Technical Data Sheet

Extrusion Blow Molding of Grilamid and Grilon

EMS-GRIVORY

Contents

1 EMS-GRIVORY extrusion blow molding materials

The blow molding process has been employed since about 1950, though its application to polyamides came much later. Since 1990 the development of technical blow molding materials has advanced, so that there is now a considerable variety of them.

With Polyamide 6 and Polyamide 66/6 alloy there are now grades ranging from good to very high impact strength. The reinforced grades are being produced with 15% and 20% glass fiber reinforcement.

Table 1:

Designation	Glass content	Impact strength	Melt strength
Grilon EB50 H	—	good	high
Grilon EB50 HDZ	—	high	high
Grilon BRZ-350/1H	—	very high	very high
Grilon EBV-15H	15 %	good	high
Grilon EBV-2H	20 %	good	very high
Grilon ELX 40 HNZ	—	very high	high
Grilon ELX 50 HNZ	—	very high	high
Grilon XE4242	15%	good	very high
Grilon EBGM-20HX	15%	good	very high

2. Processing behavior of polyamide in extrusion blow molding

2.1. Melt strength

Very exacting requirements are imposed on the material when processing polyamide by extrusion blow molding. One of the most important properties is the melt strength.

The term melt strength describes the “stability” of the parison. With higher melt strength it remains dimensionally stable, whereas with low melt strength it elongates more.

Consequently, materials with high melt strength are needed for extrusion blow molding.

For this EMS-GRIVORY has developed its own procedure to assess the melt strength. A tube is continuously extruded and the time taken by the tube to cover the distance (1 meter) from nozzle to floor is measured.

The melt strength is always measured with an output of 100 cubic centimeters per minute and a fixed temperature profile

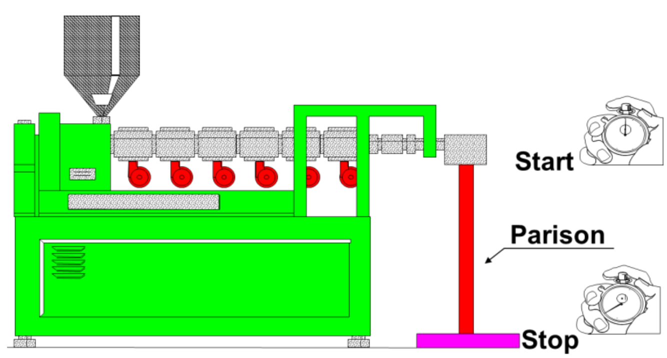

Fig. 1: Device for determining the melt strength by the EMS-GRIVORY method.

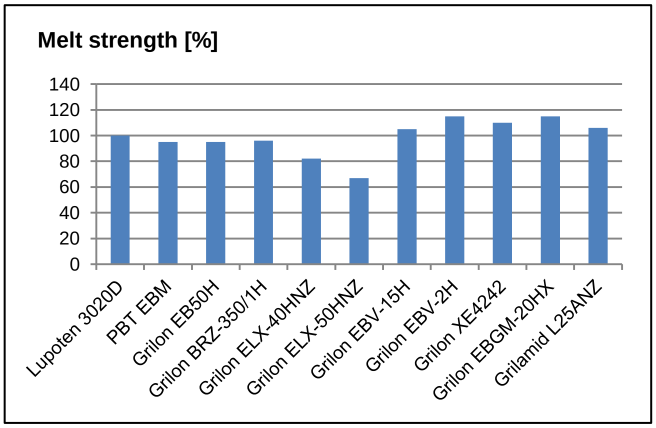

Fig. 2: Comparison of a standard PE- LD (at 210C melt temperature) with the EMS-GRIVORY blow molding types (at 270°C melt temperature).

2.2 Drying

Polyamides are moisture absorbing (hydrophilic) and take up moisture from the ambient air during storage. The moisture absorption rate depends on the relative air humidity. Only 20 minutes exposure to ambient air at 23°C / 50% R.H. may cause difficulties in processing.

EMS-GRIVORY blow molding materials are supplied with moisture content below 0.1%. It is important to avoid damage to the package during storage and delivery. They should also not be opened in cold conditions; otherwise condensation on the granule will be take place. This happens especially during winter, when cold material is brought to the machine. To prevent this problem, about 24 hours before processing, the material should be placed in a room with the same temperature as the production location.

For blow molding, the granule must have a residual moisture content of less than 0.1%. Make sure that the moisture content is kept at the same level (0.04~0.06% moisture content is recommended), to ensure constant processing. With more than 0.15% moisture, bubbles arise in the parison, leading to rejects. Moreover processing with elevated moisture content reduces the melt strength. This means if the material is processed with varying moisture levels that the melt strengths will fluctuate too which leads to unstable process and inconsistent article quality.

Desiccant dryers with a dew point of at least –40°C have proved themselves suitable for drying polyamides. Drying temperatures from 80°C to 90°C are applied for 4 to 8 hours. If the material has been exposed to the ambient air for several days or weeks, it has to be dried for at least 10 hours. Mostly, unreinforced Polyamides melt strength is more sensitive to moisture content.

