

Polyacetal (POM)

DURACON®

M140-44

CF2001

(Standard grade)

General Properties of M140-44

table1-1 General Properties (ISO)

| Item | Unit | Test Method | Standard |
|--|---|-------------------------|----------------------|
| | | | M140-44 |
| | | | High Flow |
| Color | | | CF2001 |
| ISO(JIS)quality-of-the-material display: | | ISO11469 (JIS K6999) | >POM< |
| Density | g/cm ³ | ISO 1183 | 1.41 |
| Water absorption (23℃,24hrs) | % | ISO 62 | 0.5 |
| MFR (190℃、2.16kg) | g/10min | ISO 1133 | 14 |
| MVR (190℃、2.16kg) | cm ³ /10min | ISO 1133 | 12 |
| Tensile strength | MPa | ISO 527-1,2 | 62 |
| Strain at break | % | ISO 527-1,2 | 33※1 |
| Tensile modulus | MPa | ISO 527-1,2 | 2,700 |
| Flexural strength | MPa | ISO 178 | 87 |
| Flexural modulus | MPa | ISO 178 | 2,500 |
| Charpy impact strength (notched) | kJ/m ² | ISO 179/1eA | 5.5 |
| Temperature of deflection under load (1.8MPa) | ℃ | ISO 75-1,2 | 100 |
| Coefficient of linear thermal expansion (23 - 55℃、Flow direction) | x10 ⁻⁵ /℃ | Our standard | 11 |
| Coefficient of linear thermal expansion (23 - 55℃、Transverse direction) | x10 ⁻⁵ /℃ | Our standard | 11 |
| Dielectric breakdown strength (3mmt) | kV/mm | IEC 60243-1 | 19 |
| Volume resistivity | Ω·cm | IEC 60093 | 1 × 10 ¹⁴ |
| Surface resistivity | Ω | IEC 60093 | 1 × 10 ¹⁶ |
| Volume resistivity (Our standard) | Ω·cm | | - |
| Surface resistivity (Our standard) | Ω | | - |
| Rockwell hardness | M(Scale) | ISO2039-2 | 80 |
| Specific wear amount (vs C-Steel, material side, pressure 0.98MPa, 30cm/s) | x10 ⁻³ mm ³ /(N·km) | JIS K7218 | 0.30 |
| Specific wear amount (vs C-Steel, steel side, pressure 0.98MPa, 30cm/s) | x10 ⁻³ mm ³ /(N·km) | JIS K7218 | 0.01> |
| Coefficient of Dynamic Friction (vs C-Steel, pressure 0.98MPa, 30cm/s) | | JIS K7218 | 0.40 |
| Specific wear amount (vs M90-44, material side, pressure 0.06MPa, 15cm/s) | x10 ⁻³ mm ³ /(N·km) | JIS K7218 | - |
| Specific wear amount (vs M90-44, M90-44 side, pressure 0.06MPa, 15cm/s) | x10 ⁻³ mm ³ /(N·km) | JIS K7218 | - |
| Coefficient of Dynamic Friction (vs M90-44, pressure0.06MPa, 15cm/s) | | JIS K7218 | 0.37 |

| Item | Unit | Test Method | Standard |
|---|------|-------------|------------------------|
| | | | M140-44 |
| | | | High Flow |
| Flammability | | UL94 | HB |
| The yellow card File No. | | | E45034 |
| Appropriate List number of Ministerial Ordinance for Export Trade Control | | | Item 16 of Appendix -1 |

※1) Nominal strain at break

All figures in the table are the typical values of the material and not the minimum values of the material specifications.

Introduction

Duracon® POM is a representative engineering plastics material that possesses numerous excellent properties, together with good flowability when molding. It is used in a wide variety of applications centered on functional parts in various industrial applications.

From a processing perspective and a perspective of the required performance in molded parts, there are various suitable grades and series available.

Here, we introduce **the “-44” series**, which is used widely as standard grade of Duracon.

The “-44” series includes the general purpose intermediate viscosity type **M90-44**, the high flow types **M140-44** and **270-44**, and the ultra-high flow type **M450-44**. In addition, there is high viscosity type **M25-44** indicating the superiority of creep resistance or fatigue properties.

1. Performance characteristics of -44 series

1.1 Prevention of deposit formation at electrical contacts

For the previous grades M90-02 and -04, M90-12 and -14, deposits can be formed in parts in the proximity of electrical contacts under certain high temperature conditions. This can result in component failure. In such cases, grades in the-44 series can solve these problems.

1.2 Short- and medium-term light fastness and weatherability

For applications where a high level of weatherability is necessary over extended periods outdoors, the results of outdoor irradiation tests over a relatively short time are shown in table 1-1 for natural colored grades.

Table 1-1 Light fastness of DURACON® POM M90-44
(Outdoor exposure of 30 days)

| Item | | DURACON® M90-44 |
|---|-------|--------------------|
| Tensile strength (30d) Retention (%) | | 100 |
| Tensile elongation (30d) Retention (%) | | 73 |
| Discoloration Δ E | (8d) | 1.9 |
| | (19d) | 2.2 |
| | (30d) | 2.8 |

Note: Discoloration is determined from the equation shown below using a hunter-type color meter with Δ L, Δ a and Δ b defined as values of L, a and b after exposure respectively.

