of your input/decisions only plays a minor role. Results are immediately displayed or updated when all the necessary entries and decisions have been made.

1. Specify which tolerance values are to be used for the calculation. You can choose between "ISO 20457" and "DIN 16742" (Settings menu).
2. Define the evaluation method for determining the tolerance group. In the software, you can choose between "Point evaluation" and "Assignment help(s)".
3. Make all the necessary entries and decisions about the selected evaluation method.
4. Enter the part dimensions to be tolerated in the corresponding lists "Tolerance of length dimensions", "Tolerances for profile shape deviations" or "Direct position tolerance with cylindrical tolerance zones".
5. Optionally, you can specify a required functional dimension/a required tolerance for each nominal dimension. This is then automatically compared with the possible production dimension/tolerance.
6. If necessary, save your inputs and decisions in a file. We recommend that you create a corresponding file for each moulded part.

Application and decision aids

1. Tolerance principles and recommendations
2. scope of application
3. Definition equations for processing shrinkage
4. Causes and influencing factors on the processing shrinkage (VS) of non-porous plastics
5. Tool binding of the moulded part dimensions
6. Testing and structuring of the stiffness/hardness level of polymers without solid additives
7. Notes on the classification of tolerance groups according to process and moulding compound
8. Nominal sizes definitions
9. Dimensional reference planes, causes of dimensional changes and moulded part acceptance conditions
10. Notes on the classification of the tolerance series

Tolerance principles and recommendations
The principle of independence according to DIN EN ISO 8015 applies, deviations from this principle (e.g. envelope condition) must be agreed between the contracting parties.

Shaped part drawings or CAD data sets correspond to the nominal geometry. The tolerances are given as limit dimensions symmetrically to the nominal geometry. Asymmetrical tolerances of size dimensions (e.g. fitting dimensions) must be converted into a symmetrical tolerance field position by formal nominal dimension modification to the tolerance center dimension: 100-0.6 ∆ ; Ø9°0.25Ø

The verification of the part with regard to quality assurance must be clearly defined. The measuring concept is particularly important for parts that are not dimensionally stable, see also DIN ISO 10579.

Unless otherwise agreed, moulded parts may not be automatically rejected if the general tolerances are not complied with, provided the function is not impaired.

Constructively specified inclination differences due to draft angles are not part of dimensional tolerances or deviations in shape and position. In the specification, measurement points must be defined for function dimensions on inclined surfaces in order to define two-point dimensions.

To specify radii, at least 90° of the circle segment must be available as a measurable contour. Alternatively, radii can be tolerated by profile shape tolerances.

Freeform surfaces shall be specified with a profile shape tolerance. Verification shall be agreed

Directly tolerated angles and edges are subject to agreement. All angles and edges not directly tolerated are to be neglected during verification.

Separating crest, tool offset and their combination must be agreed with regard to the position of the separating lines between the customer and the manufacturer of the moulded parts.

With regard to the tolerance analysis of dimensional chains, it should be noted that the usual procedures require the rigid body. For plastic moulded parts, this condition is usually not sufficiently fulfilled due to the low stiffness of the moulding material and the distortion.

**scope of application**

ISO 20457/DIN 16742 is used to determine production-related possible tolerances (manufacturing tolerances) and for comparison with functional tolerances in order to check the attainability of a dimensional accuracy required by the design.

**Detected tolerances:** Limit deviations for size dimensions (two-point dimensions) as indirect tolerance (general tolerances) and as direct tolerance (dimension given on the nominal size dimension).

For tolerating deviations in shape and position with profile shape tolerances as general tolerances and position tolerances for direct tolerance through cylindrical tolerance zones.

**Process engineering basics:** original moulding process with tools closed on all sides, such as injection moulding, injection embossing, injection moulding and pressing of non-porous moulded parts made of thermoplastics, thermoplastic elastomers and thermosets as well as rotational moulding of thermoplastics. For special process variants of the above-mentioned processes, the standard can be applied analogously after agreement with the moulding manufacturer.

**Not normatively recorded:** Porous moulding materials (e.g. foams) and other processing and machining methods. The same also applies to process combinations of original forming and forming processes (e.g. injection blow moulding, injection stretch moulding).