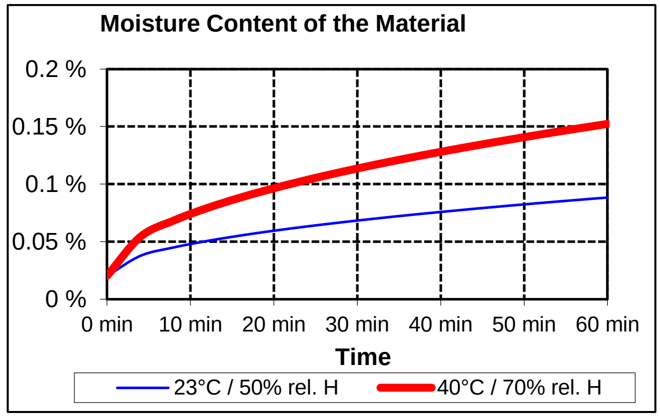

Fig. 3: Grilon EB-50H moisture content versus in different conditions expose time

When using regrind, grinding must be done right at the blowing machine, followed by immediate reuse. If the regrind is exposed to the ambient air longer than 20 – 30 minutes, it must be dried again, just like granule from bags.

For glass fiber reinforced material, regrinding must be sieved to remove the powder before recycle.

After drying, the material must not be allowed to take up moisture again before processing. This may be ensured by taking following precautions:

- Keeping small material quantities in the hopper or using small hoppers
- Always keep the hopper closed
- Convey dry material with dry air
- Desiccant must be maintained monthly, mostly in summer

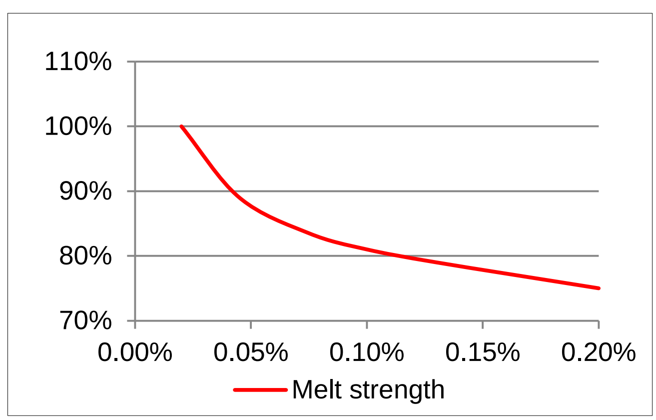

Fig. 4: Melt strength versus moisture content in Grilon EB50H

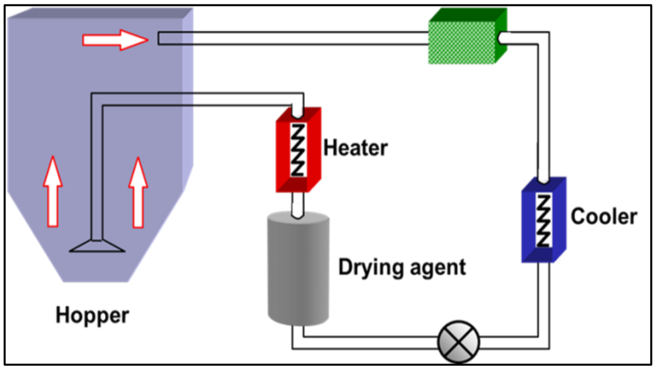

Fig. 5: Schematic desiccant dryer

As a rule of thumb, the dryer volume should be 6 to 10 times the hourly material throughput. For example with a throughput of 40 kg/h the dryer volume should be at least 400 liters. The throughput multiplier depends on the particular process, how long the regrind has been exposed to the ambient air, and whether the virgin material is in undamaged bags. To obtain constant material drying, the dryer should preferably operate continuously. There are desiccant dryers that adapt the drying temperature automatically to the material throughput, keeping the residual moisture more constant than conventional equipment.

2.3 Processing temperatures

Polyamide blowing grades are generally tolerant in processing with regards to the temperature control. Of course, the melt strength is lowered by higher processing temperatures. The standard processing temperatures are set out in Table 2.

Feed zone temperatures:

By using a grooved feeding zone, temperature control should run with oil, a temperature at least 120°C should be used for glass fiber reinforced material. If the machine has a smooth feed, a temperature of 60°C – 80°C at the hopper may be used.
To ensure proper material conveying, a high feed zone temperature must be chosen. Accordingly, the rule is: the deeper the grooves, the higher the temperature should be. However, if the extruder still stalls, the material must be feed in slowly at the beginning.

Cylinder temperatures:

The cylinder temperatures must be selected so that the melt temperature does not have a bigger difference than 15°C. If deviation exceeds 15°C, the cylinder temperature must be adjusted accordingly. Generally speaking, very good results can be achieved with an elevated cylinder temperature at the first zone followed by a constant temperature profile. This temperature profile may differ depending on the screw geometry, but it must be optimized. The temperature setting and actual temperature exhibit in Fig. 13.

Head temperatures:

The head temperatures must be set according to the melt temperature. To check the parison swelling at the die, a temperature lower or higher than the melt temperature may be run. It should, however, not be too low if a good surface quality is to be assured.

