PolSelec - Material selection system for plastics
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**PolSelec - Intro**

**PolSelec**

... the material selection and information system for plastics ...

The designer of plastic products must have at least a rough idea of the applicable materials and manufacturing processes at the latest after specifying the task and after selecting active principle solutions.

Therefore we have developed the software **PolSelec** for the pre-selection of basic material types and associated manufacturing processes for the material and process pre-selection. The conceptual approach to this decision algorithm was developed back in 1978.

The basic plastic types are displayed and printed by means of abbreviations based on ISO 1043 and DIN 7728 and in compliance with the respective DIN moulding compound standards. **PolSelec** requires some modifications and additions to the abbreviations, which are, however, largely in line with usual spellings.

**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.

**Quick start**

1. After starting, switch to the **Selection Criteria** tab.
2. In the selection structure, select the selection criteria that are relevant for you. To do this, you must display the last level.

![Selection criteria diagram]

3. In the last level, either a so-called **checkbox** or a so-called **radio button** appears.
4. Select the corresponding criteria.
5. The selection starts immediately (if you have set the option **Immediate selection**).

![Selection criteria interface]

6. The number of materials found is displayed in the header text of the **Selection criteria** tab.
7. Switch to the tab **Results (list of materials)** to display the materials found.
8. If necessary, select a material in the list to display details to the right of it.

**Extras/additional functions**

The following extras/additional functions are currently supported:

- **Climae maps:** among other things for the consideration of weathering and heat resistance
- **Heat aging:** permissible application temperature at continuous heat load
- **Permissible recycled content:** Determination of permissible recycled material percentages in the processing of thermoplastics

**Heat aging**

In the tab "Extras/Additional functions" you will find another tab "Heat aging".

The experience-based Montsinger rule, which specifies a halving of the service life of organic materials at a temperature increase of 10 K, is assumed. The Arrhenius law is used for the mathematical evaluation of heat ageing.

**Determination of permissible recycled material percentages**

You would like to know the maximum amount of recyclate that can be added during processing to ensure that a specified property limit value is not exceeded.
General information

The reprocessing of thermoplastic return material (reclaim, regranulate, recyclate) usually fails because of the uncertainty about the effect of recycling additives on the quality of plastic products under practical conditions. This is usually based less on objections that can be justified on factual grounds than on prejudices that generally label waste additives as an impermissible quality risk, and on a lack of experience.

By a combination of experiment and calculation the permissible recyclate portions for measurable quality criteria of plastic products are determined. This concept has been thoroughly tested experimentally for the most important plastics, processes and quality requirements.

As an example, the shortest recycling path (closed material cycles in the processing plant) is used, which offers the greatest economic and ecological advantages. The well-known dependence of the part properties on the processing cycles leads to the determination of the limit recyclate content. Above a certain limit recyclate content, the specified property limit value is no longer undershot or exceeded, even with any number of material cycles. This limit is identical with the maximum permissible proportion of return material. Lower percentages do not pose a problem for the utility value of the product.

If this limit value is determined by systematic tests, a considerable effort (tests, measurements, evaluations) is involved. Instead of predicting the property changes by means of complex tests, it is advisable to use a calculation model to determine the limit recyclate content in this way.

For the recyclate content that can be added, which does not exist as a material-related fixed value, the flat-rate value of 20% is often mentioned in the company literature of the raw material manufacturer. In fact, however, this percentage can often be considerably exceeded depending on the moulding. With
regard to the processing properties, the influence of the recyclate on intake and flow behaviour (molecule degradation/crosslinking reactions) must be taken into account. However, the usual deviations in processing parameters (time, temperature, pressure) can usually be neglected.