Deviations from the surface quality of the molded part, such as sink marks, unwanted flow structures and roughness as well as weld lines are not the subject of the standard.

If tolerances outside the scope of the standard are required, these must be agreed with the manufacturer of
the moulded part and specified in the drawing.

**Definition equations for processing shrinkage**

<table>
<thead>
<tr>
<th>equations</th>
<th>explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{VS} = \left(1 - \frac{L_F}{L_W}\right) \cdot 100[%] )</td>
<td>Processing shrinkage</td>
</tr>
<tr>
<td>( L_F )</td>
<td>Part dimensions</td>
</tr>
<tr>
<td>( L_W )</td>
<td>Tool contour dimension</td>
</tr>
<tr>
<td>( \Delta \text{VS} = \left</td>
<td>\text{VS}<em>{\perp} - \text{VS}</em>{\parallel} \right</td>
</tr>
<tr>
<td>( \text{VS}_{\perp} )</td>
<td>VS transverse to the direction of melt flow</td>
</tr>
<tr>
<td>( \text{VS}_{\parallel} )</td>
<td>VS parallel to melt flow direction</td>
</tr>
<tr>
<td>( \Delta S = \text{VS}<em>{\text{max}} - \text{VS}</em>{\text{min}} )</td>
<td>( \Delta S ) Scattering range (shrinkage fluctuation) of the VS</td>
</tr>
<tr>
<td>( \text{VS}<em>{\text{max}}, \text{VS}</em>{\text{min}} )</td>
<td>Extreme values of the VS due to the respective influencing conditions</td>
</tr>
<tr>
<td>( \text{VS}<em>R = 0.5 \left( \text{VS}</em>{\text{max}} + \text{VS}_{\text{min}} \right) )</td>
<td>( \text{VS}<em>R ) Calculation value of VS, average of ( \text{VS}</em>{\text{max}} ) and ( \text{VS}_{\text{min}} )</td>
</tr>
</tbody>
</table>

**Causes and influencing factors on the processing shrinkage (VS) of non-porous plastics**

<table>
<thead>
<tr>
<th>causes</th>
<th>Influence on processing shrinkage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density increase due to thermal contraction by cooling the demoulding temperature to room temperature and compression by the action of pressure</td>
<td>lessening</td>
</tr>
<tr>
<td>• high effective pressure on moulding compound and contour until demoulding (holding pressure)</td>
<td>• low or prematurely reduced holding pressure until demoulding</td>
</tr>
<tr>
<td>• low demoulding temperature (long cooling time and/or low contour temperature)</td>
<td>• high demoulding temperature (short cooling time and/or high contour temperature)</td>
</tr>
<tr>
<td>• low coefficient of thermal expansion (hard elastic polymers)</td>
<td>• high coefficient of thermal expansion (soft or rubber-elastic polymers)</td>
</tr>
<tr>
<td>Density increase due to thermodynamically induced structural order processes (crystallization; gelation)</td>
<td>• amorphous polymers</td>
</tr>
<tr>
<td>• ow degree of crystallinity of semi-crystalline polymers due to rapid solidification (subcooling due to low contour temperature and/or thin-walled parts)</td>
<td>• high degree of crystallinity due to slow solidification (high contour temperature and/or thick-walled parts) and improved nucleation (nucleation additives)</td>
</tr>
<tr>
<td>• high degree of gelation of polymers containing plasticizers</td>
<td>• low degree of gelation of polymers containing plasticizers</td>
</tr>
<tr>
<td>Density increase due to molecular construction and cross-linking processes (curing; vulcanization;)</td>
<td>• high degree of cross-linking and thus lower coefficient of thermal expansion (long curing or vulcanization time and/or high</td>
</tr>
</tbody>
</table>
polyreaction) | melt temperature) | melt temperature)  
| Preformed or pre-crosslinked molding compounds (e.g. prepolymer) | non-crosslinked precursors (oligomers) or monomers as molding compositions

Changes in stiffness or hardness due to additives (e.g. fillers and reinforcing materials; plasticizers)  
- Additives with low coefficient of thermal expansion (e.g. inorganic fillers and reinforcing materials)  
- no or low plasticizer additives  
- Additives with high coefficient of thermal expansion (e.g. organic fillers and reinforcing materials)  
- plasticizer additives

**Tool binding of the moulded part dimensions**

Different deformations and positional deviations of tool parts due to compressive stress are detected by differentiating between tool-bound and non-tool-bound part dimensions. Tool-related dimensions are dimensions in the same tool part, while dimensions that are not tool-related are created by the interaction of different tool parts and thus tend to cause larger dimensional variations. In addition to the rigidity of the tool design, the processing conditions have a significant influence. For the graphical demonstration of corresponding dimensions (x), a corresponding representation from ISO 20457/DIN 16742 was adopted.