Table 2:

Material	Melt temperature [°C]	Grooved/Feeding Zone [°C]	Cylinder [°C]	Head [°C]	Mould [°C]
Grilon EB50 H	240 –250	120 –160	240 –260	230 –250	40 – 80
Grilon EB50 HDZ	240 –250	120 –160	240 –260	230 –250	40 – 80
Grilon BRZ-350/1H	240 –250	100 –160	240 –260	230 –250	40 – 80
Grilon EBV -15H	250 –260	120 –180	250 –260	230 –260	40 – 90
Grilon EBV-2H	250 –260	130 –180	250 –260	230 –260	40 – 90
Grilon XE4242	275 –285	130 –180	275 –285	260 –280	40 – 90
Grilon EBGM-20HX	275 –285	130 –180	275 –285	265 –285	40 – 90
Grilon ELX 40 HNZ	230 –240	100 –140	230 –240	225 –240	20 – 60
Grilon ELX 50 HNZ	230 –240	100 –140	230 –240	225 –240	20 – 60

Mold temperatures:

Owing to the molecular chains of the extrusion blowing materials, crystallization generally proceeds very slowly. Therefore blow molding polyamides can be processed with low mold temperatures and still achieve good product quality.

Melt temperatures:

Through the melt temperature the melt strength can be adjusted within certain limits. Increasing the melt temperature by 20°C will lower the melt strength by 20% – 30%. For the flexible polyamide blowing materials the melt temperature should always be about 230°C – 235°C if smooth surfaces are to be obtained.

2.4 Parison swelling

Parison swelling is defined as the change of diameter after the die exit. No values of general validity can be stated for it, because a great number of parameters are involved. Only tendencies can be indicated here:

- The lower the melt temperature, the greater the swell (depending on the die geometry, see Fig. 6).
- The higher the melt strength, the greater the swell.
- The higher the extrusion speed, the greater the swell.
- The gentler and slower the melt is formed into the required diameter, the less the swelling.
- Glass fiber reduces the swelling.

Extrusion Die

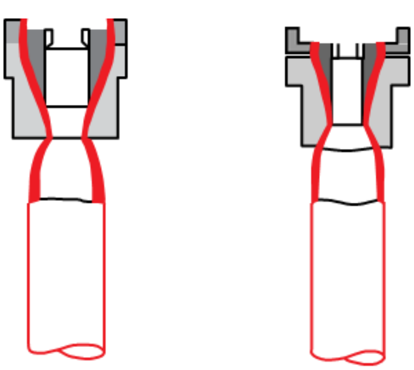

Fig. 6: Tube swelling versus die design and schematic presentation of swell.

Normally, glass fiber reinforced polyamide swelling is about 110% to 140%, without glass fiber reinforced polyamide swelling is about 180% to 220%. Nevertheless it can be said that polyamides have a lower swelling than polyethylene and polypropylene.

2.5 Blow-up ratio

The blow-up ratio is defined as the ratio between the diameter of the parison and the diameter of the finished part. If the parison has a diameter of 60 mm and the finished part 120 mm, the blow-up ratio is 2:1.

The blow-up ratio has considerable influence on the mechanical properties and above all on the shrinkage. It can be said that with an increasing blow-up ratio the orientation of the molecules and fibers increases in radial direction. This effect may be used deliberately in order to obtain isotropic shrinkage (see Fig. 9) or improved orientation of glass fibers in radial direction for example.

2.6 Shrinkage

The shrinkage of blow-molded articles has the same rules as in injection molding. We speak of process shrinkage and post-shrinkage. Process shrinkage is measured after the part cools, while post-shrinkage appears only after some days or weeks. It can be stated that shrinkage increases with rising demolding temperatures (see Fig. 7).

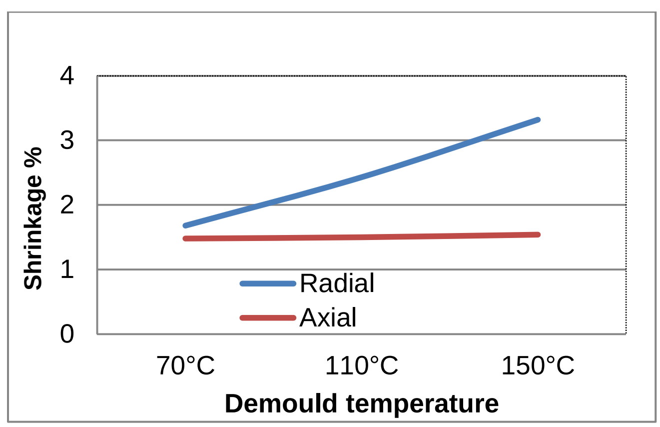

Fig. 7: Shrinkage versus demolding temperature (XE4242 diameter 52mm)

All polyamide blowing materials show very little post shrinkage, like they do in injection molding, because the moisture uptake compensates the post crystallization.

2.7. Recycling

Conventional blow molding processes always produce reground material. The proportion of this can be greatly reduced by the 3D technologies described in the next section.

The blowing materials supplied by EMS-GRIVORY all behave very well under repeated recycling. In the regrind tests as shown in Fig. 8, 100% recycled material was used without any blend-in of virgin material.

