Durethan® AKV 325 H2.0 901510 for aluminum window insulating profiles

- Non-Newtonian, branched PA 66, 25 % glass fiber
- Heat transmission barrier
- Suitable for stoving finish

1 Application and intended purpose

Present-day windows and window frames in aluminum are designed with a two-shell structure in order to provide thermal insulation. The two halves of the aluminum profile are joined by means of a plastic profile. This plastic profile assumes the thermal insulation function by preventing the formation of cold bridges (Figure 1).

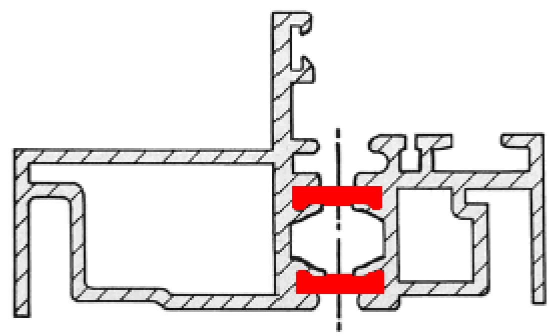


Figure 1 Composite aluminum profile/insulating profile

2 Demands on the material

The plastic profile is joined to the aluminum profile prior to the downstream processing stages of anodizing and painting. When fitted, the overall composite part (aluminum profile/insulating profile) is exposed to static loading and fluctuating temperatures. The thermoplastic to be used for the insulating profile is thus subject to the following requirements:

- chemical resistance to acids and alkaline solutions
- heat resistance of 230 °C for stoving finish on the aluminum profile
- thermal expansion as similar as possible to that of the aluminum profile
- high mechanical strength on a friction-locked joint with the aluminum profiles

The product must also fulfill the properties required of a material for use in the production of profiles by the extrusion process. These include, in particular, a high melt elasticity coupled with a broad processing window. The solidification rate must permit both a high take-off rate and sufficient time for calibration/shaping in order to ensure that an optimum profile quality can be produced on a cost-efficient basis.

The profile dimensions are subject to very tight tolerances. It is thus necessary for tolerances of plus/minus 0.05 mm to be observed for the profile and wall thickness dimensions. This places stringent requirements on both the extrusion process and the material in respect of achieving process stability in profile extrusion.

3 Durethan® AKV 325 H2.0 901510 for window insulating profiles

This material is a branched/non-Newtonian PA 66 GF25 that has a considerably higher viscosity than the linear PA 66 GF products in the low shear rate range. This means that Durethan® AKV 325 H2.0 901510 has high melt elasticity at the die orifice when extruded, which constitutes a major advantage for the calibration of window profiles (Figure 2).

Durethan® AKV 325 H2.0 901510 is heat-stabilized (as shown by the "H2.0" suffix) for use at elevated temperatures, such as for the application of stoving finishes to fully made-up aluminum window profiles, and is colored black (901510).

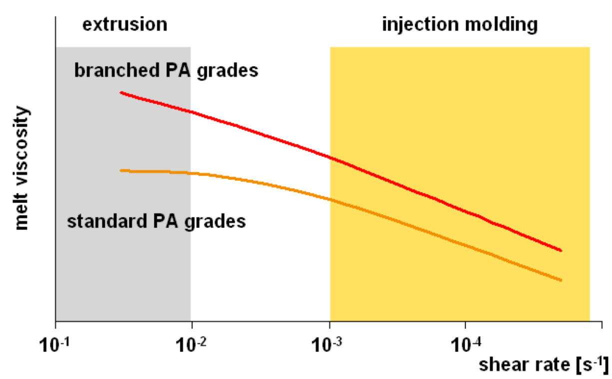


Figure 2 high melt viscosity through branching

4 Production of window insulating profiles

A description is now given of the production process for a window insulating profile, which was optimized in the course of our development work.

5 Profile dimensions

A profile like the one shown in Figure 3 was extruded.