**Testing and structuring of the stiffness/hardness level of polymers without solid additives**

<table>
<thead>
<tr>
<th>hardness</th>
<th>E in N/mm²</th>
<th>Shore</th>
<th>IRHD</th>
<th>Polymers</th>
</tr>
</thead>
</table>

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**grade** | **hardness** | **Remarks**
---|---|---
hard | > 5000 to 20000 |  \( \hat{w} \)  
| > 1200 to 5000 | > 75 D |  \( \hat{w} \)  
| | | Tough to brittle hard thermoplastics, thermosets, hard rubber  
semi-hard | > 300 to 1200 | > 60 to 75 D |  \( \hat{w} \)  
| > 30 to 300 | > 35 to 60 D |  \( \hat{w} \)  
soft | 3 to 30 | 50 to 90 A | 50 to 90  
exremely soft | < 3 | < 50 A | < 50

**E**: E-module of origin from the short-time tensile test according to DIN EN ISO 527  
**Shore hardness**: Penetration hardness according to DIN EN ISO 868 (Methods A and D)  
**IRHD**: International rubber hardness (ball indentation hardness) according to DIN EN ISO 48

All tests are carried out at 23 °C and with normal conditioned test specimens.

- Steel for comparison:  \( E = 200\,000 \text{ N/mm}^2 \)
- Filled or reinforced polymers can be assigned with their modulus of elasticity.

**Notes on the classification of tolerance groups according to process and moulding compound**

- To classify the process, it can only be stated that "spraying processes" allow a higher production accuracy than pressing processes.

- The classification of moulding material stiffness and hardness is unproblematic, as corresponding data are always available (moulding material manufacturers, databases). The classification of cross-border data is at the discretion of the user.

- The classification of the expected calculation value of the processing shrinkage should be agreed with the manufacturer of the moulded part, if no own experience is available. A detailed compilation of guide values is available in the programme as a guide.

- The assessment of the expected fluctuations in shrinkage may be problematic as a result of many influencing factors. This is where the moulded part manufacturer can be expected to provide the most effective help. In case of doubt, "only inaccurately possible" should be entered in order to consider further processing by means of a more precise tolerance series if necessary. ISO 20457/DIN 16742 specifies the following aids for classification:
  - **Exactly possible**: Calculated values of the VS are known, e.g. from experience, systematic measurements, computer simulations. Shrinkage anisotropy is insignificant or can be sufficiently accurately considered in the respective dimensional direction. Possible deviations
from the calculated value are max. ± 10 %.

- **Accurately possible**: Calculated values are known in ranges up to ± 20 %.

- **Only inaccurately possible**: Calculated values of the VS are only known as rough guide value ranges. Shrinkage anisotropy cannot or only insufficiently be considered. Practical experience for estimating relevant calculation values is not available. Possible deviations from the calculated value are above ± 20 %.

In agreement with the users of rotational moulding of thermoplastics, the tolerance group TG9 was defined for this process.

For multicomponent parts, the tolerance group must be determined for each material and specified as a separate general tolerance (e.g. hard component according to TG5, soft component according to TG7). The more inaccurate material is the basis for defining tolerances for all material sizes.

### Nominal sizes definitions

**Nominal size dimensions (linear dimensions, two-point dimensions)** for limit deviations according to Table 2 of ISO 20457/DIN 16742 are tolerance center dimensions for drawings and CAD data sets.