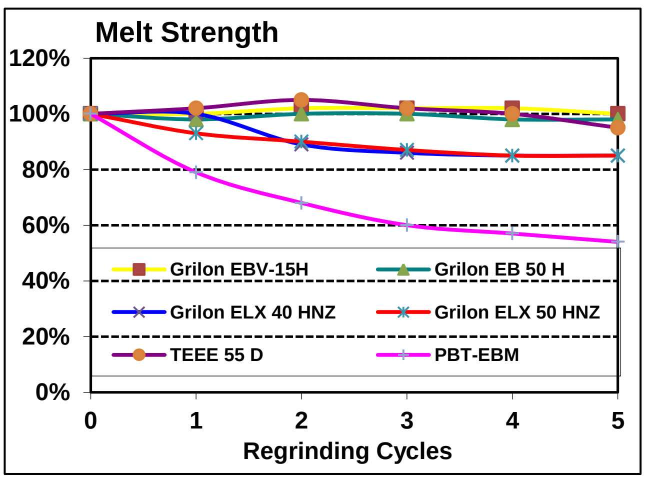

Fig. 8 Alteration of melt strength versus number of re-granulations

The regrind must be used at once, before it can take up moisture. If the regrind is not mixed with the virgin material and processed at once, it must be redried.

Experience has shown that with up to 30% regrind no processing problems or altered mechanical properties are to be feared, provided there is no improper treatment or extreme processing conditions (such as excessive shearing etc.). If, however, higher proportions of reground material are used, the melt strength, pinch-off seam strength etc. may be impaired, resulting in unsatisfactory product quality.

Sieve the powder of the regrind material before recycling to avoid the powder degradation or unmelt, the regrind granule size should be similar with the virgin pellet for uniform mixture.

3. Machinery for polyamide blow molding

3.1. Suction blow molding technology for technical parts

Suction blow molding is one variant of the 3D blow molding.

The plastic melt is first delivered into an accumulator and then extruded through this. The melt accumulator may be integrated in the extrusion blowing head or located outside between the extruder and extrusion head. When using a melt accumulator it is important to assure the FIFO principle (first in, first out) for polyamides. If no FIFO head is employed, the melt will spend a lot of time in the accumulator because not every extrusion will consume the entire melt quantity. Consequently there will always be a certain amount of melt left in the accumulator, leading to long retention times, possibly degrading the material and producing articles of inferior quality.

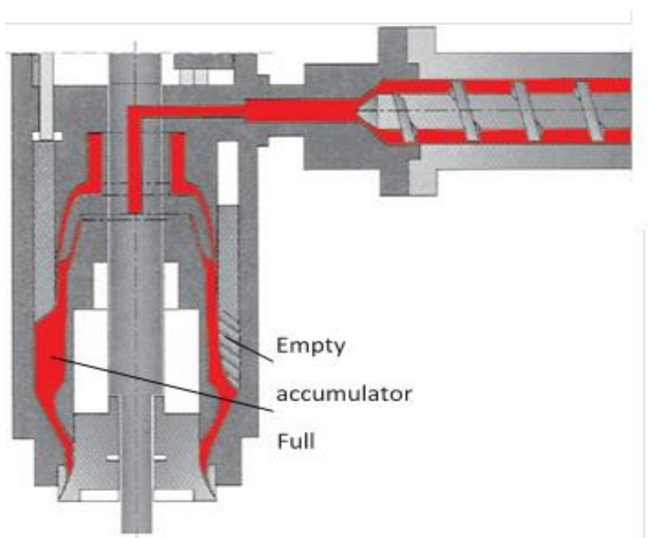

Fig. 9: Schematic FIFO accumulator head

For suction blow molding processing, the tool is closed sequentially during or even after the completed parison transfer. When employing suction blow molding, though, it is already closed beforehand. The parison is then drawn through the mold via vacuum, subsequently inflated and thus shaped. This facilitates low-waste production of complex geometries.

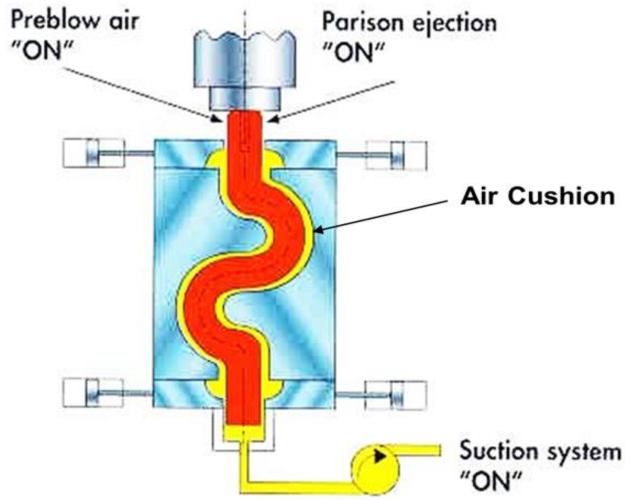

Fig. 10: Suction blow molding processing method

The suction blow molding technology offers various advantages,

Including:

- Ability to produce parts with very complex three-dimensional and pronounced shapes
- Less flash
- No pinch-off line in stressed zones
- Less energy demanded owing to lower parison weight
- Smaller extruder diameter
- Smaller melt accumulator
- Lower clamping forces
- Considerable energy savings
- Reduced cost for deflashing equipment

SECO (Sequential Co-extrusion) Blow Molding:

Sequential Co-extrusion blow molding involves a succession of two or more materials in the extrusion direction. First may come typically a rigid material like Grilon EB-50H, followed by a soft component such as Grilon ELX 50 HNZ, and finally the rigid type once more.