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

1.3 Long-term characteristics

1.3.1 Heat stability at elevated temperature

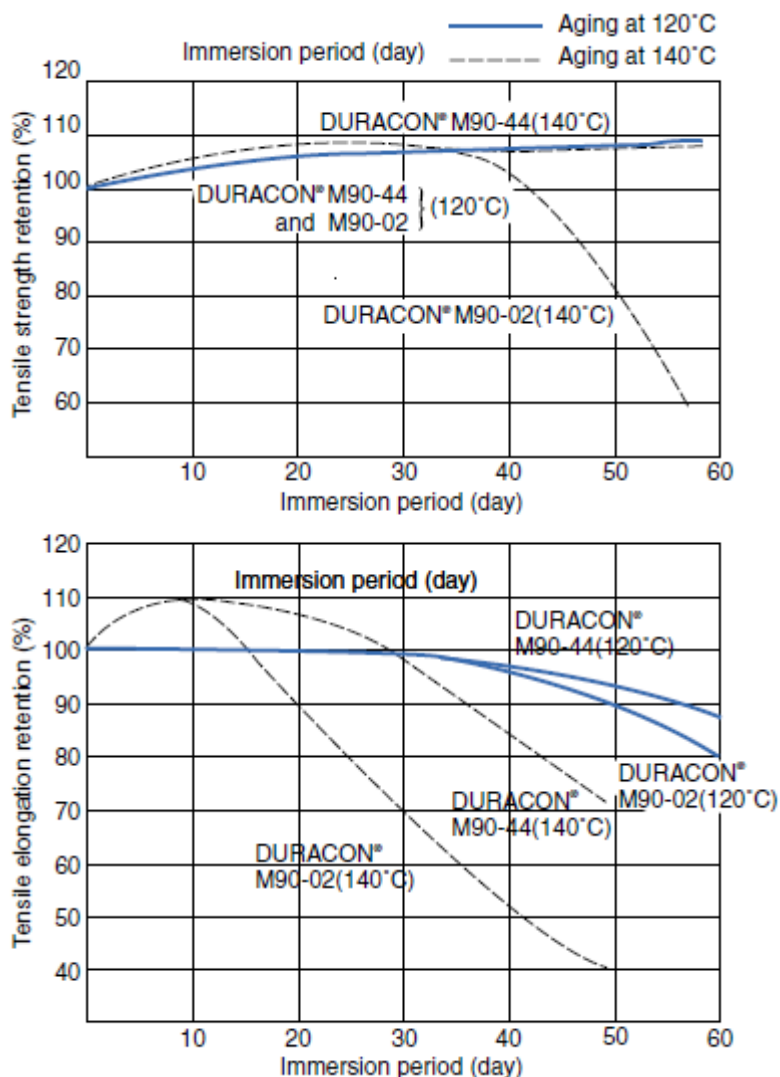
The -44 series has superior thermal stability under elevated temperatures. **Figure 1-1** shows the results of tests for property changes caused by high temperature heat aging. As the tests indicate, **the -44 series** has superior heat stability. In addition, for this level of heat aging, the color change of **the -44 series** is of the order of M90-02, and there is, therefore, no problems.

The UL (Underwriters Laboratories Inc.) temperature index on the basis of the long-term heat degradation experiments from these tests is shown in **Table 1-2**. As is shown, **the -44 series** is approved at 5-10 deg C higher than the -02 series.

Table 2-2 UL approved temperatures
for DURACON® POM
(Unit: °C)

| Grade | Electrical | Mechanical | |
|-----------------|------------|-------------|----------------|
| | | With impact | Without impact |
| DURACON® M90-44 | 110 | 95 | 100 |

Fig. 1-1 Chage in tensile strength characteristics through heat aging(at 120°C and 140°C)



The changes in mechanical properties due to heat aging are as shown in **Table 1-3**. While elongation and Izod impact strength degrade 20-30% over 12 months of treatment, tensile strength and flexural strength do not fall, and there is also no difference for **M90-44**.

As shown in the data below, compared with **M270-44** and **M90-44**, one can consider the physical data to be almost the same,

although in terms of toughness and long term properties, in particular creep at high temperature, there is a fear that properties will degrade somewhat relative to **M90-44**. This point should be noted.

In applications where toughness and high temperature creep characteristics are of particular concern, we recommend using **M25-44** and **M90-44**.

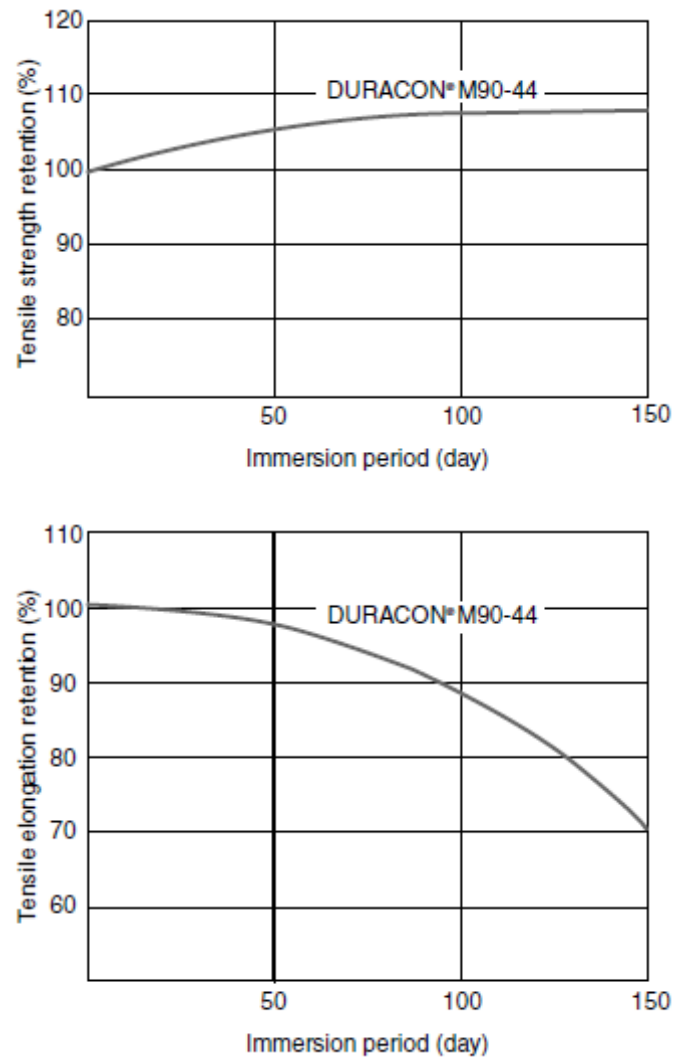
Table 1-3 Changes in mechanical properties of DURACON® POM M270-44 from heat aging
(in atmospheric air, 82°C, 12 months)

| Property | | Unit | DURACON® M270-44 | | DURACON® M90-44 | |
|--------------------------------|-----------------------|------|------------------|-----------------|-----------------|-----------------|
| | | | Initial | After 12 months | Initial | After 12 months |
| Tensile property | Yield strength | MPa | 60 | 62 | 60 | 61 |
| | Elongation at yield | % | 12 | 10 | 12 | 10 |
| | Break strength | MPa | 54 | 55 | 54 | 56 |
| | Elongation at break | % | 40 | 28 | 60 | 38 |
| | Modulus of elasticity | MPa | 2.820 | 2.820 | 2.820 | 2.820 |
| Flexural property | Flexural strength | MPa | 96 | 98 | 96 | 97 |
| | Flexural modulus | MPa | 2.580 | 2.580 | 2.580 | 2.580 |
| Izod impact strength (notched) | | J/m | 52 | 43 | 63 | 48 |

1.3.2 Hot Water Resistance

figure 1-2 indicates changes in tensile strength as an example of property changes upon immersion in 95°C water.

