

TOP TEN DESIGN TIPS

By Jürgen Hasenauer, Dieter Küper, Jost E. Laumeyer and Ian Welsh

1. Comparison of materials
2. Material selection
3. Wall thickness
4. Ribbing
5. Gate positioning
6. Cost-saving designs
7. General assembly technology
8. Welding technology
- 9. Tolerances**
10. Check list

9. Tolerances

Hidden cost factors

Tolerances – Injection mouldings cannot be produced to the same tolerances as machined parts. Although most people are aware of this, tolerances are continually being specified that cannot be attained and/or make cost-efficient production impossible.

Tolerances and their cost implications

A distinction is generally made between three quality classes: general-purpose injection moulding, technical injection-moulding and high-precision injection-moulding. In the DIN 16901 standard, these are specified in terms of general tolerances and dimensions with directly figured allowances (ranges 1 and 2):

- “general-purpose” injection-moulding requires a low level of quality control and is characterised by low reject rates and fast production cycles
- technical injection-moulding is considerably more costly, since it makes higher demands on the mould and the production process, requires frequent quality control checks and is therefore likely to have increased reject rates
- the third group, high-precision injection-moulding, requires precision moulds, optimum production conditions and 100 % production monitoring with continuous quality control. This affects cycle time and-through increased production and quality control costs-on the unit price.

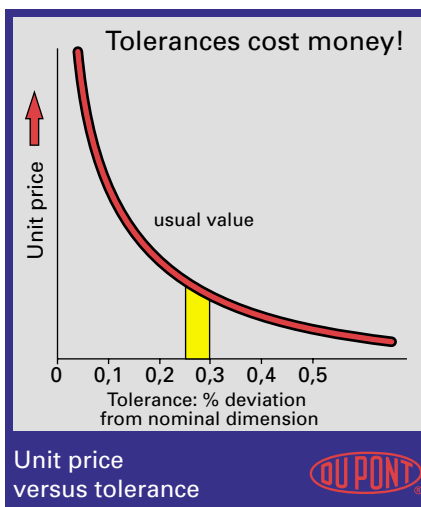


Fig. 1

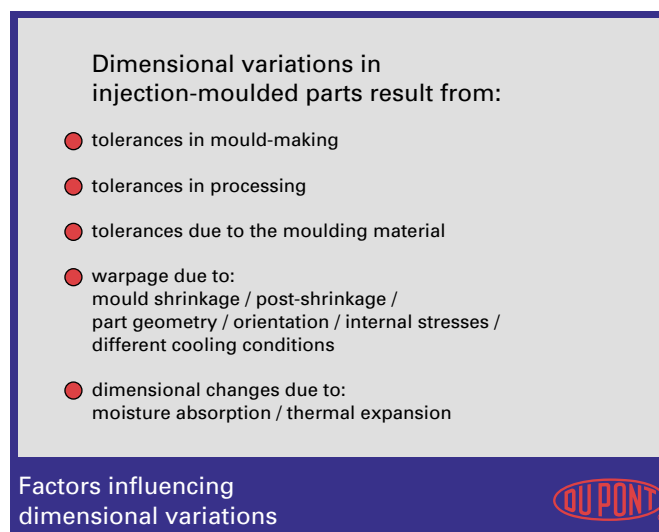


Fig. 2

TOP TEN DESIGN TIPS

By Jürgen Hasenauer, Dieter Küper, Jost E. Laumeyer and Ian Welsh

Since designers play a key role in determining the costs of an injection-moulded part, they must also ensure commercially viable tolerancing. The selected tolerances should not be as tight as possible but as tight as necessary.

A commercially acceptable value for a production tolerance would be 0,25 to 0,3 % deviation from the nominal dimension, but this must be checked against application requirements (Fig. 1).

It should be remembered that thermoplastics, which typically have high elongation and elasticity, do not need to have the close tolerances that are specified for metals with their high rigidity, low elongation and low elasticity.

Factors influencing tolerances

To avoid excessively close tolerances for plastics components, the many different factors that influence the dimensional accuracy of an injection-moulded part (Fig. 2) must be kept in mind. Tolerances in tool-making have to be observed relatively closely. Designers should not forget, however, that demoulding tapers for easy, distortion-free ejection from the injection mould are vital (Fig. 3).