When processing two or more materials, it's recommend to run the material with the higher swelling inside in order to avoid excessive diameter differences or bubbles of the parison. The soft materials supplied by EMS-GRIVORY are optimized to the hard components so that combinations can be used freely.

Coextrusion Blow Molding:

At present two component machines are most common used for air duct components.

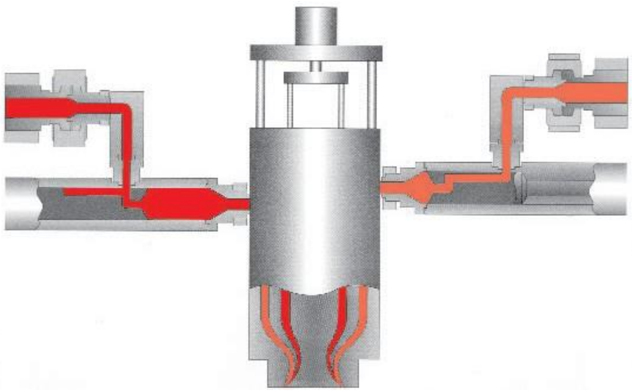

Fig. 11: Sequential blowing head with external melt accumulators

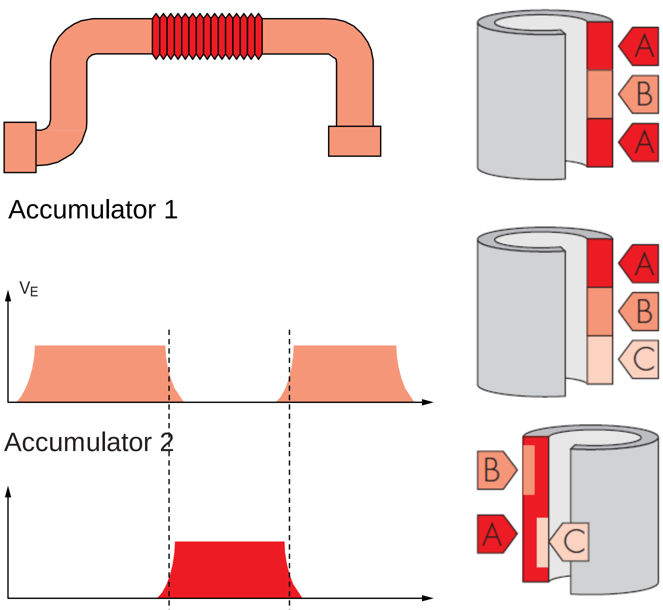

Fig. 12: Extrusion principle and further typical combination possibilities with SECO-extrusion

3.2. Extrusion blow molding heads

As already described in connection with conventional blow molding, it is important to use FIFO blowing head when processing polyamide.

To be also noted is that polyamide blow molding materials have higher viscosities than standard polyethylene so that higher pressures build up in the head. This must be designed for high viscosity products.

The distributor system should preferably be a mandrel head with double cardioid curves mandrel. This way glass fiber reinforced products can be worked optimally too. The double cardioid curves distributor is designed for the viscosity behavior of polyamide. Compared to polyethylene, polyamide has a lower structural viscosity causing a different distribution of the melt in the spiral channel.

Spiral distributor systems are not well suited for working glass fiber reinforced plastics. Consequently their use is very limited.

Spider heads cause, through their spiders, a lengthwise orientation of the glass fibers in reinforced plastics and subsequently create weaknesses in the molding. Besides, the fibers can no longer be oriented radially during the blow-up step. If possible, the glass fibers should be orientated along the main stress axis and not lie lengthwise.

3.3. Screw configuration

Screw geometry:

Various screw concepts are used, depending on the machine maker. It can be claimed that EMS-GRIVORY blow molding materials may be used with almost any screw geometry. Nevertheless, some designs are better than others. For working polyamides optimally, the following facts are to be considered:

- Shearing must be kept low.
- No mixing and/or shearing parts may be used.
- Screw length should be 22 – 26 times the diameter.
- A too short feed zone causes pulsating feed.
- A too short compression zone will lead to poor melting and low feed rates.
- The higher the melting point, the longer the compression zone must be.
- The higher the material viscosity, the lower the compression zone must be.

As already mentioned, there are various concepts. The simplest one employs the standard 3-zone screw without grooves like in injection molding. With this concept the melt temperature can be easily controlled, allowing constant operation. None the less, it has a lower feed rate than a grooved feeding zone.

Other machine makers generally use grooved feeding zones in conjunction with different screw concepts. The usage of barrier screws has increased and also has found its way to blowing machines as well.

The best way to find the optimal screw configuration is to talk to the machine supplier.

