Processing Durethan® by extrusion blow molding

1 Preparation of the material, drying

In the automotive sector and other areas, blow molded parts produced with the engineering plastics polyamide 6 and polyamide 66 are increasingly being used. These grades are mostly glass-fiber reinforced, but unreinforced grades can also be used. When polyamides are processed by extrusion blow molding, it is particularly important that the material be very well pre-dried. The moisture content of the material affects both the stability of the parison and the surface quality of the blow molded parts.

With well pre-dried materials the melt viscosity is increased, allowing larger blow molded parts to be obtained. Fig. 1 compares the length of continuously extruded parisons with the length they would have if the parison was unable to lengthen under its own weight (here PA66 GF25, Durethan AKV 325 H2.0 is shown as an example). The plot clearly shows that even small amounts of moisture can have a significant effect on the melt stiffness.

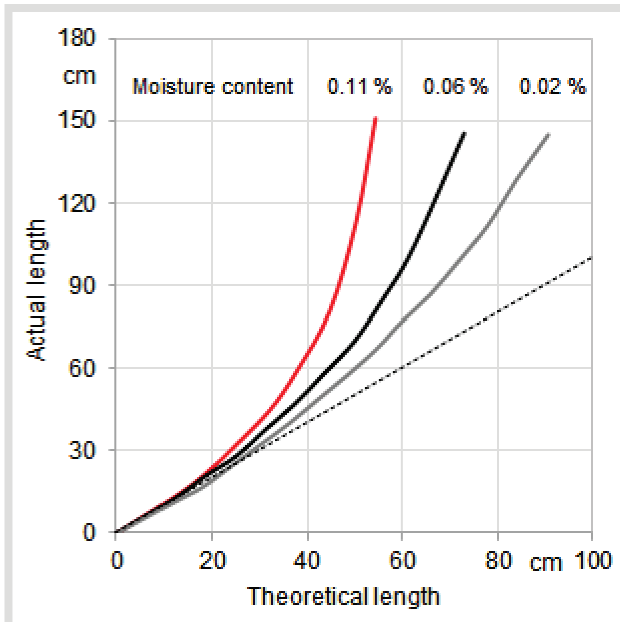

Fig. 1 Influence of moisture on melt stability

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2 Surface quality

The amount of moisture in the plastic pellets has a crucial influence on the surface quality: the more effective the drying process, the fewer flaws on the part surface (Fig. 2).

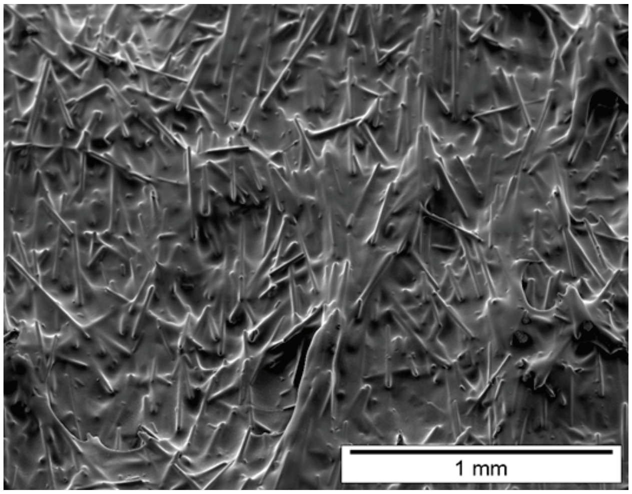
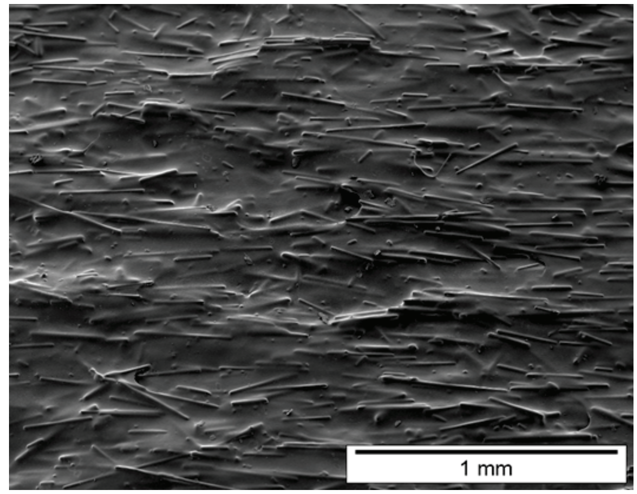