Adherence to tolerances is a problem when moulding parts from different materials or with different wall thicknesses. Mould shrinkage values are direction- and thickness-dependent. This behaviour can be seen most clearly with glass-fibre-reinforced materials. Here, the orientation of the glass fibres can produce significant differential shrinkage between the longitudinal and transverse directions, and this can lead to dimensional inaccuracies.

The geometry of the moulded part can also have an effect on shrinkage and hence on tolerances (Fig. 4).

If complex mouldings are to be produced to close tolerances, a prototype mould is essential to obtain accurate information on the actual shrinkage value and warpage behaviour.

Production and operating tolerances

It is important to decide whether only a production tolerance is required or whether an operating tolerance is also necessary, since thermoplastics are affected by their service environment. For example, thermal expansion – which can be ten times more than for metals (Fig. 5) – and the marked tendency of some polymers (e.g. nylons) to absorb moisture play a crucial role in the operational reliability of a part in service.

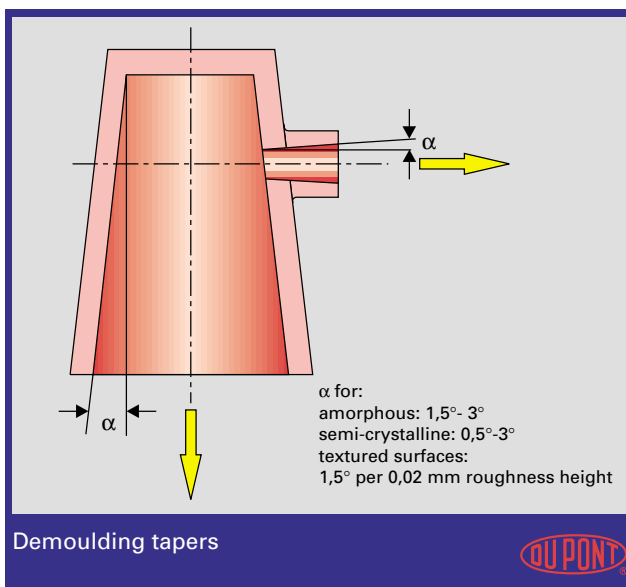


Fig. 3

TOP TEN DESIGN TIPS

By Jürgen Hasenauer, Dieter Küper, Jost E. Laumeyer and Ian Welsh

With semi-crystalline materials, post-shrinkage must also be taken into account. This phenomenon, which is influenced mainly by injection moulding conditions, can lead to dimensional changes in finished parts after demoulding.

Quality control must not be carried out immediately after demoulding. The DIN 16901 standard specifies that quality control should be undertaken only after 16 hours' storage under standard climatic conditions (23 °C, 50 % relative humidity) or after suitable pre-treatment.

Recommendations

The tolerances specified in DIN 16901 can be used as a starting point for cost-efficient production of moulded parts. However, the improved technology of modern injection moulding machines enables considerably closer tolerances to be attained than the values specified in this standard. For high-precision injection mouldings, individual industry sectors have developed separate tolerance tables because DIN 16901 is no longer adequate.

In any case, however, when close tolerances are needed, it is important to consult with the injection moulder or material supplier to see if the required tolerances are technically feasible and commercially appropriate (Fig. 6).