**D_p-Dimensions (distance dimensions)** according to ISO 20457/DIN 16742 are nominal dimensions for position tolerances according to Table 9 and for profile shape tolerances according to Table 10 with the following definition:

> „A component can have one or more reference systems. To determine the profile shape and position tolerance, the longest distance of the tolerated element to the origin of the reference system (D_p dimension) used for profile shape and position tolerance shall be used. This does not have to match the coordinate system of the part or assembly.“

An example of position tolerance is given in Appendix G of ISO 20457/DIN 16742.

For tolerating the distance of parallel surfaces which are not directly opposite each other but are arranged offset from each other, the D_p dimension for limit dimensions according to Table 9 of ISO 20457/DIN 16742 is provided as the nominal size dimension. Furthermore applies:

- Nominal dimensions below 1 mm and above 1000 mm are subject to agreement.

- For general tolerances, only the limit dimensions for moulded part dimensions that are not tool-bound apply.

- Limiting dimensions for wall thicknesses are subject to agreement.

- General tolerances shall be specified in the design documentation as follows: Example: DIN 16742 w TG6.

### Dimensional reference planes, causes of dimensional changes and moulded part acceptance conditions

The dimensional variation in the application and production of plastic moulded parts requires the consideration of three closely connected dimensional reference planes: **Parts application, parts production, tool production**. For the dimensional reference planes, different physical causality relationships must be observed and systematically merged, whereby the design of the construction is to be
processed mentally in the opposite direction to the direction of dimension formation. The principle of different dimensional reference planes is also clearly explained in DIN 16742 (Annex A).

Figure 1 shows the dimensional quantities and dimension relationships with respect to position (center of tolerance dimension C), displacement (offset $\Delta l$), and dispersion (tolerance $T$) for the dimensional reference planes. The direction of the dimensional displacement is taken into account by sign.

![Diagram of dimensional reference planes](image)

**Conditions of use (COU):** All conditions of use and storage of the parts during the period of use after manufacture, provided that they affect the dimensional accuracy and functional performance of the products.

If assembly or completion of the individual parts to form assemblies only takes place in longer periods after the parts have been manufactured, the parts storage and completion conditions may have to be treated as a special case by the COU. For soft or rubbery moulding materials, the influence of the COU can often be neglected. The same applies to assemblies made of completely identical materials. In each individual case, however, the COU must be determined depending on the situation and function. For the part user, the recording of the company-specific COU and its influence on dimensional accuracy is a useful rationalization tool. A general compilation or standardization of all COU is not possible due to the large number and complexity of the influences.

**Cause factors of the application-related dimensional change** (all relevant factors are summarised in groups below):

- Climate effects due to ambient temperatures, humidity, precipitation and solar radiation,
- Energy effects caused by heat sources and high-energy radiation,
• Diffusion contact with vapours and liquids as well as migration contact with solids,
• Material removal (wear) due to friction, cavitation and erosion as well as biological influences,
• Mechanical deformation by external forces and moments as well as by relaxation of internal stresses,
• Molecular and micromorphological material structure transformations.

Causes for length deviations due to production:
• Scattering of processing shrinkage depending on moulding compound and production,
• Uncertainties in the determination of calculated values of the processing shrinkage for tool contour calculation, especially with large shrinkage values and with shrinkage anisotropy,
• Different reshaping behaviour of the parts after demoulding, depending on the stiffness or hardness of the moulding material,
• Production-related dimensional variation of the tool contours including hardness distortion and surface coating,
• Deformations and positional deviations of tool parts due to compressive stress,
• Tool contour wear.

Causes of moulding distortion: Distortion (warping, twisting, warping) is the physical cause of deviations in shape, position and angle of the plastic moulded parts. It is caused by local and direction-dependent shrinkage differences (shrinkage anisotropy) and at extreme post- or compression pressure by re-deformation (relaxation) of elastic residual stresses. In principle, distortion of molded parts cannot be avoided, but can be minimized (Chapter 5).

Acceptance conditions for the production of fittings (ACF): For normative acceptance conditions according to ISO 20457/DIN 16742 and DIN EN ISO 219, the test dimensions are considered acceptance values if the fittings are stored at 23 °C ± 2 K and 50 % ± 10 % relative humidity after production until acceptance and are tested at the earliest 16 h and at the latest 72 h after manufacture.