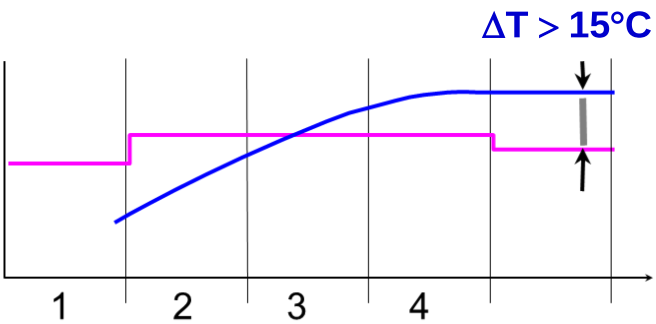

Fig. 13a: Melt temperatures attainable with an unfavorable screw

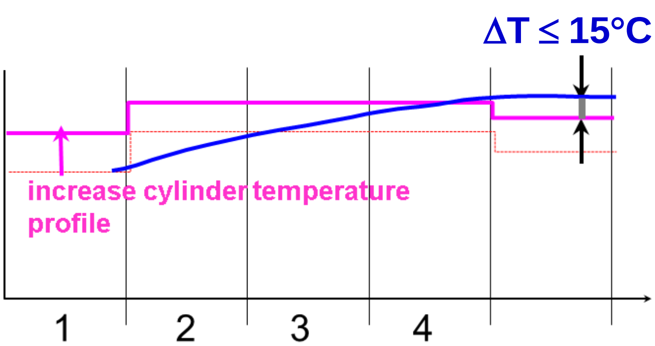

Fig. 13b: Melt temperatures attainable with an optimal screw

Grooved feed bushing design:

When using grooved feeding zones one adverse property of polyamide shows itself: polyamide granules are very hard compared with polyethylene granules. Accordingly the grooves must be adapted to this. If a grooved feeding zone is used for polyamide as it is for polyethylene, the screw may become blocked, especially when starting the machine. Blocking is rather rare with the unreinforced types such as Grilon EB50H, but more critical with the reinforced types, which have high fiber content.

To prevent blocking when starting the extruder, attention must be given to following points:

- Warm up the granule at 80°C – 130°C (preferably having been dried before).
- Start at low speed (5 rpm), increase the rpm step by step according the torque.
- Warm up the grooved feeding zone to 120°C – 180°C (by oil heating).

The driving power needed depends on the combination of the grooved feeding zone and screw geometries. If there is high material compression in the grooved feeding zone, a high drive input will be necessary too.

A typical grooved feeding zone for working polyamide has a length of 2 – 3 diameters, a groove depth of 0.01– 0.1 diameters at the hopper, and 0.05 – 0.1 D grooves. The groove section may be saw tooth shaped or rectangular, though here the screw geometry has a strong influence.

Finally it must be said that the grooved feeding zone and screw have to be very well adapted to each other if optimal processing is to be achieved. This especially represents a challenge for the machine maker.

3.4. Tooling

Mold material:

The tooling depends heavily on the used process technology. Nevertheless, it can be said that Aluminum alloy fulfill the processing requirement because less vibration and low pressure, Aluminum can also reduce the mold weight.
Sandblast treatment of the mold cavity surface is very important for optimal processing ability. Matt cavity surface lead the suction air flow to vertical direction and support the parison as it goes through in the cavity and avoid the parison touch the mold surface.

Mold temperature:

As we had mentioned, blow molding shrinkage is not the same as injection, demold temperature has a big influence for the article diameter. Post treatments, especially hot plate welding procedures need consistent articles diameter. Mold temperature setting guiding see Fig. 14.

Demolding temperature	70°C	110°C	150°C
Mold temperature	20-30°C	70-90°C	70-90°C
Cooling Time	45s	45s	25s
Longitudinal Shrinkage	0.2-0.5%	0.2-0.5%	0.2-0.5%
Radial Shrinkage	1.2-1.8%	2.0-3.0%	3.0-4.0%

Fig. 14: Grilon EBV-15H demold shrinkage

4. Integration of joined parts

Welding joined parts is particularly important in the 3D technique because the inserting of the parison makes it more difficult to integrate terminal lugs or similar parts in one step. Consequently they must be fixed differently. To achieve this there are two possibilities:

- Insert and over blowing
- Welding afterwards

Insertion:

Insertion may be limited by design circumstances or processing difficulties. Insertion is suited when working polyamide 12 because cold parts can be inserted. These must be clean (free of oil, mold release agents etc.). The cold inserted parts weld on when the parison is blown around them. To obtain very good welding, however, the insert must be heated too. This is not the case with polyamide 6. Here the inserted parts must be heated and blown around as quickly as possible to obtain a durable bonding.

Heating the inserted parts can be difficult and therefore the joined parts are often attached afterwards, e.g. by welding with a heating element, when working with PA 6.

Welding:

The welding methods applicable depend on the design of parts to be joined, i.e. rotationally symmetric parts may be rotation welded. Generally speaking, all EMS-GRIVORY blow molding materials are adequate for all commonly used welding processes, see Fig. 15

Heating element welding:

The heat element welding deserves special mention, because it is frequently used within the blow molding industry.

Besides choosing the right material it is important to apply a proper welding process as follows:

1. *Tighten the parts:* the parts to be joined need tightening because they are usually distorted and must therefore be leveled first. Normally this step is path-controlled.
2. *Deep heating:* involves creating a melt reservoir of about 0.5mm to 0.8mm deep. Deep heating is performed almost pressureless, i.e. the position is held constant after tightening.
3. *Joining:* involves removing the parts to be joined from the heater and the actual joining. Withdrawing must be done as quickly as possible, as must also the joining, though the contact of the joined parts must not be too fast, otherwise the melt will be displaced too severely.