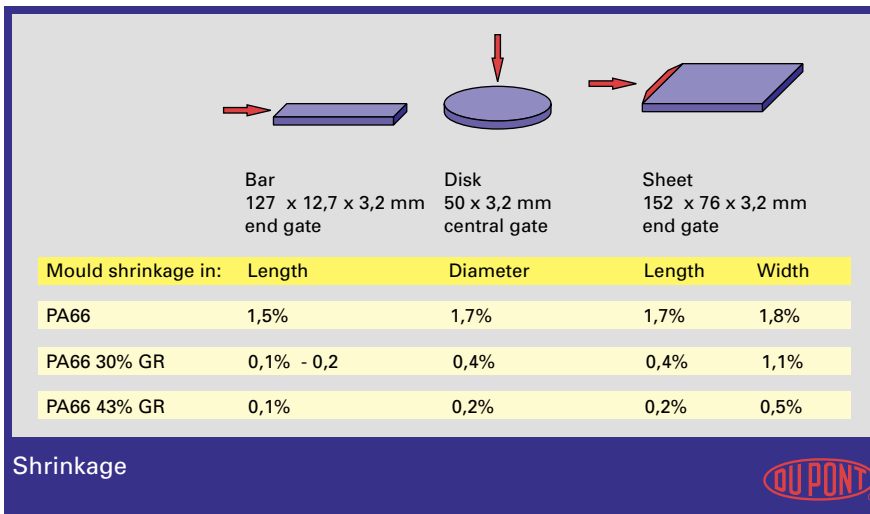


Fig. 4

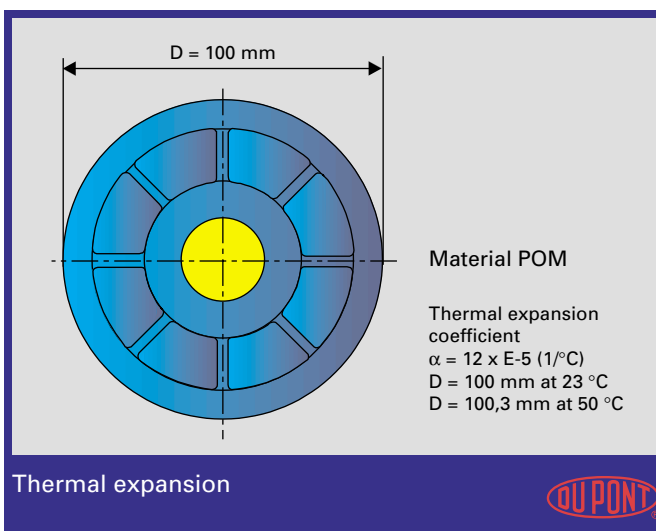


Fig. 5

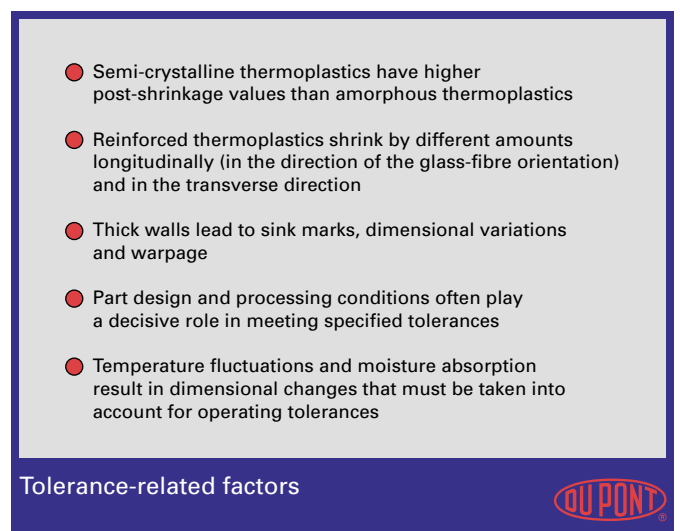


Fig. 6

EUROPE/MIDDLE EAST/AFRICA

Belgique / België
Du Pont de Nemours (Belgium)
Antoon Spinoystraat 6
B-2800 Mechelen
Tel. +32 15 44 14 11
Telefax +32 15 44 14 09

Bulgaria
Serviced by
Biesterfeld Interrowa GmbH & Co. KG.
See under Österreich.

Ceská Republika a
Slovenská Republika
Du Pont CZ, s.r.o.
Pekarska 14/268
CZ-155 00 Praha 5 – Jinonice
Tel. +42 257 41 41 11
Telefax +42 257 41 41 50-51

Danmark
Du Pont Danmark ApS
Skjøtevej 26
P.O. Box 3000
DK-2770 Kastrup
Telefax +45 32 47 98 05
Telefax +45 32 47 98 05

Deutschland
Du Pont de Nemours
(Deutschland) GmbH
Du Pont Straße 1
D-61343 Bad Homburg
Tel. +49 6172 87 0
Telefax +49 6172 87 27 01

Egypt
Du Pont Products S.A.
Bldg no. 6, Land #7, Block 1
New Maadi
ET-Cairo
Tel. +202 754 65 80
Telefax +202 516 87 81

España
Du Pont Ibérica S.A.
Edificio L'Ilia
Avda. Diagonal 561
E-08029 Barcelona
Tel. +34 227 60 00
Telefax +34 227 62 00