**Processing cycle for determining permissible proportions of regenerated material:**

![Diagram](image)

**Basic data / master curves**

The basis for the forecasts is a measurement series or master curve. This measurement series represents the course of a measured property of a certain type of plastic with 100% use of regenerated material. This means that original material is processed and then the determining property is measured on the products or test pieces. Then all products or test specimens are regenerated and 100% reprocessed. Subsequently, measurement is carried out again, regenerated and returned. This cycle should be repeated approx. 6 to 10 times.

The software currently contains approx. 200 of these master curves for different plastics, properties and manufacturing processes.

Furthermore, you can also enter measured values of your own measurement series/master curves and have the permissible regenerate content determined from them.

**Using the functions**

The influence of different regenerate contents on the property profile can be considered. Here you can specify the desired regenerate content. The software then determines the corresponding characteristic curve.
1. In the list, select the appropriate material, manufacturing process and property (the list can be sorted according to the contents of the columns).

2. If there is/was a property change due to the use of recycled material for the selected entry, the corresponding values and the **calculated values are displayed graphically**. If not, a corresponding note is given that no change in properties could be observed due to the use of recycled material.

3. You can now vary the proportion of recycled material in such a way that a certain property limit value is not fallen below or exceeded. The calculation starts immediately after changing the corresponding value.

4. You can switch the display to absolute values or relative values.

5. If the master curves contain value ranges (from/to values), you also have the option of using the corresponding **mean values instead** of the from/to values.

**own measurement series/master curve**
A click on the button [own measurement series] opens another window.

Enter information here on the material, the property and, if necessary, the unit of measurement and select the addition rule. Then enter your measured values in the list. At least 6 values must be entered.

To delete a line in the list, mark the line and press the [Del] key.

When you are done, press the [Apply] button. The window is closed and the data file is added to the list and displayed immediately.
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+**
PolSelec - Material identification

The formal framework of the abbreviation notation is the three-part data block system provided with examples below:

<table>
<thead>
<tr>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field 1</td>
<td>Field 2</td>
<td>Field 3</td>
</tr>
<tr>
<td>PP</td>
<td>-B</td>
<td>-VI</td>
</tr>
<tr>
<td>(PC+ABS)</td>
<td></td>
<td>V0</td>
</tr>
<tr>
<td>S/B</td>
<td>-T</td>
<td>T20+GF10</td>
</tr>
<tr>
<td>PE</td>
<td>-UHMW</td>
<td>GF15±5</td>
</tr>
<tr>
<td>PF31.5</td>
<td>-N</td>
<td>GF15±5</td>
</tr>
<tr>
<td>Hgw2082</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Block 1**

If necessary, the **block 1** can be composed of four fields, each separated from the other by "-". In the **field 1**, the base polymer is entered by abbreviations in accordance with DIN 7728 or the future DIN ISO standard. In the case of polymer blends, the polymer with the highest mass content is written first. After this basic polymer, the blend is assigned to the characteristic polymer groups in **PolSelec**. In addition, the blend composition can be indicated by mass percentages on the respective polymer abbreviation, e.g. (PC+ABS35).

In Germany, plastic type abbreviations for curable moulding compounds and laminates that have already been bindingly defined are entered in the **field 1** in accordance with the applicable DIN standard:

- DIN 7708: Phenolic and aminoplast moulding compounds, cold moulding compounds
- DIN 16913: Polyester resin mats (prepreg)
- DIN 16946: Casting resin moulding materials
- DIN 16926: Decorative laminates A
- DIN 7735: Hard paper, hard tissue and hard mat laminated materials
- DIN 7737: Vulcanized fibre

If appropriate, these type designations are supplemented by the basic polymer abbreviation (e.g. MF152) and reduced in scope (e.g. Vf311 instead of Vf3111).

In the **field 2**, information on substance formation processes and/or material composition may be given by the following letter meanings:

- **B**: Block polymer
- **C**: chlorinated
- **E**: Emulsion polymer
- **G**: Cast resin
- **H**: Homopolymerisate
- **L**: graft copolymer
- **M**: Bulk polymer
- **N**: Novolak
- **P**: plasticized
- **Q**: Polypropylene-olefin elastomer blend
- **R**: Statistical copolymer;resol
S: Suspension polymer
U: plasticizer-free

If several characteristics are specified, these are separated by commas (e.g. PVC-U,S).

