DURETHAN® BKV315Z H2.0 FOR SHEET EXTRUSION AND THERMOFORMING APPLICATIONS

LANXESS
Energizing Chemistry

Product Information

ISO: 1874-PA6, EH, 22-050, GF15

- High melt strength, branched, polyamide 6.
- Heat stabilized for service temperatures of up to 284° F and for short periods of up to 338° F.
- 15% Glass fiber filled.
- Impact modified.

Product Description

Durethan® BKV315Z H2.0 high viscosity, branched polyamide 6 with 15% glass fiber, has improved melt strength at low shear rates (<100 1/sec). This improved melt strength allows Durethan BKV15Z H2.0 polyamide resin to be extruded into sheets and subsequently thermoformed. Additionally it is impact modified to aid trimming after thermoforming.

Drying

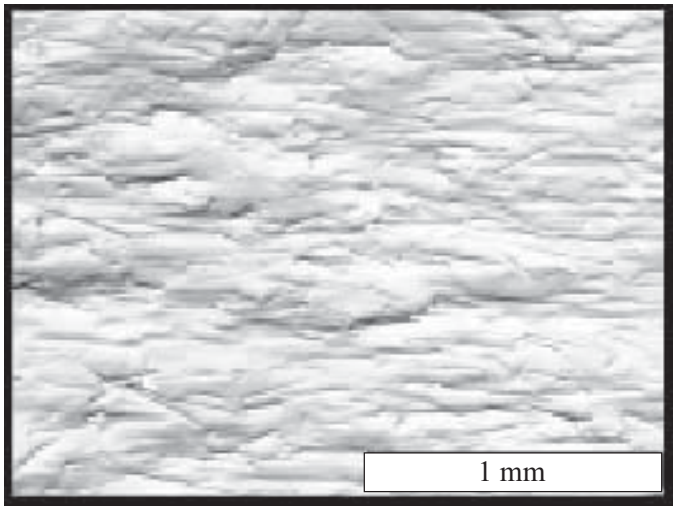
The material moisture content is critical for problem free extrusion and is recommended to be <0.06% H_20. Higher moisture levels can result in micro-bubble formation in the melt. In the case of glass fiber-reinforced polyamides, this can cause a microporous structure with defects in the polymer/glass fiber bond, impairing the material's mechanical properties. Higher moisture levels will also reduce the melt viscosity and can cause material to be deposited on the die surface, resulting in imperfections as these deposits drip on to the melt stream.

In applications where regrind is used, it is important to keep the moisture content <0.06%. Drying is recommended to ensure the regrind stream is at a sufficiently low level. Drying is also recommended for material from containers that have been previously opened.

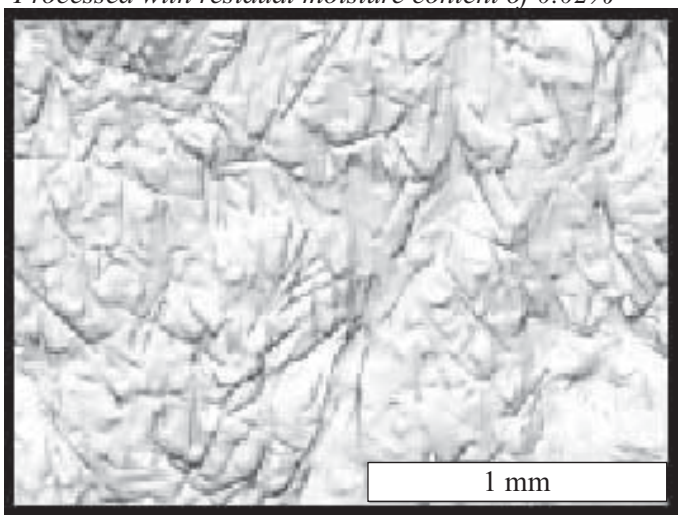
The drying of polyamide materials for extrusion thus constitutes a key measure for process stabilization and quality assurance.

The best drying results are obtained by using desiccant dryers, which are fed with dehumidified air at a dew point of approximately –20°F. The drying temperature should be set at 176°F while the drying time will be a function of the moisture content of the material. Where regrind is fed back into the process continuously, without lengthy intermediate storage in the open air, experience has shown that a residence time of 4 to 6 hours in the dryer will be sufficient. The dryer should be able to hold at least 4 to 6 times the hourly throughput of the extruder. If very moist material has to be dried, such as regrind that has been stored in the open for a long period, then 10 to 12 hours drying may be necessary. The emerging melt must be smooth and free from bubbles. In case of doubt, the moisture content may be determined by the K.-Fischer method. Figure 1 shows the surface quality obtained with dry and wet material.