Fig. 2 Residual moisture 0.1 %



Residual moisture 0.02%

This applies to both the outer and the inner surface of a blow molded part. Stringent requirements are placed on the inner surface of media ducts in particular. When moisture content is too high, so-called "beards" can form through deposits of glass fiber reinforced polyamide building up on the edge of the mandrel. These become detached from time to time and stick to the inside of the hollow part. Fig. 3 shows defects of this type on the inside of a hollow part.

Fig. 3 Defects due to "beard" formation

When polyamides are processed in a blow molding process, they require considerably lower moisture content than for an injection molding process, for example. Therefore, both virgin material and regrind should be dried to a moisture content of less than 0.06% (or preferably less than 0.03%) in order to satisfy the stringent quality requirements of the automotive industry. The best driers to use are desiccant driers with a dew point of approximately -30 °C.

Since the PA products referred to here are mostly black in color as well as heat-stabilized for use in the engine compartment, they can be dried at higher temperatures than natural-colored polyamide 6 and polyamide 66 grades or those with lighter colors. For such

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light-colored grades, the drying temperatures may not exceed 80 °C in order to prevent yellowing due to oxidation.

The drying conditions shown in Table 1 are suitable for heat-stabilized PA 6 and PA 66 blow molding grades in practice.

Drying conditions

Material		Dry air dryer	
Product class	**Durethan**	**Temperature**	**Drying time**
PA 6 unreinforced	BC 550 Z DUSXBL BC 700 HTS DUSXBL	80 – 100 °C	6 – 12 h
PA 6 GF15 PA 6 GF20 PA 6 GF25	BKV 315 Z H2.0 BKV 320 Z H2.0 BKV 325 Z H2.0	80 – 100 °C	6 – 12 h
PA 66 GF20 PA 66 GF25	AKV 320 Z H2.0 AKV 325 H2.0	100 – 110 °C	6 – 12 h

Recommended moisture content < 0.06% (preferably< 0.03%)
* Dew point approx. -30 °C

Table 1 Drying recommendations for black colored (900116) blow molding grades

Experience has shown that these conditions are sufficient for virgin material in the "as delivered" state and also for regrind that is re-used directly without lengthy intermediate storage.

For material with a higher moisture content, i.e. material from open or damaged containers, or regrind that has been stored in unsealed containers for a prolonged period of time, a considerably longer drying time may be necessary.

3 The plasticizing unit

Processing glass-fiber-reinforced polyamides requires a wear-resistant extruder barrel and screw.

Extruders with a smooth feed section are generally used, guaranteeing a plasticizing capacity which is sufficiently high and uniform.

It is acceptable to use conventional three-section screws with medium-level compression (compression ratio approximately 1 : 2.5 to 1 : 3) and a length of 20 to 25 D. When processing glass-fiber-reinforced polyamides, it is essential to avoid shearing sections with a narrow shear gap so as not to grind the glass fibers and unnecessarily reduce the mean glass fiber length, which is critical for good mechanical properties.

The glass fibers used for these engineering polyamides are generally 0.2 to 0.4 mm in length and have a diameter of approximately 10 µm. Therefore, it is strongly recommended not to use fine-meshed melt filters between the extruder and the die head, since such filters can rapidly become clogged by the glass fibers.

