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

---

3. Wall thickness

As much as necessary – as little as possible

Wall thickness – In designing components made from engineering plastics, experience has shown that certain design points arise time and again, and can be reduced to simple design guidelines. One such point is wall thickness design, which has an important influence on component quality.

Effect on specific component criteria

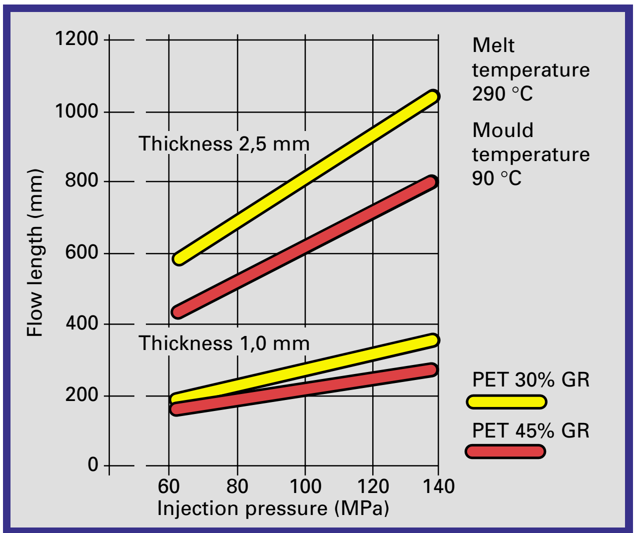
Changing the wall thickness of a component has a significant effect on the following key properties:
- component weight
- achievable flow lengths in the mould
- production cycle time of the component
- rigidity of the moulded part
- tolerances
- quality of the component in terms of surface finish, warpage and voids.

Ratio of flow path to wall thickness

At an early design stage, it is important to review the question whether the required wall thicknesses can be achieved with the desired material. The ratio of flow path to wall thickness has a critical influence on mould cavity filling in the injection-moulding process. If long flow paths combined with low wall thickness are to be achieved in an injection mould, only a polymer with relatively low melt viscosity (easy-flowing melt) is suitable. To gain an insight into the flow behaviour of polymer melts, flow lengths can be determined using a special mould (Fig. 1-2).

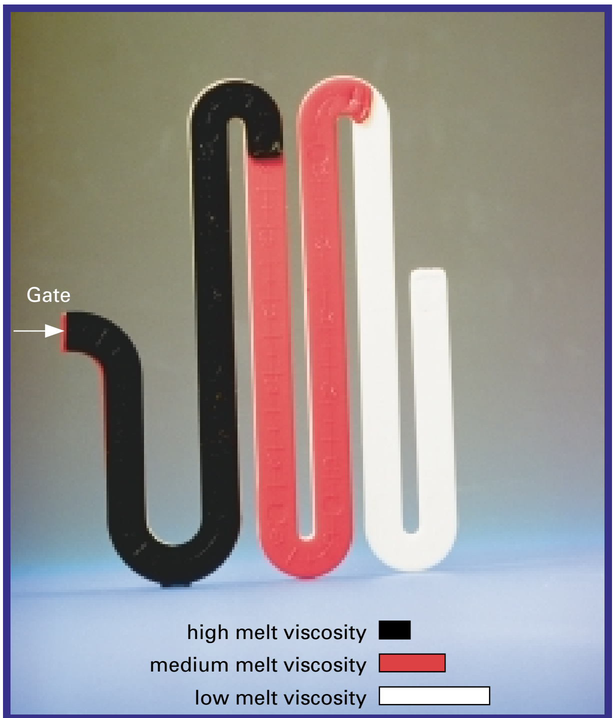
Flexural modulus as a function of wall thickness

The flexural rigidity of a flat sheet is determined by the material-specific elastic modulus and the moment of inertia of the sheet cross section. If wall thickness is automatically increased to improve the rigidity of plastic components without any thought given to the consequences, this can very often lead to serious problems with partially crystalline materials. In the case of glass-fibre-reinforced materials, changing the wall thickness also influences the orientation of the glass fibres. Close to the mould wall, the fibres are oriented in the direction of flow. On the other hand, in the centre of the wall cross section, random fibre orientation occurs as a result of turbulent flow.
By increasing wall thickness, it is mainly the cross-sectional area of randomly oriented glass fibres