France
DuPont de Nemours (France) SAS
Défense Plaza
23/25 rue Delarivière Le Foullon
Défense 9
92 064 La Défense Cedex
Phone: +33 (0)1 41 97 44 00
Telefax +33 1 47 53 09 67

Hellas
Biesterfeld Hellas Intralink S.A.
Trading Establishment
149, AG, Triados Menidi Acharnes
GR-13671 Athens
Tel. +30 210 24 02 900
Telefax +30 210 24 02 141

Israël
Gadot Chemical Terminals (1985) Ltd.
16 Habonim Street
Netanya – South Ind. Zone
IL-42504 Netanya
Tel. +972 3 526 42 41
Telefax +972 3 528 27 17

Italia
Du Pont de Nemours Italiana S.r.l.
Centro Direzionale "Villa Fiorita"
Via Piero Gobetti, 2/A
20063 Cernusco s/N (MI)
Tel. +39 02 92629.1 (switchboard)
Fax +39 02 36049379

Magyarország
DuPont Magyarország Kft.
HU - 2040 Budaörs
Neuman J.u. 1
Tel. +36 23 509 400
Telefax: +36 23 509 432

Maroc
Deborel Maroc S.A.
40, boulevard d'Anfa – 10°
MA-Casablanca
Tel. +212 227 48 75
Telefax +212 226 54 34

Norway / Norge
Distrupol Nordic
Ostenssloveien 36
N-0677 Oslo
Tel. +47 23 16 80 62
Telefax +47 23 16 80 62

Österreich
Biesterfeld Interrowa GmbH & Co. KG
Bräuhausgasse 3-5
P.O. Box 19
AT-1051 Wien
Tel. +43 1 512 35 71-0
Fax +43 1 512 35 71-31
e-mail: info@interrowa.at
internet: www.interrowa.at

Polska
Du Pont Poland Sp. z o.o.
ul. Powazkowska 44C
PL-01-797 Warsaw
Tel. +48 22 320 0900
Telefax +48 22 320 0910

Portugal
Biesterfeld Iberica S.L.
Rua das Matas
P-4445-135 Alfena
Tel. +351 229 698 760
Telefax +351 229 698 769

Romania
Serviced by
Biesterfeld Interrowa GmbH & Co. KG.
See under Österreich.

Russia
DuPont Russia LLC.
ul. Krylatskaya 17/3
121614 Moscow
Tel. +7 495 797 22 00
Fax. +7 495 797 22 01

Schweiz / Suisse / Svizzera
Biesterfeld Plastic Suisse GmbH
Dufourstrasse 21
Postfach 14695
CH-4010 Basel
Tel. +41 61 201 31 50
Telefax +41 61 201 31 69

Slovenija
Serviced by
Biesterfeld Interrowa GmbH & Co. KG.
See under Österreich.

Suomi / Finland
Du Pont Suomi Oy
P.O. Box 54 (Keilaranta 12)
FI-02150 ESPOO
Tel. +358 207 890500
Fax: +358 207 890501

Sverige
Serviced by
Du Pont Danmark ApS.
See under Danmark.

Türkiye
Du Pont Products S.A.
Buyukdere Caddesi No. 122
Ozsezen Ismerkezi, A block, Kat: 3
Esentepe, 34394 Istanbul
Tel. +90 212 340 0400
Telefax +90 212 340 0430

Ukraine
Du Pont de Nemours
International S.A.
Representative Office
3, Glazunova Street
Kyiv 252042
Tel. +380 44 294 96 33 / 269 13 02
Telefax +380 44 269 11 81

United Kingdom
Du Pont (UK) Limited
Wedgwood Way
Stevenage
Hertfordshire SG1 4QN
Tel. +44 1438 734000
Telefax +44 1438 734109

South Africa
DuPont de Nemours
Societe Anonyme
South African Branch Office
4th Floor Outspan House
1006 Lenchen Avenue North
Centurion
Pretoria 0046
Tel. +27 0 12 683 5600
Telefax +27 0 12 683 5661

NORTH AMERICA

USA
DuPont Engineering Polymers
Barley Mill Plaza, Building 26
P. O. Box 800026
Wilmington, Delaware 19880
Tel. +1 302 992 4592
Telefax +1 302 992-6713

DuPont Automotive
950 Stephenson Highway
P.O. Box 7013
Troy, MI 48007-7013
Tel. +1 248 583-8000