Figure 1



Processed with residual moisture content of 0.02%



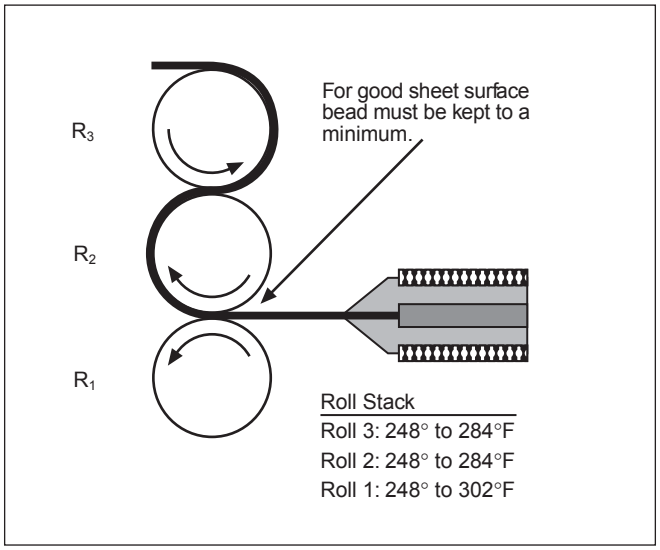
Processed with residual moisture content of 0.11%

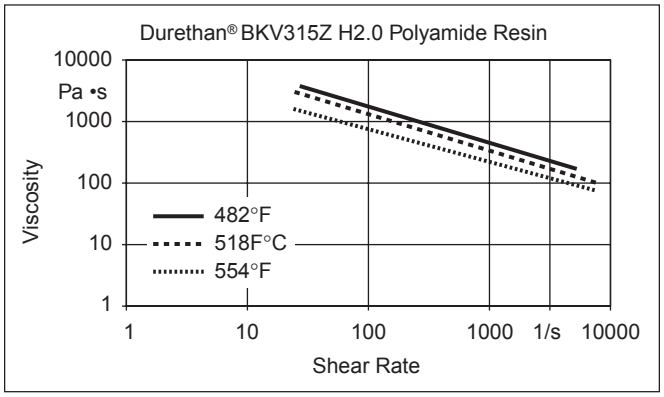
Extrusion

Durethan® BKV315Z H2.0 polyamide resin can be processed with conventional three section screws without a shearing section and moderate compression ratio (approximately 3:1). Grooved feed sections are not recommended. Due to the glass content, wear resistant screws and barrels are necessary.

Temperature settings on the extruder and sheet line can be set as follows:

Extruder:	
Feed section:	465° to 500° F
Compression section:	500° to 535° F
Metering section:	520° to 535° F
Adapter:	520° to 535° F
Die:	520° to 535° F





The given data for roll temperatures are starting guidelines as actual settings depend on sheet line, sheet thickness, roll surface (smooth or embossed) and take off roll speed.

The temperature of the melt at the die orifice should be between 520° and 535°F. For start up, the extruder, adapter, and die settings should be 15° to 25°F higher than the values given, to prevent the equipment from being damaged by excessively high melt pressure (danger of cold plugs).

Screen packs are not recommended for glass fiber reinforced Durethan® BKV315Z H2.0 polyamide resin, because the screens will become clogged with glass fibers.