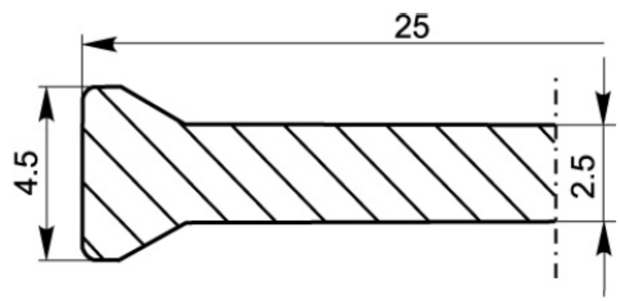


Figure 3 Window insulating profile with the main dimensions in mm

6 Extrusion line

The window profile was produced by the conventional profile extrusion process. The line comprises an extruder, a calibration and cooling section, a take-off unit and an automatic saw.

7 Extruder

- Screw diameter: 48 mm
- Screw length: 33 D
- Screw geometry: see annex
- Special feature: barrel and screw with a vented section

It is also possible to use a conventional three-section screw instead of a vented screw (see page 5 - Screw geometries).

8 Downstream units

- Calibration table
- Take-off unit
- Automatic saw

9 Tooling

Standard corrosion-resistant and temperature-resistant steels were used for the extrusion die and the calibration unit. The calibration unit, which was indirectly cooled, had a highly polished surface (Figure 4).

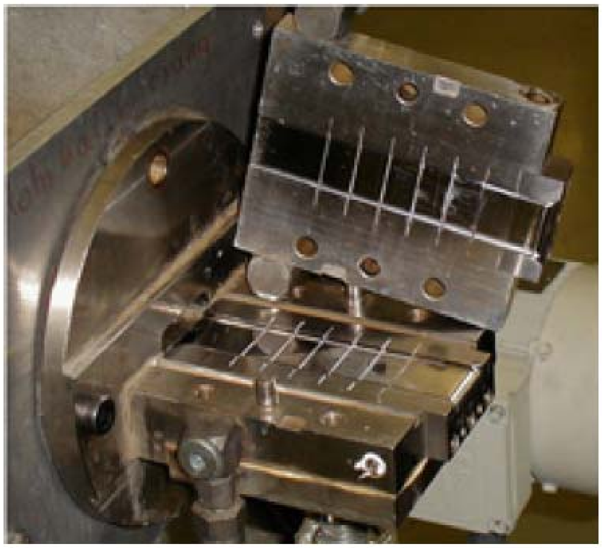


Figure 4 Calibration unit in open position

The two calibration shells (top and bottom section) could be heated and cooled separately Their length was approx. 115 mm. This was followed by further cooling in an open water bath.

The take-off unit was controlled by means of an optical sensor mounted between the die and the calibration unit. This sensor had an infrared transmitter and receiver. The edge of the melt strand passed through the infrared beam (Figure 5).

The sensor was adjusted in such a way that, when the gauge was filled in the optimum manner, part of the infrared beam was absorbed by the melt and part reached the receiver. This signal was displayed as a setpoint value (target value) for the operator by means of a light-emitting diode on the control unit.

Figure 5 Fork sensor located between the die and the calibration unit

If the melt at the die orifice moves further into this infrared beam as a result of conveying fluctuations inside the extruder (which moves off its optimized basic setting), then the velocity of the take-off unit will be raised or, if less melt is being conveyed, the velocity will be reduced. This then ensures that a constant profile quality is achieved. Experience has shown that it is better to adjust the take-off, since these changes have a more rapid effect than changes to the basic extruder setting. It is important not to constantly change the extrusion parameters, however, since this will not allow the extrusion unit to be kept in a stable operating state.

10 Processing

10.1 Material drying

If the extrusion barrel is vented, Durethan® AKV 325 H2.0 901510 may be processed without pre-drying. Moisture and other volatile components will then be removed from the melt through efficient barrel venting. This is particularly important for achieving an optimum structural density in the extruded profile, without any micro-pores.