Canada
DuPont Engineering Polymers
P.O. Box 2200
Streetsville, Mississauga
Ontario, Canada L5M 2H3
Tel. +1 905 821-5953

Mexico
DuPont S.A. de C.V.
Homero 206
Col. Chapultepec Morales
11570 Mexico D.F.
Tel. +52 555 575 221 000

SOUTH AMERICA

Argentina
Du Pont Argentina S.A.
Avda. Mitre y Calle 5
(1884) Berazategui-Bs.As.
Tel. +54 11 4239-3868
Telefax +54 11 4239-3817

Brasil
DuPont do Brasil S.A.
Al. Itapecuru, 506 Alphaville
06454-080 Barueri-Sao Paulo
Tel. +5511 7266 8229

ASIA-PACIFIC

Australia
DuPont (Australia) Ltd.
168 Walker Street
North Sydney NSW 2060
Tel: +612 9923-6111
Fax: +612 9923 6011

Hong Kong/China
DuPont China Ltd.
26/F, Tower 6, The Gateway,
9 Canton Road
Tsimshatsui, Kowloon, Hong Kong
Tel: +852 2734 5345
Fax: +852 2724 4458

Shanghai/China
DuPont China Holding Co. Ltd.
15/F, Shui On Plaza
333 Huai Hai Road (Central)
Shanghai 200021
Tel: +86 21 6386 6366
Fax: +86 21 6386 6333

India
E.I. DuPont India Limited,
"Arihant Nitco Park" Sixth floor,
90, Dr. Radhakrishnan Salai,
Mylapore,
Chennai 600 004
Tel: +91 44 28472800
Fax: +91 44 28473800

Japan
DuPont Kabushiki Kaisha
Sanno Park Tower, 11-1
Nagata-cho 2-chome
Chiyoda-ku, Tokyo 100-6111
Japan.
Tel: +81 3 5521 8500
Fax: +81 3 5521 2595

Korea
DuPont (Korea) Ltd.
4/5 Floor, Asia Tower
#7/26, Yeoksam-dong, Kangnam-Ku
Seoul 135-082
Tel: +822 2222-5200
Fax: +822 2222-5470

Singapore
Du Pont Company (S) Pte Ltd
1 HarbourFront Place #11-01
HarbourFront Tower One
Singapore 098633
Tel: +65 6586 3688
Fax: +65 6272 7494

Taiwan
DuPont Taiwan Ltd.
Hung Kuo Building, 13th floor
#167 Tun Hwa North Road
Taipei 105
Tel: +8862 2719-1999
Fax: +8862 2719-0852

Thailand
DuPont (Thailand) Limited
6-7th Floor, M. Thai Tower
All Seasons Place
87 Wireless Road
Lumpini, Phatumwan
Bangkok 10330
Tel: +66 2 659 4000
Fax: +66 2 659 4001

CRASTIN® PBT
THERMOPLASTIC
POLYESTER RESIN

DELTRIN®
ACETAL RESIN

HYTREL®
THERMOPLASTIC
POLYESTER ELASTOMER

MINLON®
MINERAL REINFORCED
NYLON RESIN

RYNITE® PET
THERMOPLASTIC
POLYESTER RESIN

THERMX® PCT
HIGH PERFORMANCE POLYESTER

TYNEX®
NYLON MONOFILAMENT

VESPEL®
PARTS AND SHAPES

ZYTEL®
NYLON RESIN

ZYTEL® HTN
HIGH PERFORMANCE
POLYAMIDE

ZENITE® LCP
LIQUID CRYSTAL POLYMER

DUPONT® ETPV
THERMOPLASTIC RUBBER
THAT RESISTS OIL & HEAT

The DuPont Oval Logo, DuPont™, The miracles of science™, and Crastin®, Deltrin®, DuPont® ETPV, Hytrel®, Minlon®, Rynite®, Thermx®, Tynex®, Vespel®, Zytel®, Zenite® are registered trademarks or trademarks of DuPont or its affiliates.

The information set forth herein is furnished free of charge and is based on technical data that DuPont believes to be reliable. It is intended for use by persons having technical skill at their own discretion and risk. DuPont makes no warranties, express or implied, and assumes no liability in connection with any use of this information.

©2007 E.I. du Pont de Nemours and Company



The miracles of science™