

# ENGINEERING POLYMERS: THE 'TOP TEN' MOULDING PROBLEMS


By R. Wilkinson, E. A. Poppe, Karl Leidig, Karl Schirmer



The ten problems listed below occur often when moulding semi-crystalline engineering polymers such as POM, PA, PBT and PET. In this series of articles the authors describe simple ways to identify and avoid them.

## Chapter 1. Moisture in the granules






1. Moisture in the granules
2. Feed system too small
3. Wrong gate position
4. Hold time too short
5. Wrong melt temperature
6. Wrong tool temperature
7. Poor surface finish
8. Problems with hot runners
9. Warpage
10. Mould deposit

	Symptoms when moulding	Visible symptoms in moulded parts	Influence on mechanical properties
<b>PA</b>	<ul style="list-style-type: none"> <li>• Drooling</li> <li>• Bubble formation in the purge</li> </ul>	<ul style="list-style-type: none"> <li>• Splaying in direction of flow</li> <li>• Increased formation of flash</li> </ul>	<ul style="list-style-type: none"> <li>• Lower impact and tensile strength</li> </ul>
<b>PET PBT</b>	<ul style="list-style-type: none"> <li>• No noticeable symptoms</li> </ul>	<ul style="list-style-type: none"> <li>• N.B.: Surface streaks (splaying) are not visible</li> </ul>	<ul style="list-style-type: none"> <li>• Much lower impact and tensile strength</li> </ul>
<b>POM</b>	<ul style="list-style-type: none"> <li>• Bubbles may be formed in the purge</li> <li>• Some mould deposit may be formed</li> </ul>	<ul style="list-style-type: none"> <li>• There may be splaying</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>
<b>TEEE</b>	<ul style="list-style-type: none"> <li>• No noticeable symptoms</li> </ul>	<ul style="list-style-type: none"> <li>• Slightly increased tendency to form flash</li> </ul>	<ul style="list-style-type: none"> <li>• Lower impact and tensile strength</li> </ul>

**How to recognise excess moisture content** Source: DuPont

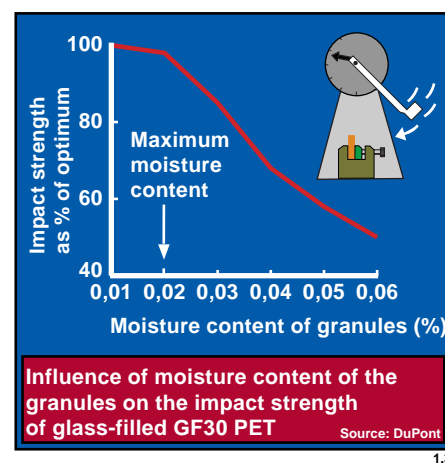
1.1

Many plastics absorb moisture from the atmosphere; how much they absorb depends on the type of resin. Moisture in the granules, even if it is only surface condensation, can cause problems in parts moulded with engineering polymers. Many kinds of undesirable effects can occur, including processing problems, poor surface on moulded parts, or loss of mechanical properties. It is seldom possible to establish whether there is moisture present by means of visual examination alone. The authors prepared this article to give moulders who process a broad range of plastics some useful guidance on how to handle those polymers that are sensitive to moisture.

					
PA	0,2 %	80°C	2 - 4 h	Needed only if resin has been exposed to atmosphere	
PBT	0,05 %	120°C	3 - 4 h	Always needs drying (dehumidified-air dryer)	
PET	0,02 %	130°C	3 - 4 h	Always needs drying (dehumidified-air dryer)	
TEEE	0,1 %	80°C - 110°C	2 - 4 h	Drying temperature depends on hardness	
POM	0,05 %	80°C	1 h	Only if you suspect surface condensation	

**Recommendations for maximum moisture content of the granules, drying temperatures and drying times**

Source: DuPont



## Drying Plastic Materials

Most engineering polymers require the moisture in the granules to be below a certain maximum level for processing. The need for drying depends mainly on how sensitive the raw material is to water. Naturally, the moisture content of the material as delivered, the type of packaging and the period of storage are also important criteria. For example, polyamide is generally packed in bags with a barrier layer of aluminium, so that it can be used straight out of the bag. However, most processors of PA prefer to dry the resin in any case, even though drying is not necessary if the material is used within one hour.