Fig. 1-2 Hot water resistance of DURACON® POM M90-44
(Property retention ratio in 95°C hot water)



2. Processing characteristics of -44 series

2. Flow characteristics

shown in Table 2-1. In addition, Figure 2-1 shows a comparison of M90-44 and M140-44.

Results of bar flow length tests using a bar flow length mold and sample thickness of 2mm are

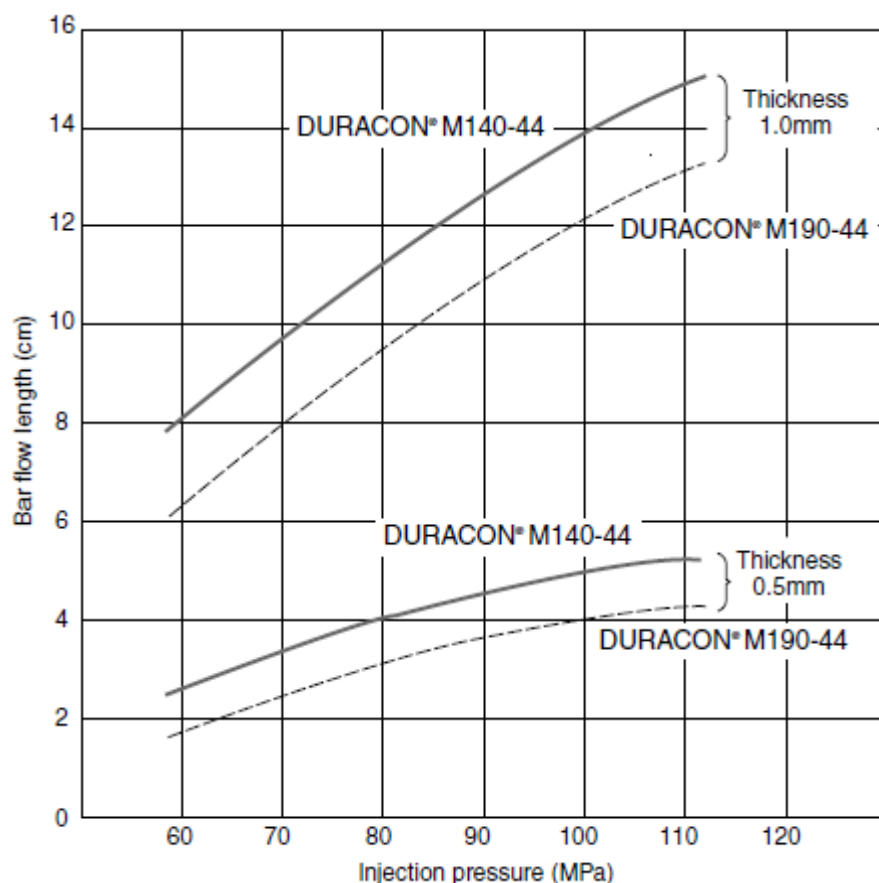
Table 2-1 Bar flow length using bar flow length test mold
(Unit:mm)

| injection pressure MPa | DURACON® M90-44 |
|---------------------------|--------------------|
| 49.0 | 240 |
| 73.5 | 323 |
| 98.0 | 404 |
| 122.5 | 490 |

Processing parameters

Material temperature : 200°C
Mold temp : 80°C
Injection speed : 50mm/sec
Mold cavity : Bar flow test mold halves, Thickness
of molded products 2mm
Gate : Width 20mm, Thickness 200

Fig. 2-1 Bar flow lengths for DURACON® POM M140-44 and M90-44



Processing parameters

Cylinder temp. : 190°C
Gate : 2×2×0.5mm
Mold temp. : 80°C
Cycle : Injection 12s/
cooling 10s
Injection speed : 33mm/sec

The flow characteristics of M270-44 are shown in **Table 2-2** and **Figure2-2**. Compared with the general purpose type M90, the flowability of **M270-44** is vastly improved, and this is the main characteristic of the grade. This is characteristic, as explained below, contributes to the shortening of cycle times, making possible cost-effective molding. In addition, compared with M90, sprue and

runner cross sections can be reduced by almost half, thereby enabling considerable reduction of the amount of scrap. Moreover, **M270-44** generally does not generate flow marks, so a major characteristic of the grade is that an excellent surface finish can be achieved with a relatively low mold temperature.

Table 3-2 Bar flow length of DURACON® POM M270-44 and M90-44

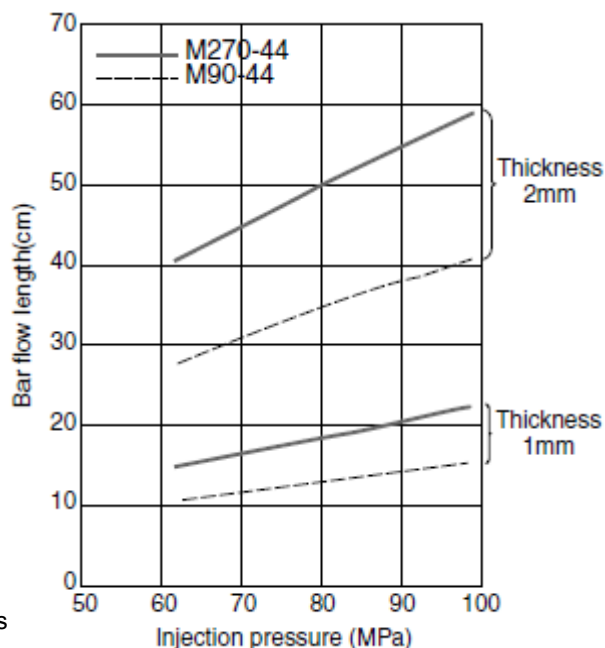
| Thickness (mm) | Material Injection pressure MPa | M270-44 | | M90-44 | |
|-------------------|--|---------------------|-------------|---------------------|-------------|
| | | Flow length (cm) | Flow ratio* | Flow length (cm) | Flow ratio* |
| 1 | 61 | 15.7 | 143 | 11.0 | 100 |
| | 73 | 18.0 | 141 | 12.8 | 100 |
| | 85 | 20.1 | 141 | 14.3 | 100 |
| | 98 | 22.3 | 139 | 16.0 | 100 |
| | Average | — | 141 | — | 100 |
| 2 | 61 | 42.2 | 148 | 28.5 | 100 |
| | 73 | 48.2 | 146 | 33.1 | 100 |
| | 85 | 54.6 | 146 | 37.4 | 100 |
| | 98 | 60.0 | 145 | 41.3 | 100 |
| | Average | — | 146 | — | 100 |