A large number of extrusion blow molding machines are equipped with grooved feeding zone extruders which are standard for high-molecular polyolefins. These can also be used, with certain reservations, for the PA products described here. However, It may happen that the feed capacity of the grooved feeding zone exceeds the melting capacity of the screw. Depending on the screw geometry, this can then lead to an unacceptably high drive torque or to an uneven feed, or even to a total breakdown in the feed. Parts of the material that did not melt can block the flow channel in the compression zone and metering zone. It is possible to alleviate the force-feed effect of the grooved feeding zone by employing higher temperatures, which will also promote proper melting. Therefore, when processing PA 66 grades, in particular, it is advisable to make provision for an oil heating unit to heat the grooved feeding zone. Grooved feeding zone

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temperatures of 130 to 170 °C have proven successful in achieving less damaging feed characteristics.

4 Barrel temperatures

It has been seen on different extruders that a so-called "inverse temperature profile" gives good plasticizing results with respect to both throughput and melt quality. Fig. 4 shows appropriate temperature range settings for processing PA 6 and PA 66 products. It is also permissible to raise the temperature setting to a level considerably higher than the proposed ranges if the feed is not sufficiently uniform, the screw torque is too high or the melt quality is not sufficient. Heat-stabilized Durethan products are relatively insensitive to short-term peak temperature loads. Therefore, in the case of Durethan AKV 325 H2.0, the temperature setting for the first heating zone can be in the range of 320 to 330 °C, with the downstream temperatures falling to the lower level at a correspondingly later stage. Specific throughputs of 1.2 to 1.4 (kg/h)/(1/min) were achieved with these settings on different 60 mm extruders.