In case of deviations from the normative ACF, the acceptance parameters for the control dimension test according to ISO 20457/DIN 16742 must be agreed and documented separately between manufacturer and customer:
• Dimensional position and deviations (if necessary after testing),
• Dimensional inspection procedures,
• Minimum and maximum period of dimensional inspection after parts production,
• Storage and test conditions until parts are removed (room air temperature, relative air humidity, special storage regulations if necessary).

Deviations from the normative ACF can be:
• Subsequent operations at the parts manufacturer with material application (painting, coating) or material removal (machining, grinding, polishing),
Post-treatment of parts by tempering (anticipation of post-shrinkage, compensation of internal stresses, post-hardening) or subsequent operations with significant thermal stress on parts (painting, solder bath treatment, etc.)

Partial after-treatment by conditioning, e.g. by watering (anticipation of swelling, increase in toughness),

Low dimensional stability of the structure and condition of the moulding material at ACF. Examples are structural changes in the crystalline phase of semi-crystalline polymers (e.g. PB) and swelling as well as softening due to water absorption of thin-walled molded parts made of hydrophilic polymers (e.g. PA6, PA66, PA46, biopolymers).

Acceptance conditions for tool production (ACT): The control dimensions of the tool contours determined by testing are considered acceptance values at a reference temperature of 23 °C ± 2 K. They include hardening distortion.

Notes on the classification of the tolerance series

According to ISO 20457/DIN 16742, the realization of the required level of accuracy in the production of moulded parts requires an assignment to the tolerance series:

| Series 1 (standard production): Production with general tolerances may be possible. Dimensional requirements are not a particular focus of quality. |
| Series 2 (precise production): Production and quality assurance are oriented towards higher dimensional accuracy requirements. |
| Series 3 (precision production): Complete alignment of production and quality assurance to the very high dimensional accuracy requirements |
| Series 4 (special precision production): Same as series 3, but with intensified process monitoring. |

Tolerance series 3 and 4 are always subject to agreement

Only absolutely necessary small functional tolerances justify the production costs of series 3 and 4, which must be compensated for with a significant surcharge. Therefore, it must first be clarified between the customer and the manufacturer whether the tolerance requirements can be met. Self-deceptions are bad advisors for all cooperation partners. The following conditions should be checked with appropriate expertise:

- Dimensionally accurate design and dimensioning of the moulded part.
- Functional safety of tools that are sufficiently rigid and thermally and rheologically balanced.
- Operation of necessary machines and systems by sufficiently qualified operating personnel including quality assurance.
- Delivery conditions of the molding compounds with regard to dimensionally relevant properties, in particular fluctuations in shrinkage.

To support the assignment of the tolerance series, selection criteria for thermoplastic injection moulding are listed in Appendix D of DIN 16742 as examples. These selection criteria are taken into account internally by an extended selection algorithm.

How to use

We have published a corresponding YouTube video for a quick introduction to how to use the software. You
can find the link to the video on our website in the description of the respective software product.

**Project / Project files**

- You can manage all your input and decisions in individual project files.
- Usually, a project file considers a single molded part to be tolerated.
- You can protect certain decisions by accidentally editing them by ticking the corresponding box in the "Project management" tab. This editing protection is additionally highlighted by a corresponding icon and saved in the project file.

### Import of dimensions

Sie können Daten aus einer CSV-Datei importieren. Dazu sind folgende Voraussetzungen erforderlich bzw. die CSV-Datei muss folgender Spezifikation entsprechen.