Processing parameters

Material temp. : 195-200°C
Mold temp. : 80°C
Injection speed : 50mm/sec
Cycle : Inj. 12s, Cooling 10s, Total 37s
Mold : 20W×1,550L×(1 and 2t)mm
Gate : 12×6×3mm

*Flow ratio: For all conditions, the flow length ratio of M270-44 with the flow length of M90-44 is 100.

Fig. 3-2 Bar flow length of DURACON® POM M270-44 and M90-44



Processing parameters

Material temp. : 195-200°C
Mold temp. : 80°C
Injection speed : 50mm/sec
Cycle : Inj. 12s, Cooling 10s, Total 37s
Mold : 20W×1,550L×(1 and 2t)mm
Gate : 12×6×3mm

The main characteristic of M450-44 is its vastly superior flowability compared with **M90-44** and **M270-44**. Therefore, it can be readily applied to thin wall molding, and there is also a tendency for parts to have little residual stress. In addition, cycle times can be shortened and sprue and runner cross sections reduced, so the scrap recycling rate can be reduced. These factors bring advantages from an economic perspective. Moreover, compared with **M90-44**, flow mark formation is generally small, so therefore a relatively superior surface finish can be achieved.

Figures 2-3 and 2-4 compare the flowability of **M450-44** with other grades at a thickness of 2mm. When comparing bar flow lengths, generally speaking **M450-44** is considered to be roughly 30% longer than **M270-44**, and 90-100% longer than **M90-44**.

In addition, **Tables 2-5 and 2-6** show comparisons of bar flow lengths with **M270-44** for thin-wall thicknesses of 0.2mm and 0.4mm. In thin-wall cases, the flow length of **M450-44** is approximately 10% longer than **M270-44**, thus indicating **M450-44's** high flow characteristics.

Fig. 2-3 Flowability at 2 mm wall thickness
(Mold temperature: 80°C)

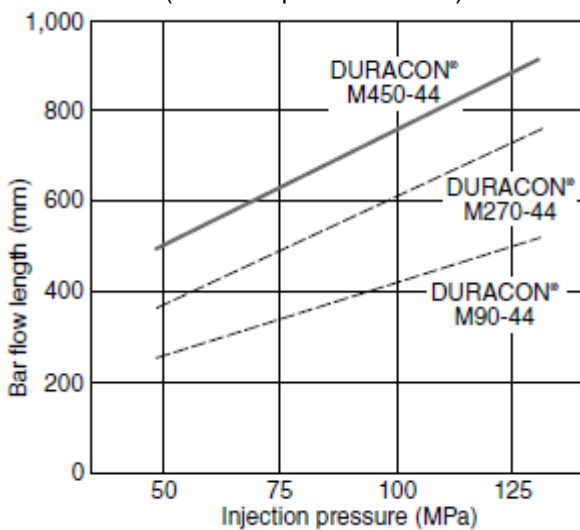


Fig. 2-4 Flowability at 2 mm wall thickness
(Mold temperature: 40°C)

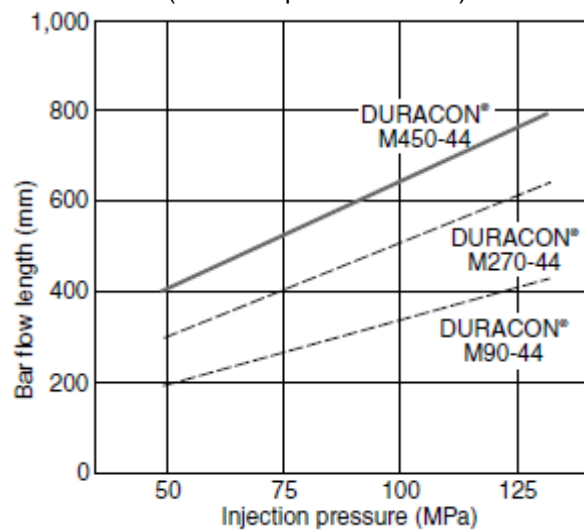


Fig. 2-5 Flowability in case of thin wall
(Mold temperature: 80°C)

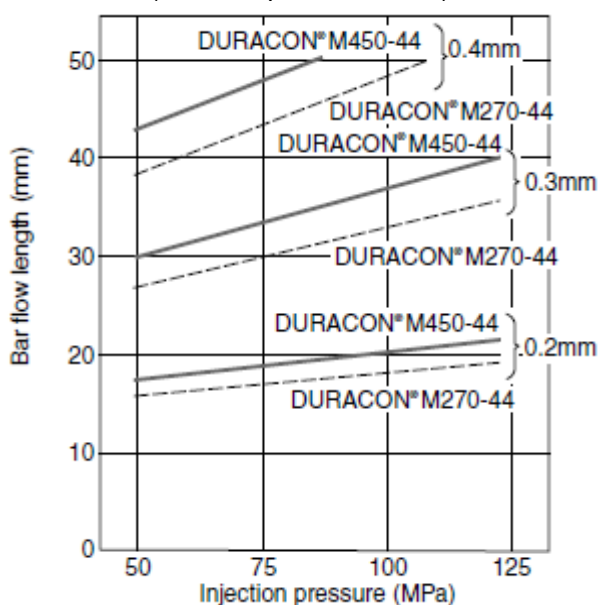
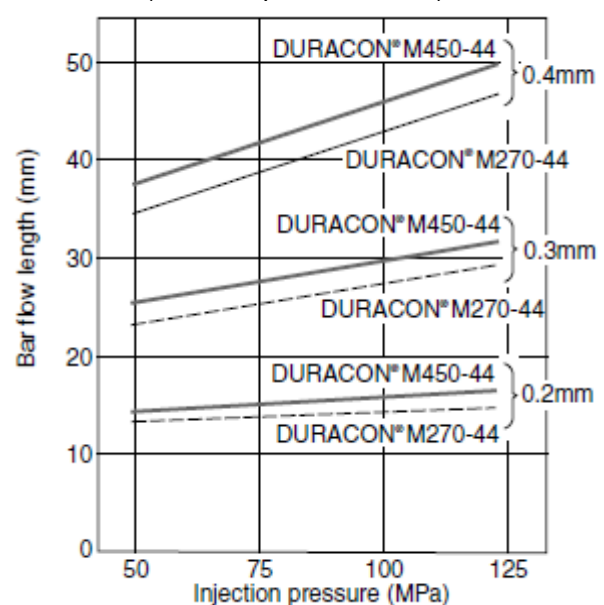