The field 3 is used to indicate characteristic polymer properties by a combination of the following letter characters:

D: Density
F: flexible, soft
H: high
I: impact resistant
L: linear, low
M: mass, medium, molecular
N: normal
U: ultra
V: very
W: Weight
X: networked, networkable

Examples:
ultra-high molecular weight - UHMW
linear & low density - LLD
very soft - VF
high impact - HI

The equality of some letters with those of the field 2 does not lead to misinterpretations, since they cannot appear as single characters.

In the field 4, special properties of the plastics are displayed if necessary, which are achieved by special equipment and/or processing or by chemical modification:

AR: particularly low frictional resistance and/or high wear resistance
CR: particularly resistant to chemicals
FR: Fire protection equipment
GC: particularly suitable for electrochemical metallization
RM: modified for reduced water absorption (Reduced Moisture)
T: increased transparent
Y: electrically conductive (volume resistance below 1000 W-cm)
Z: antistatic equipment

It is not possible to confuse the abbreviation CR with the same abbreviation for polymers with a narrow molecular weight distribution (controlled rheology), since PolSelec does not take rheological properties into account. If several special properties apply to the basic plastic type, these are separated by commas and inscribed in the field 4 (e.g. PC-AR,FR).

block 2

Type characteristics can be specified in the block 2 by class allocation or numerical value ranges. In PolSelec these are mainly the following properties:

- Material density in g/ccm at 23°
- Fire classes according to UL94:
- Dimensional stability temperature in °C according to DIN 53461:
- Martens temperature in °C according to DIN 54462:
- Vicat temperature in °C according to DIN ISO 306:
- Shore hardness A or D acc. to DIN 53505:
Ball indentation hardness in N/mm² according to DIN 53456: H...

Block 3

The block 3 is intended for marking the type, quality and quantity of additives, in particular fillers and reinforcing materials. Quantities are given in percent by mass as fixed values or ranges. Types and forms of additives are designated by letters or letter combinations in accordance with ISO 1043, whereby extensions of this designation system are required for PolSelec:

- **AF**: asbestos fibre
- **AP**: Asbestos paper
- **AT**: Asbestos cords
- **AW**: Asbestos fabric
- **CF**: carbon fiber
- **CB**: carbon black
- **CG**: Graphite
- **CR**: Carbon fiber strands
- **CW**: carbon fibre fabric
- **COC**: Cotton shred
- **COF**: cotton fibre, cotton flocks
- **COW**: Cotton fabric
- **GB**: solid glass microspheres
- **GHB**: hollow glass microspheres
- **GD**: glass powder
- **GF**: glass fibre
- **GFC**: chemically coupled glass fibre
- **GG**: Glass fibre ground material, very short glass fibre
- **GK**: Glass fibre knitted fabric
- **GM**: Glass fiber mats and matte analog structures
- **GR**: Glass fibre roving, Unidirectional glass fabric
- **GS**: long glass fibre reinforced rod moulding compound (duromers only)
- **GW**: orthogonal glass fibre fabrics and scrims
- **K**: chalk, calcium carbonate
- **LC**: Cellulose paper pulp
- **LF**: cellulose fibre and flakes
- **LGF**: long glass fibre
- **LGFC**: chemically coupled long glass fibre
- **LP**: cellulose paper
- **M**: unspecified minerals
- **PD**: Mica powder
- **PS**: mica scales, leaflets
- **PP**: mica paper, foil
- **RF**: aramid fibre
- **RM**: Aramid fibre mats
- **RR**: Aramid fibre strands
- **RW**: orthogonal aramid fibre fabric
- **SC**: Synthetic fabric chips
- **SF**: Synthetic fibre
- **SK**: Synthetic knitted fabrics
- **SM**: Synthetic mats and scrims
- **SW**: orthogonal synthetic tissues
- **SR**: synthetic fibre strands, unidirectional synthetic fabric
- **T**: Talcum
- **WD**: wood flour
- **WC**: wood chips and shavings
- **WV**: Wood veneers