	Infrared	Hot plate	Ultrasonic	Vibration	Laser
Melt of the plastics	Transfer of the heat Via IR without contact	Heat transfer Via contact with a hot plate	The joint area under a defined pressure (melt heat from molecular interfacial friction)	Friction of the joint area under defined pressure	Transfer the energy through the laser beam transparent material into the second laser beam absorption material.
Joining of the parts	After transfer the heat the hot plate removed from the joint area, the parts to be joined and hold together in a setting position or under a defined pressure		Ultrasonic or vibration were switch off after welding phase. The parts are held together under pressure until they have closed.		Laser beam absorption material welt the laser transparent material, the parts were joined at melt area.
Reproducibility	Limit (Over heat possible)	Good	Good	Good	Good
Welding parameter	• Distance of emitter to joint area • Welding distance • Welding time • Emitter temperature • Joint pressure	• Heat time • Welding distance • Joint pressure • Hot plate temperature	• Welding distance • Welding time • Joint pressure • Holding time • Amplitude • Frequency	• Welding distance • Welding time • Joint pressure • Holding time • Amplitude • Frequency	• Focus diameter • Power • Joint pressure • Scan speed • Wave length
Notes	• Smallest distance change can cause over heating of the melt.	• Pollution of the heat plate possible	• Tolerance of the welding geometry for small parts. • Welding area limit • Special welding line design	• Construction of the part must take place into linear, circular or orbital direction	• Only laser beam transparent and absorption material can be weld
Choice	The decision regarding the choice of welding method can be made by following the dialogue between the designer, the manufacturer of the parts, the welding technologist, the machinery, mold manufacturer and the manufacturer of raw material. In most cases, the chosen method is the one which offers the greatest possible reliability, sufficient practical experience and is the most economic.				

Fig. 15: Overview of different welding processes

5. Processing problems and trouble shooting

5.1. Parison failures

Problem	Cause	Trouble Shooting
Parison diameter too big	Die too big	• Use a smaller die • Lower the extrusion rate
	Parison swelling to big	• Lower the extrusion rate • Raise the die temperature • Raise the melt temperature • Optimize flow channel on die • Use another EMS-GRIVORY type
Parison diameter too small	Die too small	• Increase extrusion rate • Use a bigger die
	Parison swelling too small	• Raise the extrusion rate • Lower the die temperature • Lower the melt temperature • Use another EMS-GRIVORY type
Different wall thickness in circumferential direction and parison runs slantwise	Die head and die ring off-center	• Re-center the die ring • Optimize cardioid curve
	Head heated unevenly	• Check head heater bands and optimize
	Unfavorable flow channels	• Optimize head flow characteristic
Parison strongly elongated	Inadequate melt strength	• Adapt wall thickness profile • Increase basic gap • Lower the melt temperature • Raise extrusion rate • Use an EMS-GRIVORY type with higher melt strength
	Material too moist	• Dry the material better
	Excessive shearing in extruder head or screw (melt temperature too high)	• Optimize flow channel in head or screw
Parison runs with slant	Die ring off-center	• Centre the die ring
Lengthwise groove or thin place on parison and molding	Flow line from torpedo head (does not apply to accumulator head)	• Optimize the spiders • Raise the head temperature
	Die fouled up	• Clean the die
Several unequal lengthwise grooves (inside or outside) or thin places on molding	Die damaged	• Recondition the die
	Die fouled up	• Clean the die
Several similar lengthwise grooves or thin places on molding	Spider head, strainer spider legs too thick or flowability unfavorable	• Optimize legs hydraulically • Lower the extrusion rate • Raise the head temperature
Rolling inwards	Die ring too hot – Core too cold	• Optimize the head heating
	Insufficient wall thickness	• Increase wall thickness at start of extrusion
Rolling outwards	Torpedo head or core too hot – Die ring too cold	• Heat the die ring more
	Insufficient wall thickness	• Increase wall thickness at start of extrusion

Problem	***Cause***	***Trouble Shooting***
Lateral folds (locally)	Local advancing	• Reduce extrusion rate • Optimize head hydraulics
Local rough strips parts	Machine does not reach temperatures above 230°C	• Raise heating of machine
Lumps, specks	Material contaminated	• Purge extruder/head longer
	Material builds up	• Raise or lower the melt temperature • Reduce drying temperature/time
Rough outer surface	Material solidifies in air	• Raise extrusion rate • Raise melt temperature • Raise die temperature
	Material decompressed	• Raise melt temperature • Optimize flow channel of die
	Irregular flow front	• Reduce extrusion rate
Rough inner surface	Material decompressed	• Optimize die entry so that material is decompressed only at die exit
Many small bubbles retarded after nozzle exit	Excessive moisture content	• Material needs drying
	Decomposed material	• Purge extruder, head • Shorten material retention time
Large bubbles immediately after nozzle exit	Air inclusions	• Raise extrusion pressure (accumulator charging pressure) • Use screw geometry with higher compression
	Material shortage	• Refill material sooner
	Decomposed material	• Purge extruder, head • Shorten material retention time
Discoloration	Contamination with extraneous material	• Use virgin feedstock and purge out the equipment
	Material overstressed thermally	• Lower the melt temperature • Optimize the screw (no mixing or shearing parts,...) • Use less regrind stock • With high regrind proportion add heat stabilizer • Eliminate dead points in the flow channel • Optimize accumulator tolerances
	Material is partially oxidized	• Lower the melt temperature • Reduce shearing in head and extruder • Use heat master batch