Fig. 2-6 Flowability in case of thin wall
(Mold temperature: 40°C)



| | | |
|-----------------------|-----------------|-------------|
| Processing parameters | Material temp. | : 185~190°C |
| | Mold temp. | : 80, 40°C |
| | Injection speed | : 67mm/sec |

2.2 Mold shrinkage ratio

Table 2-3 shows a comparison of mold shrinkage ratios for sample thickness' of 1, 2, and 3 mm for **M90-44**. **M90-44** exhibits almost the same mold shrinkage as M90-02, while slightly lower mold shrinkage anisotropy can be expected of **M90-44**.

The mold shrinkage ratio for **M140-44** is shown in **Figure 2-7**, while that for **M270-44** is shown in **Figures 2-8** and **2-9**. One can see that it is acceptable to design molds as for **M90-44**. Mold shrinkage for **M450-44** is shown in **Tables 2-4, 2-10, and 2-11**.

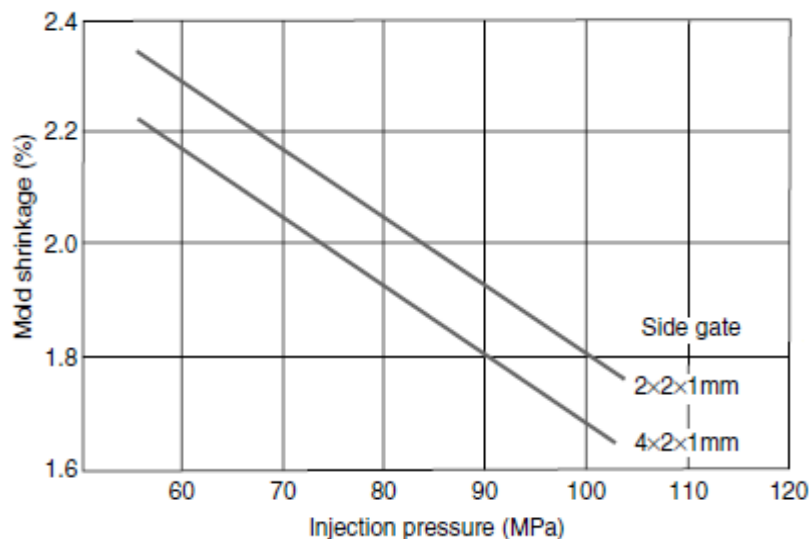
Table 2-3 DURACON® POM M90-44 mold shrinkage
(Unit : %)

| Molded product thickness | Flow direction | DURACON® M90-44 | | |
|--------------------------|----------------------------|-----------------|-------|------|
| | | Pressure MPa | | |
| | | 58.8 | 68.6 | 78.4 |
| 1mm | Perpendicular to flow (//) | | 2.09 | 1.72 |
| | Parallel to flow (⊥) | | 1.90 | 1.65 |
| | //—⊥ | | 0.19 | 0.07 |
| 2mm | Perpendicular to flow (//) | 1.89 | 1.65 | |
| | Parallel to flow (⊥) | 1.84 | 1.74 | |
| | //—⊥ | —0.02 | —0.03 | |
| 3mm | Perpendicular to flow (//) | 1.91 | 1.82 | |
| | Parallel to flow (⊥) | 1.95 | 1.86 | |
| | //—⊥ | —0.04 | —0.04 | |

Processing parameters

Material temperature : 200°C
Mold temperature : 80°C
Injection speed : 25mm/s
Mold cavity : 120×120×1~3mm
Gate : Side gate in one location at the center

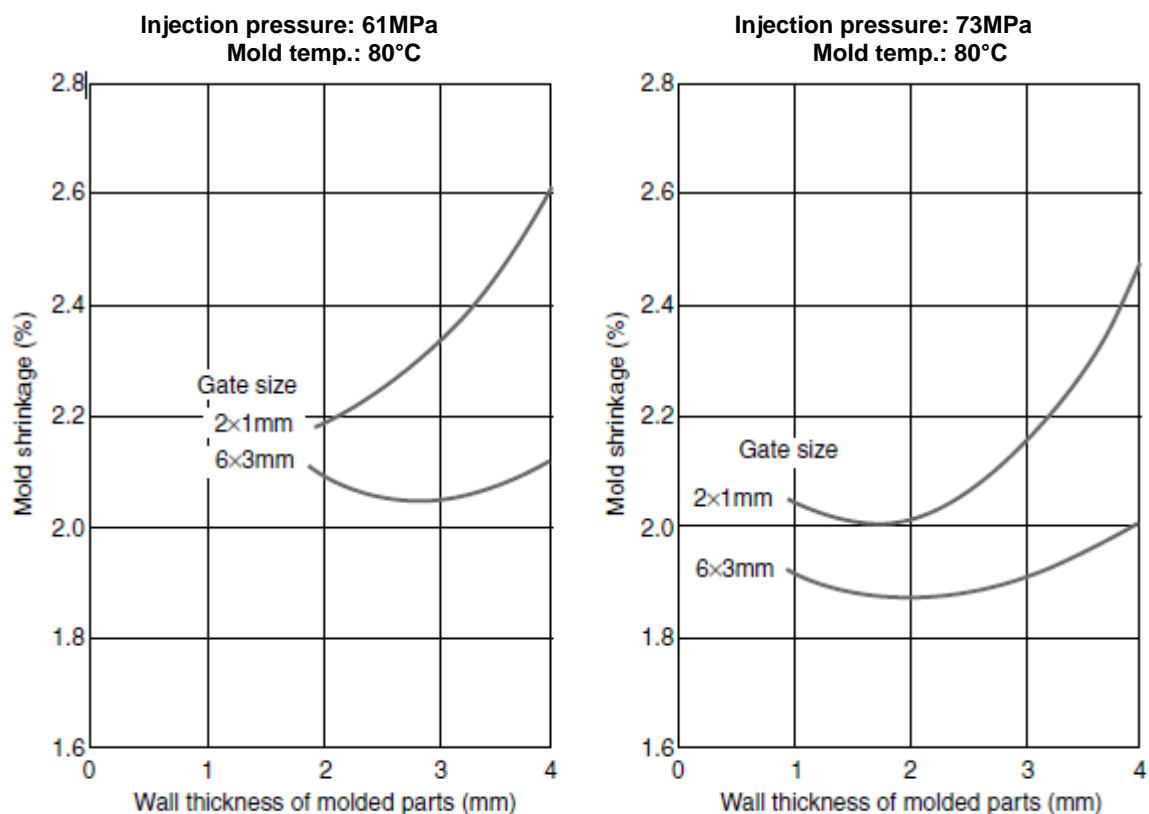
Fig. 2-7 DURACON® POM M140-44 mold shrinkage