In all other cases it is strongly recommended that Durethan® AKV 325 H2.0 901510 be pre-dried in a dry-air dryer, since even a low moisture content in excess of 0.06 % can lead to a reduction in the viscosity, to bearding at the die orifice and to a poor profile surface finish.

Drying parameters:

- Temperature: 100 to 110 °C
- Time: approximately 4 h

10.2 Extrusion temperature

In our before mentioned trial, the extruder heating sections were configured with a temperature of 270 °C at the feed section, rising to 290 °C at the first metering section. The temperature was reduced to 265 °C towards the screw tip. With a screw speed of 25 min^{-1}, a melt temperature of approximately 290 °C was measured at the die orifice.

The melt displays sufficient firmness at this temperature. Even at higher temperatures of up to 300 °C, the melt is still rigid enough and capable of calibration. The lower processing temperature, at approximately 270 °C, is some 10 K above the melting point.

10.3 Calibration temperature

The temperature of the calibration unit was set at 80 to 90 °C. This calibration temperature avoids a sudden "freezing" of the melt. This then allows more time for the calibration process inside the calibration section, and a better surface finish is achieved than with cold calibration.

10.4 Extrusion rate

It proved possible to achieve a uniform and stable profile extrusion process with a take-off rate of 2 m/min; the melt throughput was approximately 10 kg/h.

10.5 Advice on process optimization

Durethan® AKV 325 H2.0 901510 has been designed with a slow crystallization rate for processing by extrusion. This leaves sufficient time for the melt to be shaped in the calibration section.

If the surface finish is still short of the requirements, however, the following measures can be implemented:

- the melt temperature can be increased up to a level of 300 °C
- the calibration temperature can be increased

Both measures give a longer calibration time up to the point at which the melt freezes. The higher melt temperature simultaneously reduces the forces required to calibrate the melt and ensures an increased surface smoothness.

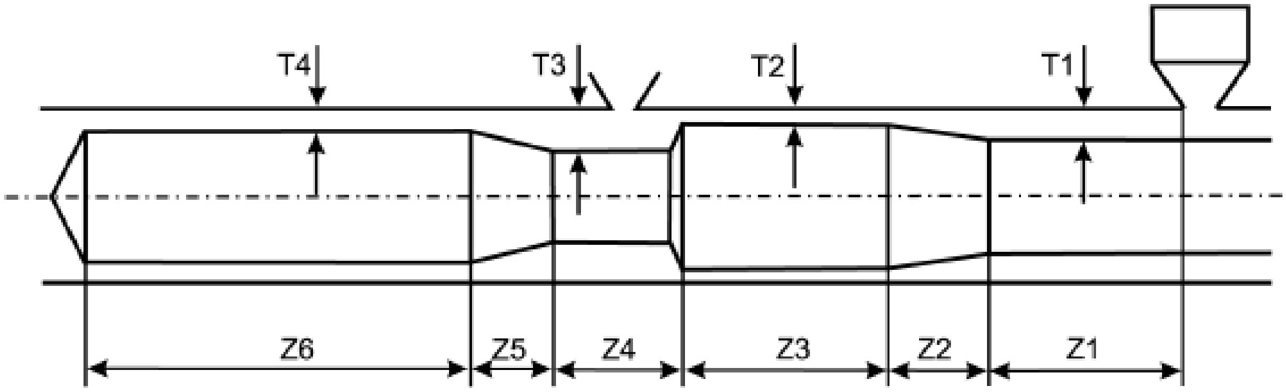
It is important that no water is sucked into the calibration section, since this will immediately impair the calibration process. The appropriate form of separation should thus be provided between the water bath and the calibration.

If excessively moist material is processed, this will lead to a rough surface with a reduced density. It will also be possible for deposits (bearding) to form on the edge of the die orifice.