1. Die Spalten der CSV-Datei müssen durch ein Semikolon voneinander getrennt sein.
2. Als Dezimaltrennzeichen für Zahlenangaben muss das Komma verwendet werden.
3. Es **muss** eine Spalte in der CSV-Datei existieren, in der die Tolerierungsart angegeben ist. Folgende **Begriffe** sind **zulässig**, um die jeweilige Tolerierungsart zu definieren:
   - Tolerierung von Längenmaßen (LaengenmaszTol oder Dimension oder Radius oder oder **Parallelism**)
   - Toleranzen für Profilformabweichungen - Flächenformtoleranz (ProfilFormabweichungFlaeche oder Flatness oder **Surface Profile**)
   - Toleranzen für Profilformabweichungen - Linienformtoleranz (ProfilFormabweichungLinie oder **Line Profile**)
   - Direkte Positionstolerierung mit zylindrischen Toleranzzonen (PositionsTol oder **True Position**)
4. Es **muss** eine Spalte in der CSV-Datei existieren, in der das zu tolerierende Maß angegeben ist.
5. Es kann optional ein symmetrisches Funktionsabmaß in einer Spalte enthalten sein. Wollen Sie, dass automatisch asymmetrische Funktionsabmaße in ein entsprechendes Nennmaß mit entsprechend symmetrischem Funktionsabmaß umgerechnet werden soll, muss in der CSV-Datei sowohl ein Spalte für das untere und obere Funktionsabmaß enthalten sein.
6. Es kann optional eine Spalte in der CSV-Datei enthalten sein, in der ein beliebiger Text zum jeweiligen Maß enthalten ist, der dann als Bemerkung übernommen wird.

Eine entsprechende CSV-Datei zum Testen des Imports finden Sie auf unserer Internetseite im Software-Download-Bereich.
Bedienung

1. Über das Menü "Daten" und den Menüpunkt "Import von Maßen (CSV-Datei)..." gelangen Sie zum nachfolgenden Import-Dialog.

2. hier wählen Sie (oben links) die CSV-Datei aus. Der Inhalt wird dann als Text unmittelbar darunter in einer einfachen Vorschau angezeigt


4. Geben Sie an, ob die Maße, die außerhalb des Gültigkeitsbereiches der Norm liegen, ignoriert werden sollen


6. Geben Sie an, ob das Maß als Wanddickenmaß gekennzeichnet werden soll (wenn die Bedingungen laut DIN hierfür gegeben sind)

7. Geben Sie an, ob das Maß als werkzeuggebundenes Maß gekennzeichnet werden soll (wenn die Bedingungen laut DIN hierfür gegeben sind)

10. Sobald alle notwendigen Eingaben vorhanden sind, können die Daten (durch Klick auf den Schalter "Übernehmen") importiert werden.

**Feasibility of required functional dimensions**

The software contains functions to determine under which conditions a certain functional dimension can be realized.
To do this, open the corresponding menu item in the "Extras" menu.

A window then opens in which you enter the nominal size dimension and the required functional dimension. You must also make decisions about the wall thickness dimension and whether it is a tool-bound or non-tool-bound dimension.

As soon as all entries are complete, you can start the function using the [Find/Refresh] button. If results are found that are smaller than or equal to the required functional dimension, this is displayed in the list (below the input).

The list can be sorted by the individual columns.

**Commercial products**

This part of the software is optionally available.

The software component contains an extensive list of plastic commercial products with the most important properties and property diagrams. The information on the properties is based on the currently published data of the plastics manufacturers.
Unfortunately, we cannot accept any responsibility for the accuracy and completeness of the data. You can also find the data - in a similar form - on the Internet (e.g. https://www.campusplastics.com).

**Comparison of property values**

- You can compare the property values of different commercial products. To do this, the selected commercial products are transferred to a corresponding matrix/table view.
- To do this, simply select the desired commercial product in the corresponding view by double-clicking with the left mouse button. This will transfer the commercial product into the matrix.
- Click the [Compare...] button to display the corresponding window. You can leave the window open and add further trading products.
- **Note:** The amount of data published for the commercial products may vary greatly per compound manufacturer and per commercial product.

**Distribution of Property Values**
Depending on the selected property, the corresponding values are displayed in ascending order (from left to right). The number of points indicates how many different property values are contained in the database. One or more commercial products can be assigned to each point.

Move the mouse pointer over one of these points to display the corresponding trading products in the tooltip.

You can enlarge parts of the view by holding down the left mouse button and selecting the area of interest.

By double-clicking with the left mouse button, the entire view is displayed again.

In addition to the property, you can also filter by polymer families. To do this, enter the name or the first characters of the name of a polymer family in the corresponding input field.

To filter by several polymer families, separate the individual polymer abbreviations with a semicolon.

Examples:

- **PA6** - searches all entries whose polymer families begin with **PA6**
- **(ABS** - searches all entries whose polymer family begins with **ABS**
- **PV; (ASA+** - searches all entries whose polymer family begins with **PV** or **ASA**
- **