Processing parameters

Material temp. : 190°C
Mold temp. : 80°C
Injection speed : 17mm/sec
Thickness of molded piece: 1mm

Fig. 2-8 DURACON® POM M270-44 mold shrinkage ratio
(Effects of sample thickness and gate size)



Processing parameters

Material temp. : 185-200°C

Injection speed : 33mm/sec

Cycle : 1mm 2mm 3mm 4mm

Injection 15s 20s 25s 35s

Cooling 10s 15s 20s 25s

Total cycle 35s 45s 55s 70s

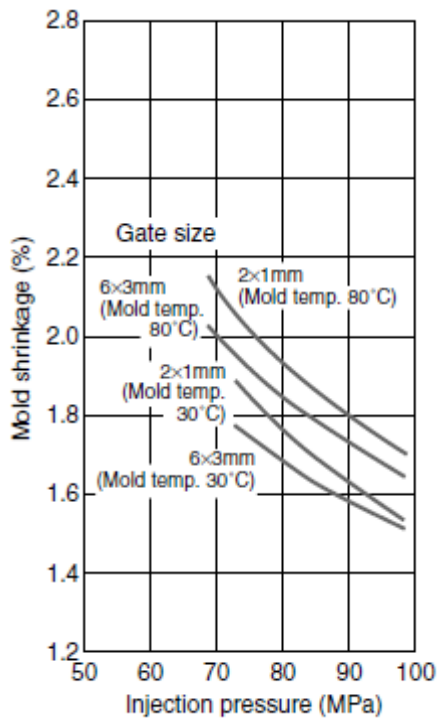
Mold : 120·120·(2, 3, 4mmt)

100·100·1mmt

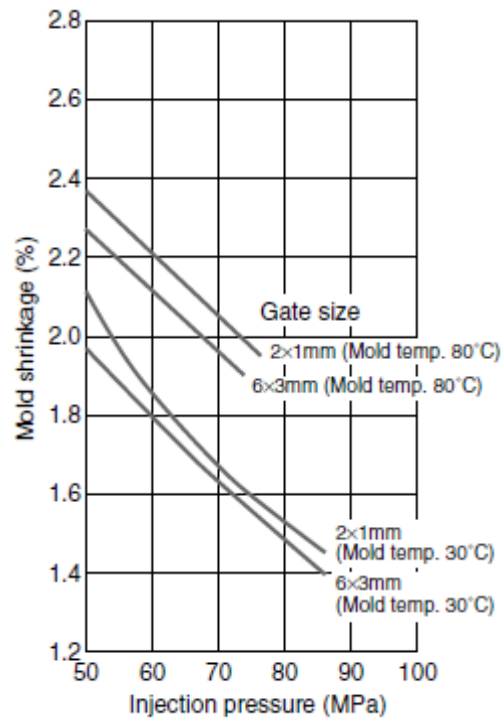
Gate : 2·1, 6·3mm, each having a double side gate.

Fig. 2-9 DURACON® POM M270-44 mold shrinkage ratio
(Effects of injection pressure and mold temperature)

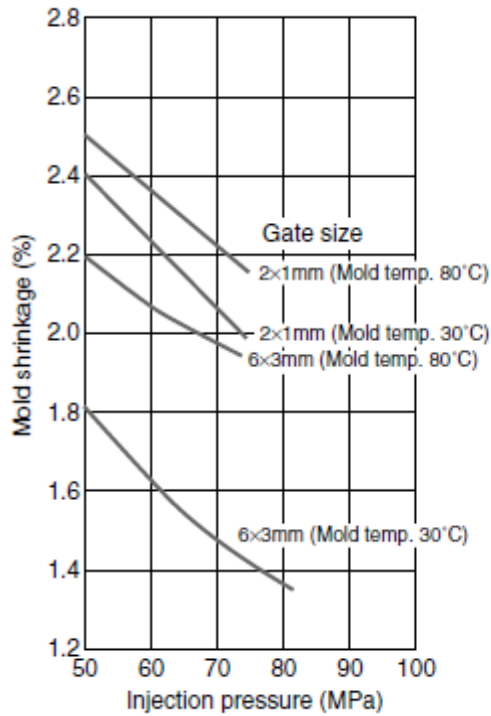
(1) Size of molded parts: 100·10mm.
1mm thick



(2) Size of molded parts: 120·12mm.
2mm thick



(3) Size of molded parts: 120·12mm.
3mm thick



(4) Size of molded parts: 120·12mm.
4mm thick

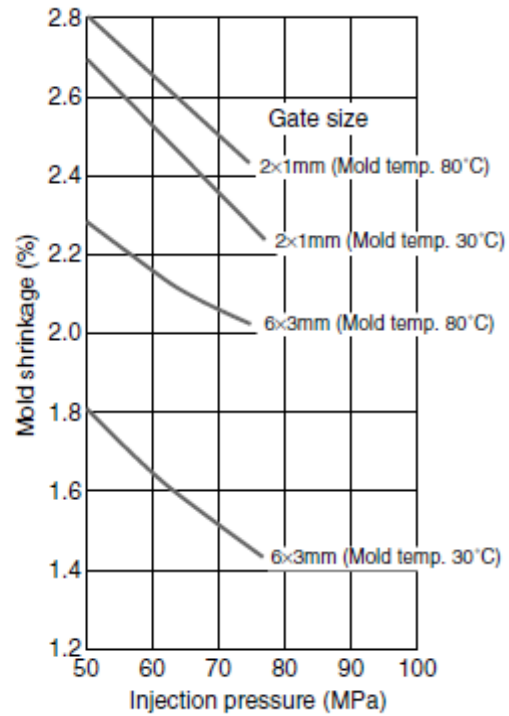


Table 2-4 DURACON® POM M450-44 mold shrinkage ratio

| Mold temp. | 80°C | | 40°C | |
|--------------------|------|------|------|------|
| Injection pressure | MPa | | MPa | |
| Thickness (mm) | 49.0 | 68.6 | 69.0 | 68.6 |
| 2 | 2.2 | 1.8 | 1.9 | 1.4 |
| 3 | 2.2 | 1.8 | 1.8 | 1.4 |