Flow behaviour in a spiral mould

Fig. 1



Flow lengths with different melt viscosities

Fig. 2

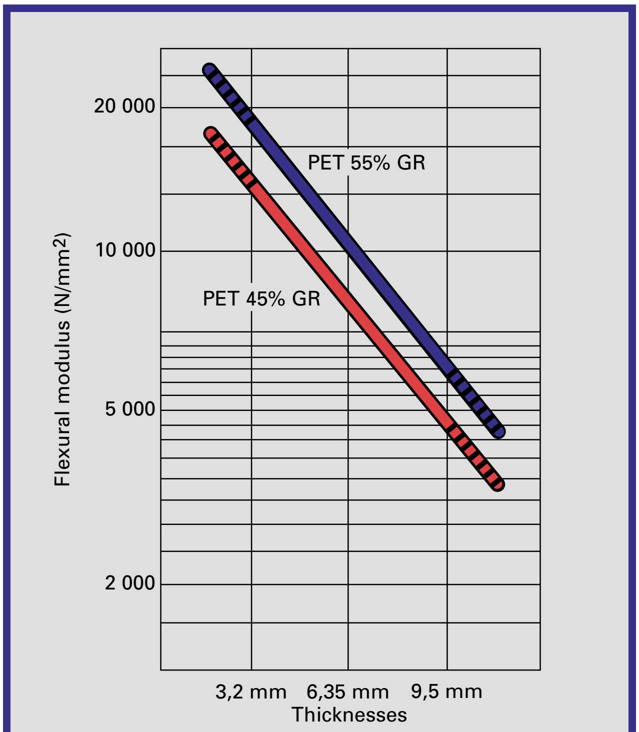
that is enlarged. On the other hand, the thickness of the zone in which the fibres are oriented in the direction of flow remains largely the same (Fig. 3).
This boundary zone, which critically determines component rigidity in the case of glass-fibre-reinforced plastics, is thus reduced in proportion to the overall wall thickness. This explains the decline in the flexural modulus (Fig. 4) when wall thickness is increased. The strength values determined on standard test bars (3,2 mm) are not therefore directly applicable to wall thicknesses deviating from this. To estimate component behaviour, it is essential to make use of safety factors. So by increasing wall thickness without consideration of the consequences, material and production costs are increased without a significant improvement in rigidity.

Increase wall thickness?

An increase in wall thickness not only crucially determines mechanical properties but also the quality of the finished product. In the design of plastics components, it is important to aim for uniform wall thickness. Different wall thicknesses in the same component cause differential shrinkage which, depending on component rigidity, can lead to serious warpage and dimensional accuracy problems (Fig. 6). To attain uniform wall thickness, thick-walled areas of the moulding should be cored (Fig. 5). In this way it is possible to prevent the risk of void formation and reduce internal stresses. Furthermore, the tendency to warp is minimized. Voids and microporosity in the component severely reduce its mechanical properties by cross-sectional narrowing, high internal stresses and in some cases notch effects.

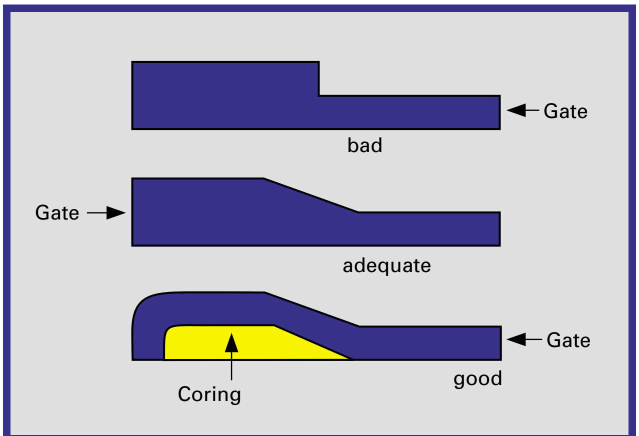
Fibre orientation
Core zone/Edge zone

Fig. 3



Flexural modulus as
a function of wall thickness

Fig. 4



Transition between
different wall thicknesses

Fig. 5

Component warpage as a result
of badly designed wall thickness transitions

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 Interowa 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
DuPont 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'Illa
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
Ostenssjoveien 36
N-0677 Olso
Tel. +47 23 16 80 62
Telefax +47 23 16 80 62

Österreich
Biesterfeld Interowa 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@interowa.at
internet: www.interowa.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 Interowa 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 Interowa GmbH & Co. KG.
See under Österreich.

Suomi / Finland
Du Pont Suomi Oy
PO 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. + 525 557 221 000

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
#726, 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
DELRIN® 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®, Delrin®, 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.

www.plastics.dupont.com

The miracles of science™