In the case of all additives not listed above or not specified precisely, the substance name can, if necessary, be indicated by standardized or industry-standard abbreviations (e.g. abbreviations for metal...
alloys, plasticizer abbreviations according to DIN 7723) or, in the case of substances sufficiently defined chemically, by the chemical gross formula (e.g. pure iron = Fe, barium sulphate or barite = BaSO4). It is also possible to use a capitalized text name to describe the substance. Polymer additives which are not to be regarded as blending components (e.g. PTFE, silicone) are designated like other additives. If necessary, the form and nature of the additives, separated by “-”, are indicated after the substance name with the following letter meanings:

- **B**: balls, beads, lenses
- **C**: Schnitzel, shavings
- **D**: Flour, powder, semolina
- **F**: fibre, fibre tufts, flakes
- **G**: Fibre ground material
- **H**: Whiskers
- **K**: Knitted fabrics
- **M**: Mats, fleeces
- **P**: Paper, foil
- **R**: Roving, strands, wires, unidirectional amplification general.
- **S**: Leaflets, scales
- **V**: Veneer
- **W**: Fabric, scrim

**Examples:**

- Aluminium powder: Al-D
- Aluminium powder: Al-D
- Aluminium hydroxide: Al(OH)₃
- Polycaprolactam fabric: PA6-W
- Dioctylphthalate: DOP
- Metal whiskers in general: METALL-H
- Steel fiber tuft: St-F
- Titanium white, titanium dioxide: TiO₂

The indication of the additives in the block 3 is possible in the following variants:

1.) **ONE ADDITIVE:**
   - Without quantity specification (e.g. PE-HD-Z...CB)
   - Percentage mass fraction as fixed value or range (e.g. PA6...GF30, PA6...GF30±5)

2.) **SEVERAL ADDITIVES:**
   - Without quantity specification (e.g. PE-UHMW...Al-D+CG)
   - Flat-rate percentage of total mass as fixed value or range (e.g. EP...(GF+M)₆₅, EP...(GF+M) ₆₅±₅)
   - Differentiated percentage mass components as fixed values or ranges (e.g. PP...GF₂₀+T₁₅, PP...GF₁₅±₅+T₁₀±₅)
   - Various additives in small proportions alternatively individually or combined (e.g. POM-AR...SILIKON,MoS₂).

**FAQ’s**

**Question/Problem:**

What distinguishes PolSelec from other plastic databases or plastic selection programs?

**Answer:**

PolSelec is a selection program in which the materials or basic material types are assigned to characteristic value ranges. It serves for the pre-selection of plastics at the beginning of the development process. The aim of this preselection is to ensure that the optimum material
to be specified later is definitely among the selected basic material types. **All basic material types are assigned to all selection criteria (without gaps).** This ensures that all materials are taken into account in the selection. The fact that a material is not included in the selection due to missing data is excluded in PolSelec.

**Question/Problem:**

What is a basic material type?

**Answer:**
Basic material type in the sense of this selection procedure is a superordinate type representative for a different number of special commercial products (special material types) with very similar properties and similar material properties.

**Question/Problem:**

Why should a pre-selection of plastics be made?

**Answer:**
Material decisions begin with the selection of materials at the earliest possible stage of the design development process. The starting point is relatively few product requirements that determine the use of the material. In plastics technology, the particularly close relationship between product design, material and manufacturing process forces the material selection and the predetermination of the manufacturing process to be carried out simultaneously. The results of the material selection are all basic material types for which there is a certain chance of application. The optimum material to be specified later must certainly be among these basic types.