Fig. 2-10 DURACON® POM M450-44 mold shrinkage ratio (2mmt)

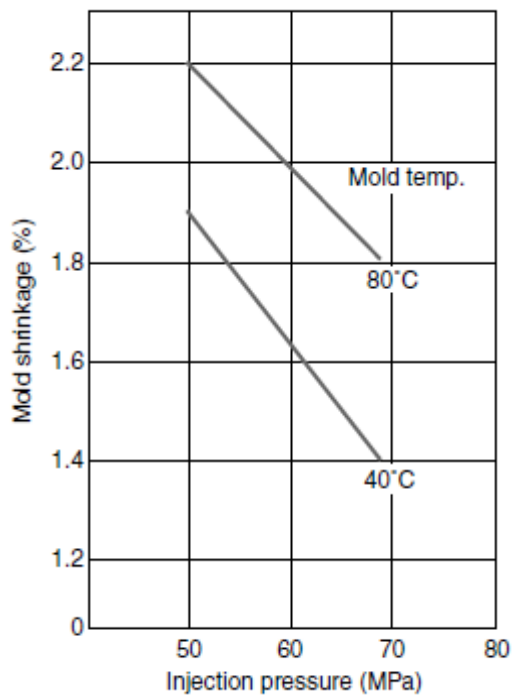
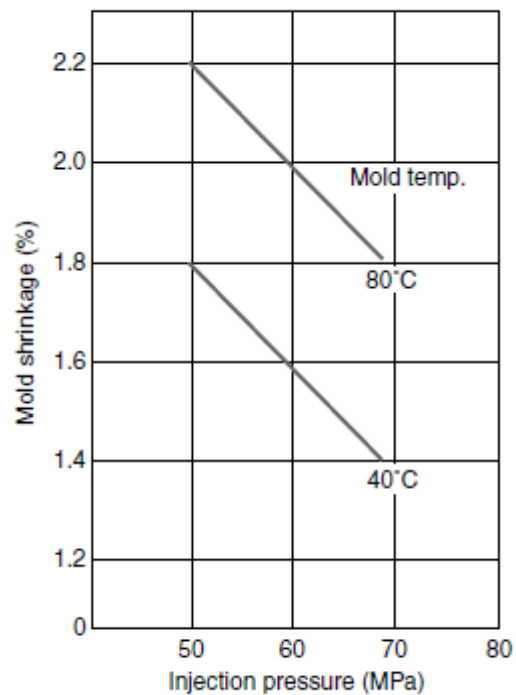


Fig. 2-11 DURACON® POM M450-44 mold shrinkage ratio (3mmt)



Processing parameters

Material temp. : 185~190°C
 Mold temp. : 80, 40°C
 Injection speed : 67mm/sec
 Mold : 120×120×(2t, 3t) mm
 Gate : 4×2mm for 2mmt
 6×3mm for 3mmt
 Cycle time : 2mmt Injection 20s, cooling 10s
 3mmt Injection 25s, cooling 10s

2.3 Molding cycle

Through employing **M270-44**, a vastly contracted cycle time is achievable compared with **M90-44**. Very cost effective molding is therefore achievable. The following points can be considered as the reasons for this.

- (1) As flowability is good, the anisotropy in the mold shrinkage ratio is small, and therefore, molded products with small deformation and warpage can be achieved in a relatively short cooling time.
 - (2) As flowability is good, the mold filling speed is fast, and injection time can therefore be shortened.
 - (3) As flowability is good, sufficient mold filling is possible even with lower material and mold temperature. Therefore, the material can setup with a relatively short cooling time, upon which take out can be carried out.
- Representative examples of cycle time shortening are introduced below.

[Example 1]

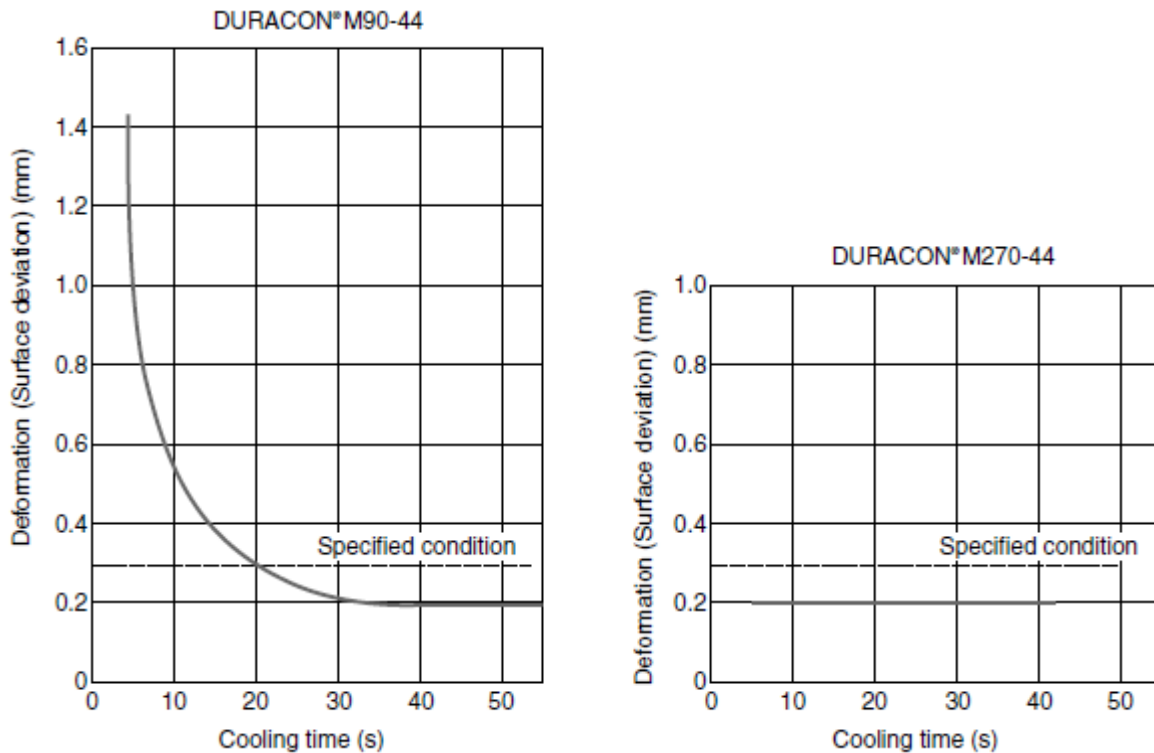
Name of molded part : flat disc (110mm × 2mm)
Mold : single cavity, central pin gate.