In this case, a check must be conducted on the drying process. If barrel venting is employed, then it is essential to ensure that the venting pipe is not blocked. The quality of the extruded profile can also be checked by determining its density. This should be as close as possible to the type-specific value of 1320 kg/m^3.

11 Screw geometries

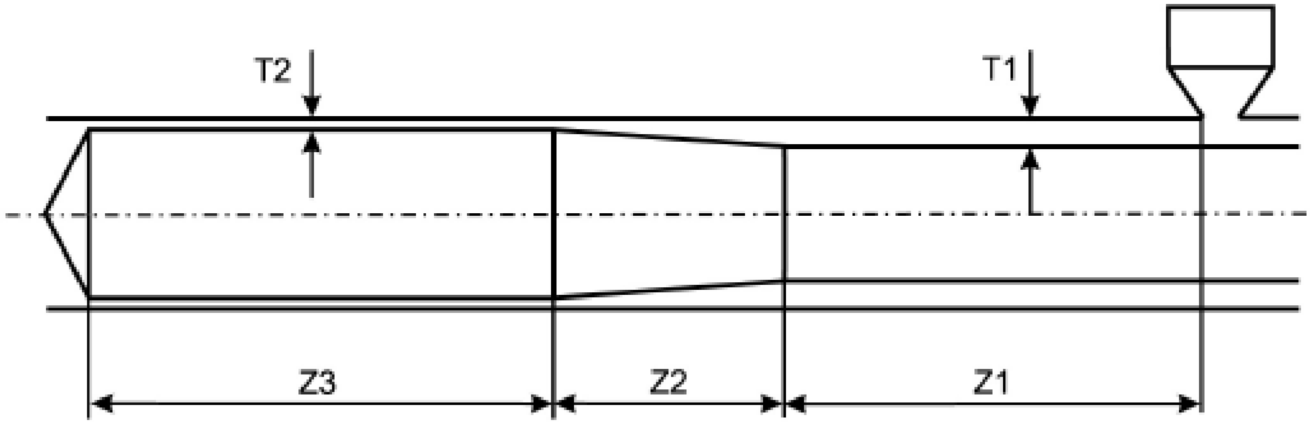
11.1 Vented screw



zone lengths	Z1	Feed zone	5.7 D
	Z2	1st compressing zone	3 D
	Z3	1st metering zone	6 D
	Z4	Venting zone	4 D
	Z5	2nd compression zone	2.5 D
	Z6	2nd metering zone	11.7 D
Flight depths	T1	Feed zone	7 mm
	T2	1st metering zone	3 mm
	T3	Vented zone	10 mm
	T4	2nd metering zone	4.3 mm
pitch			1 D

Table 1 Vented screw (schematic diagram)

11.2 Three-section screw



Screw diameter			45 mm	60 mm
Zone lengths	Z1	Feed zone	8 … 10 D	
	Z2	Compression zone	4 … 6 D	
	Z3	Metering zone	10 … 12 D	
Screw length			≥ 25 D	
Flight depths	T1	Feed zone	5 … 7 mm	8 … 10 mm
	T2	Compression zone	2 … 3 mm	2.5 … 3.5 mm
Pitch			1 D	

Table 2 Recommended geometry for three-section screws with a diameter of 45 and 60 mm respectively

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Typical Properties
Property data is provided as general information only. Property values are approximate and are not part of the product specifications.

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Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling LANXESS products mentioned in this publication. Before working with these products, you must read and become familiar with the available information on their hazards, proper use, and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets (MSDS) and product labels. Consult your LANXESS Corporation representative or contact the Product Safety and Regulatory Affairs Department at LANXESS. For materials that are not LANXESS products, appropriate industrial hygiene and other safety precautions recommended by their manufacturer(s) must be followed.

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Note:
The information contained in this publication is current as of August, 2010. Please contact LANXESS Corporation to determine if this publication has been revised.