PET and PBT, on the other hand, are far more critical where moisture is concerned and must always be dried to ensure that impact strength of the moulded parts is not affected. Another factor is that these resins pick up moisture very rapidly after drying, so that moulders should exercise special care when handling open containers of PET and PBT, when they are in transport or conveyor systems, as well as regarding their dwell time in the hopper. Thus, in unfavourable climatic circumstances PET can absorb enough moisture in 10 minutes to exceed the maximum permitted moisture content for moulding of 0,02 per cent. Drying regrind and fully saturated granules (e.g. in the case of containers which were left standing around open) requires special care. In these cases the recommended drying times are usually not enough. Fully saturated polyamide may need more than 12 hours to dry. The yellowing associated with such treatment is practically unavoidable. The following guidelines should therefore be followed:

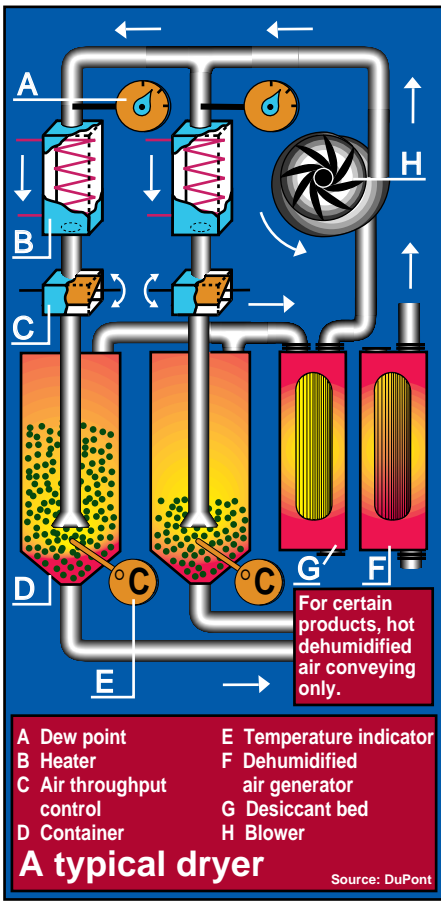
- Always store sprues and regrind in closed containers.
- Close containers or bags that have been partially used.
- Keep a lid on the hopper.

## How to Dry

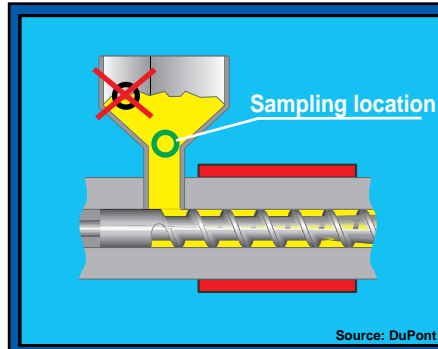
It is important to follow correct drying procedures if you want good quality mouldings. Simple hot air driers of various types are not adequate for drying polyesters, for example, but dehumidified-air drier systems are acceptable. Only these can provide the necessary constant and adequate drying, whatever the ambient climatic conditions may be. Apart from keeping the correct drying temperature, it is important to ensure that the dew point of the drying air remains lower than  $\leq -20^{\circ}\text{C}$ . When operating multiple-container installations with different filling heights and bulk density, it is also important to ensure that the air throughput in each container is sufficient.

## Measuring Moisture Content

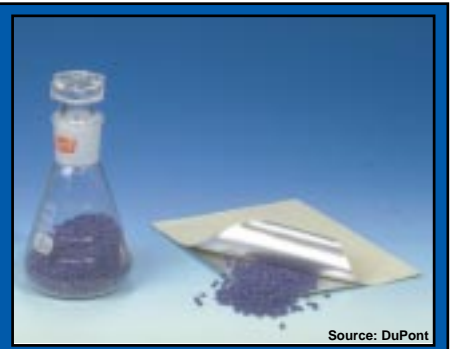
Moisture in the granules can be measured with commercially available measuring instruments, e.g. with the manometric or the Karl-Fischer method. To eliminate sources of error, the sample should be taken from well down in the hopper, and should be sealed in an appropriate container. Special heat-sealable sachets coated with PE and aluminium are suitable, as well as laboratory-type glass containers that can be hermetically sealed.



1.4



Recommended sampling location



Container for sample of granules



Manometric method



Moisture measuring instruments Karl-Fischer method

1.5

**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  
Du Pont 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™