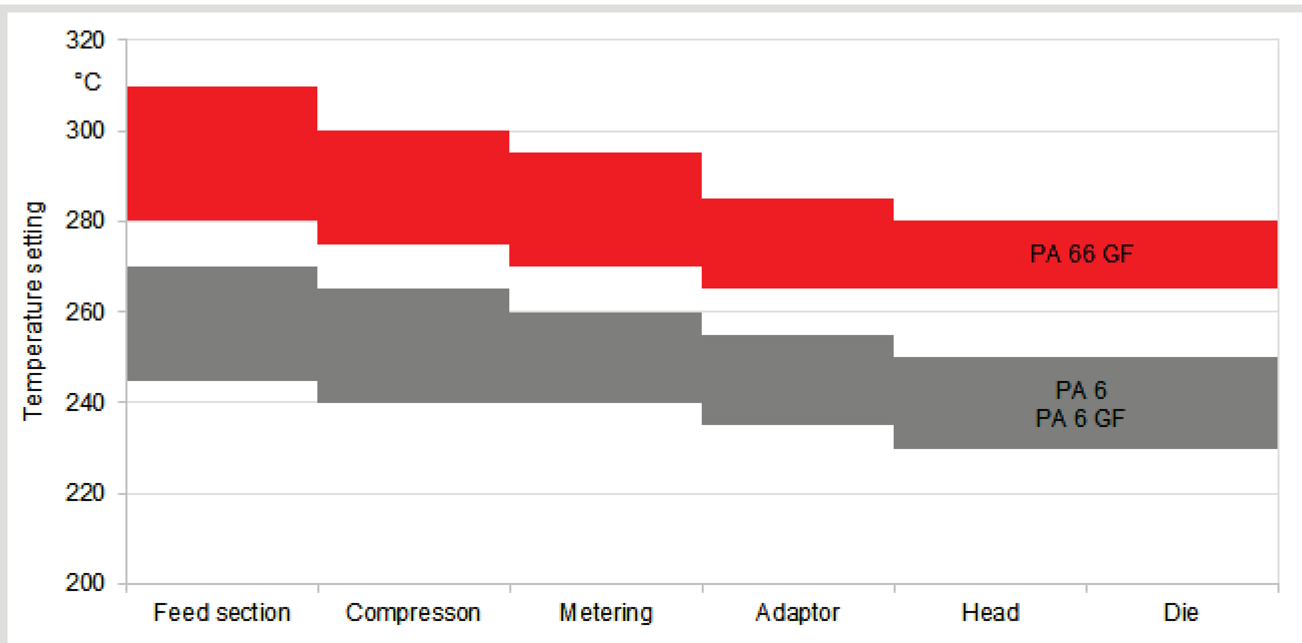

Fig. 4 Setting ranges for barrel temperatures

5 Mold temperature

Generally, the mold should be at a temperature of 60 to 90°C. As with a large number of other materials, the reproduction of detail on the polyamide surface improves with higher mold temperatures. The comparatively high solidification rate of these polyamides means that the high mold temperature does not automatically lead to longer cooling times and therefore longer cycle times. In the case of suction blow molding with Durethan BKV 315 Z H2.0 and AKV 325 H2.0 resins, mold temperatures of 120 to 140 °C showed considerably better part surfaces than a mold temperature of 80 °C.

6 Processing regrind

Experience has shown that the regrind from scrap that occurs in conventional production of engineering blow molded parts can be fed back into the process on a continuous basis. The continuous re-use of production scrap is also economically advantageous.

It is not possible to specify a maximum limit for the permitted regrind content. While the polyamide itself displays only minor signs of degradation after reprocessing, it should be noted that the length of the glass fibers is reduced with each processing cycle, leading to a reduction in the mechanical properties of the ma-

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terial. How much property reduction is acceptable for a specific part will need to be established in each individual case. It is therefore recommended that sample parts which have been manufactured under the expected production conditions, including maximum regrind percentage, be submitted for final qualification testing.

Please keep in mind that the geometry of the reground pellets differs from that of the virgin material. This can lead to a change in the flow properties and feed behavior of the material. It may therefore be necessary to adjust the machine settings to compensate, particularly the screw speed.

As has already been stated in Section 1, "Preparation of the material/drying", efficient re-drying is essential when processing regrind as well.

7 Swelling behavior

It is difficult to give precise details of the materials' swelling behavior, since swelling is not only conditioned by the material used but also by other parameters, such as:

- Output rate/extrusion rate
- Melt temperature
- Die geometry (inside cone/outside cone)
- Die gap width.

The values given in Table 2 are an approximate guide for selecting the die diameter. These are values that have been established in practical tests. The exact die diameter must then be determined in tests under the applicable process conditions with the specific mold that is to be used.

Swelling behavior

Product class	Durethan	Die swell: Ø Die : Ø Parison
PA 6 non-reinforced	BC 550 Z DUSXBL BC 700 HTS DUSXBL	1 : 1,8 1 : 1,6
PA 6 GF15 PA 6 GF20 PA 6 GF25	BKV 315 Z H2.0 BKV 320 Z H2.0 BKV 325 Z H2.0	1 : 1,4 1 : 1,2 1 : 1,1
PA 66 GF20 PA 66 GF25	AKV 320 Z H2.0 AKV 325 H2.0	1 : 1,2 1 : 1,4

Table 2 Empirical values for swelling behavior in the blow molding of Durethan

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Regrind
Where end-use requirements permit, regrind may be used with virgin material in quantities specified in individual product information bulletins, provided that the material is kept free of contamination and is properly dried (see maximum permissible quantities and drying conditions in product information bulletins). Any regrind used must be generated from properly molded/extruded parts, sprues, runners, trimmings and/or film. All regrind used must be clean, uncontaminated, and thoroughly blended with virgin resin prior to drying and processing. Under no circumstances should degraded, discolored, or contaminated material be used for regrind. Materials of this type should be discarded. Improperly mixed and/or dried regrind may diminish the desired properties of a particular LANXESS product. It is critical that you test finished parts produced with any amount of regrind to ensure that your end-use performance requirements are fully met. Regulatory or testing organizations (e.g., UL) may have specific requirements limiting the allowable amount of regrind. Because third party regrind generally does not have a traceable heat history or offer any assurance that proper temperatures, conditions, and/or materials were used in processing, extreme caution must be exercised in buying and using regrind from third parties. The use of regrind material should be avoided entirely in those applications where resin properties equivalent to virgin material are required, including but not limited to color quality, impact strength, resin purity, and/or load-bearing performance.

Note:
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