5.2. Part failures

Problem	***Cause***	***Trouble Shooting***
Wall thickness to high	Parison too thick	• Adapt wall thickness profile • Reduce basic gap
Wall thickness to low	Parison too thin	• Adapt wall thickness profile • Increase basic gap
	Parison lengthens too much	• (see: parison strongly elongated)
Insufficient wall thickness in zone close to nozzle	Insufficient melt strength	• Increase extrusion rate • Adapt wall thickness profile • Lower the melt temperature • Use an EMS-GRIVORY type with higher melt strength
Inconsistent wall thickness at circumference	(see: parison with unequal wall thickness at circumference)	
	In 3D blow molding	▪ Use radial wall thickness control
Insufficient wall thickness in corners	Melt strength too low	▪ Reduce melt temperature ▪ Use an EMS-GRIVORY type with higher melt strength
	Unfavorable part geometry	▪ Optimize preblowing ▪ Optimize parison position to mold ▪ Round off the corners
Local rough or bright places	Parison touches the mold	• Raise mold temperature • Reduce parison diameter • Reposition extruder above mold • Optimize tube manipulation (in 3D blow molding)
	Poor mold venting	• Optimize mold venting
Surface with specks/scales	Material contaminated with foreign matter	• Purge extruder/head • Optimize local temperature differences in head
Hollow parts burst during blow-up	Insufficient wall thickness	• Raise wall thickness on parison
	Excessive blow-up ratio	• Reposition extruder above mold • Optimize mold clamping position • Optimize part geometry • Increase the nozzle diameter
	Insufficient clamping force	• Raise clamping force • Reduce blowing pressure • Enlarge flash chamber • Optimize pinch-off zone geometry • Use machine with more clamping force
	Parison collapses	• Earlier preblowing • Adapt blow-up pressure/time
Big weight variations	Inconsistent feed	• Mix regrind and virgin material • Adapt grooved feeding zone and cylinder temperature

Problem	*Cause*	*Trouble Shooting*
Mold parting appears as elevation	Blowing pressure too high	• Reduce blowing pressure
Mold parting appears as elevation	Insufficient mold clamping force	• Raise mold clamping force
Mold parting appears as elevation	Blowing air supplied too early	• Increase blowing air delay
Step on part	Mold offset	• Match mold halves
Incomplete blow-out	Insufficient blowing air pressure	• Raise blowing air pressure
Incomplete blow-out	Blow-out time too short	• Extend blow-out time
Incomplete blow-out	Mold not vented	• Prevent mold venting
Incomplete blow-out	Melt temperature too low	• Raise the melt temperature
Blowing needle pricks poorly	Unfavorable pricking point	• Move pricking point to pinch-off seam
Blowing needle pricks poorly	Pricking speed too low	• Reduce throttling on cylinder • Clean blowing needle • Fit quick vent on opposite side • Extend advance
Blowing needle pricks poorly	Blowing needle runs badly in the mold hole	• Centre the needle in the hole • Clean mold hole or blowing needle • Enlarge the mold hole
Blowing needle pricks poorly	Blowing needle too blunt	• Sharpen or replace blowing needle
Blowing needle pricks poorly	Blowing needle too thick	• Use thinner blowing needle
Blowing needle pricks poorly	Blowing needle stroke too short	• Lengthen blowing needle stroke
Blowing needle pricks poorly	Material already solidified	• Shorten the pricking delay • Raise the melt temperature
Blowing needle pricks poorly	Material can be elongated too much	• Increase the pricking delay • Reduce the melt temperature • Raise parison thickness
Blowing needle pricks poorly	Blowing needle to hot	• Provide additional needle cooling
Blowing needle pricks poorly	Material clings to blowing needle	• Clean the blowing needle • Cool the needle better
Blowing needle pricks poorly	Needle blows too soon	• Increase blowing air delay
Severe distortion	Molding demolded too hot	• Increase blowing time • Lower the mold temperature • Lower the melt temperature • Provide after-cooling station
Severe distortion	Uneven wall thickness distribution	• Optimize wall thickness profile • Increase blowing time • Reduce the mold temperature locally
Severe distortion	Uneven cooling	• Optimize mold cooling • Increase the blowing time
Molding sticks in the mold	Mold too hot	• Lower the mold temperature
Molding sticks in the mold	Cooling time too short	• Increase the blowing time
Molding sticks in the mold	Deposits in the mold	• Clean the mold
Hollow moldings break after	Poor pinch-off weld strength	• (See: poor pinch-off weld strength)

5.3. General mistakes

Problem	Cause	Trouble Shooting
Extruder blocked	Material cannot be compressed	• Raise grooved feeding zone and cylinder temperature • Preheat the material • Start extruder at low speed and refill slowly until feed is constant • Add lubricant (only for starting) • Optimize grooved feeding zone and screw combination • Reduce the groove depth • Lengthen the screw feed zone • Use smooth cylinder • Do not use tapered feed bush
	Heating insufficient in feed zone	• Provide more heating
Inconsistent feeding time	Inconsistent material feed	• Adapt grooved zone temperature • Improve mixing of new material and regrind
Material forms on the die	Material deposits due to decompression at die exit	• Optimize die flow channel
Pronounced fuming	Moisture content excessive	• Dry the material
	Melt temperature too high	• Reduce the melt temperature

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The recommendations and data given are based on our experience today; however, no liability can be assumed in connection with their usage and processing.

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