Cycle-defining parameter: Surface variance around periphery is less than 0.3mm.

| Material | DURACON® M90-44 | DURACON® M270-44 |
|----------------------|-----------------|------------------|
| Cylinder temperature | 190°C | 190°C |
| Mold temperature | 80°C | 80°C |
| Cycle Injection | 12s | 12s |
| Cooling* | 20s | 5s |
| Total | 32s | 17s |

*refer to Figure 3-12

Fig. 2-12 Comparison of cooling times necessary to limit surface variance to within 0.3mm



[Example 2]

Name of molded part : small component of complicated shape (6 g/part)

Mold : 8 cavity, central pin gate.

Cycle-defining parameter: Dimensions are within limits of specifications.

| Material | DURACON® M90-44 | DURACON® M270-44 |
|----------------------|--------------------|---------------------|
| Cylinder temperature | 190°C | 190°C |
| Mold temperature | 70°C | 50°C |
| Injection pressure | 68MPa | 68MPa |
| Cycle time (total) | 40s | 25s |

[Example 3]

Name of molded part : stereo, tape, cartridge platform (thin flat disc)

Mold : 8 cavity

Cycle-defining parameter : Surface variance of less than 0.5mm

| Material | DURACON® M140-44 | DURACON® M270-44 |
|----------------------|---------------------|---------------------|
| Cylinder temperature | 190°C | 190°C |
| Mold temperature | 40°C | 55°C |
| Injection pressure | 68MPa | 68MPa |
| Cycle time (total) | 20.5s | 13.5s |

[Example 4]

Name of molded part : felt-tip pen cap

Mold : 16 cavity

Cycle-defining parameter : Core pin overheating

| Material | DURACON® M140-44 | DURACON® M270-44 |
|----------------------|---------------------|---------------------|
| Cylinder temperature | 190°C | 190°C |
| Mold temperature | 90°C | 65°C |
| Injection pressure | 98MPa | 98MPa |
| Cycle time (total) | 25s | 13.5s |

2.4 Reuse and stability while resident in molding machine

The heat stability of **M90-44** when being molded is excellent. **Table 2-5** shows the retention of properties for **M90-44** when it is repeatedly remolded, with **100%** of the material from the previous molding cycle recycled for the next cycle. As is recommended for other grades, is around **25-30%** of returned material is blended with virgin material, the resulting blend can be used with no problem. If anything, care should be exercised so as not to introduce any contaminants when grinding returned material. Test results for color change, which is often a problem caused by heat stability of material

that is resident in the molding machine for extended periods, are shown in **Table 2-6**. For practical molding parameters, color change is not a problem. Moreover, for cases where the residence time in the molding machine is extended to the point where it is regarded to be a considerably severe condition, color change is not great.

However, color change is slightly larger than M90-02, so care is necessary. Moreover, at this degree of color change, there is no degradation in terms of mechanical and physical properties. Data for **M270-44** is shown in **Table 2-7**.

Table 2-5 Property retention for DURACON® POM M90-44 under repeated molding
(Retention : %)

| Number of recycling times \ Properties | Tensile strength | Tensile elongation | Izod impact (with notch) | Change in hue (ΔE) |
|--|------------------|--------------------|--------------------------|--------------------|
| 0 | 100 | 100 | 100 | — |
| 1 | 101 | 101 | 102 | 1.4 |
| 2 | 101 | 96 | 97 | 2.7 |
| 3 | 101 | 97 | 97 | 3.8 |
| 4 | 101 | 104 | 100 | 5.3 |
| 5 | 102 | 96 | 90 | 6.5 |

Note1: For change in hue, refer to Table 2-1.

Note2: Molding conditions nozzle

Cylinder temperature : 190-190-170-150°C

Mold temperature : 80°C

Injection speed : 17mm/sec

Table 2-6 Color change resulting from DURACON® POM M90-44 being resident in molding machine

(Degree of discoloration : ΔE)

| Cylinder temperature(°C) \ Retention time(min) | 190 | 200 | 210 |
|--|-----|-----|-----|
| 15 | 0.3 | 0.5 | 0.4 |
| 30 | 0.5 | 0.9 | 0.8 |
| 45 | 0.6 | 0.8 | 1.4 |
| 60 | 0.7 | 1.2 | 3.4 |

Note : For ΔE showing degree of discoloration, refer to Table 2-2.

Table 2-7 Property changes resulting from repeated molding of DURACON® POM M270-44

| Property | Unit | New pellet | Reusing for five times |
|--------------------------------|-----------------------|------------|------------------------|
| Tensile property | Yield strength | MPa | 60 |
| | Elongation at yield | % | 12 |
| | Break strength | MPa | 54 |
| | Elongation at break | % | 40 |
| | Modulus of elasticity | MPa | 2,820 |
| Flexural property | Flexural strength | MPa | 96 |
| | Flexural modulus | MPa | 2,580 |
| Izod impact strength (notched) | | J/m | 52 |
| Vicat softening point | | °C | 162 |

NOTES TO USERS

- All property values shown in this brochure are the typical values obtained under varying conditions prescribed by applicable standards and test methods.
- This brochure has been prepared based on our own experiences and laboratory test data, and therefore all data shown here are not always applicable to parts used under different conditions. We do not guarantee that these data are directly applicable to the application conditions of users and we ask each user to make his own decision on the application.
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