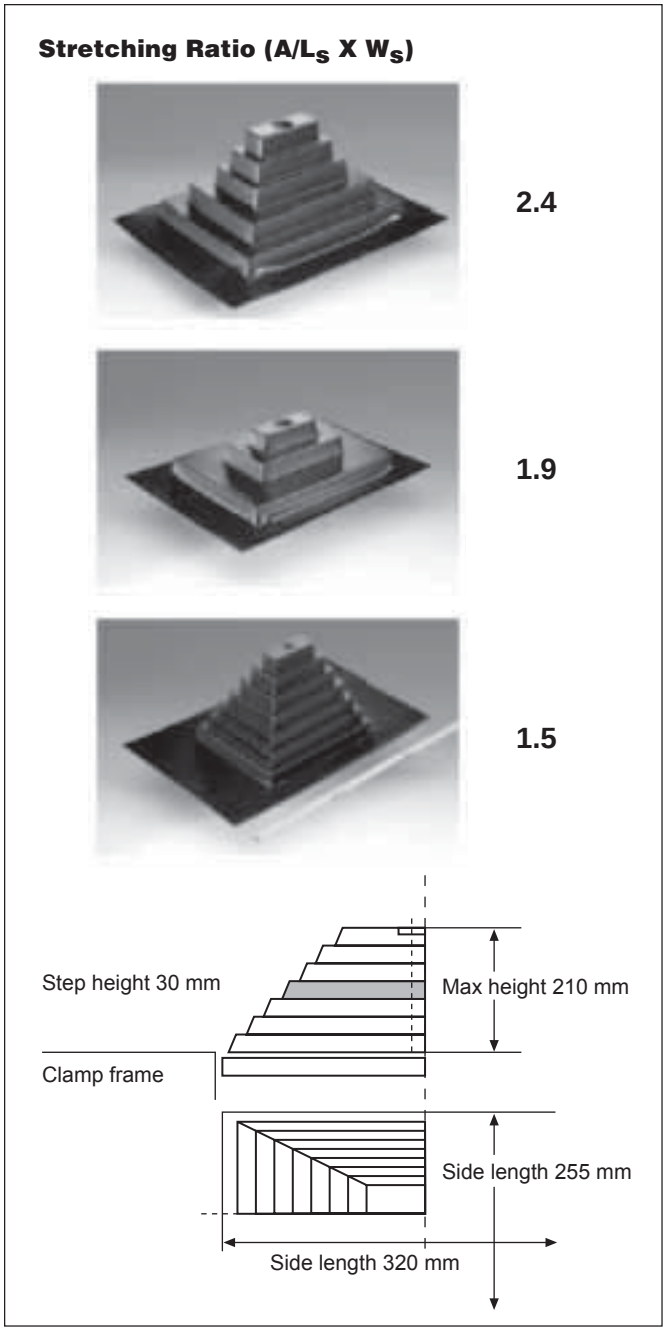
Thermoforming

The sheets made from Durethan® BKV315Z H2.0 resin will absorb moisture as all polyamides do. Therefore the sheets must be dried prior to thermoforming. Drying at 195° to 212°F for 24 hours is commonly recommended for black mono-layer structures. Colored, natural, or co-extruded structures may require lower temperatures to avoid color shifts. Due to polyamide's hydroscopic nature, desiccant air at <0°F dew point is required. Insufficient drying may impair the thermoforming properties causing surface defects, the formation of bubbles, and excessive sagging.

Thermoforming properties were investigated at the LANXESS processing facility using a variable step mold. This rectangle step pyramid allows an easy way to judge drawing characteristics and stretch ratio limitations. Figure 2 shows examples of parts with 3, 5, and 7 steps and increasing stretch ratios. The ratios were calculated using

$$\text{Stretch Ratio} = \frac{\text{Part area after draw (A)}}{\text{Sheet size before forming (LxW)}}$$

Figure 2



Thermoformed parts can be produced with good wall thickness consistency. Typical sheet surface temperatures for forming range from 450° to 500°F. Equipment with upper and lower heating elements is preferred and all banks should be on. Pre-stretching with air can provide a more uniform wall thickness distribution and better reproduction of the mold contours. A heated mold will aid in surface appearance. Adequate draft will allow for easy mold release. If the part is to be painted, care should be exercised if any mold release agent is used.

The good thermoformability of Durethan® BKV315Z H2.0 polyamide resin has been demonstrated with a Porsche model (figure 3) at the Illig company in Heilbronn. Sheets of 0.152 inch thickness have been successfully thermoformed with this tool.

Figure 3

Recycling

Durethan® BKV315Z H2.0 resin is a high-viscosity branched polyamide that displays good processing stability. Even after reprocessing 100% regrind through three passes, the material still displays only slight signs of material degradation, e.g., in melt elasticity during extrusion or in flow viscosity. However, the length of the glass fibers are inevitably reduced after the material has been reprocessed several times over, even under gentle conditions. While this will not result in a serious impairment of mechanical properties immediately, it will result in a gradual reduction in the strength values over each processing cycle.

Because results obtained in the laboratory are only guidelines, use of Durethan® BKV315Z H2.0 polyamide resin must be tested (including but not limited to field testing) in advance by the user to determine suitability. In particular, a check should be conducted on an original extruded article prior to the start of production to establish the reliability of the production process and the expected recycle content. Experience has shown that up to 50% scrap that occurs in conventional sheet extrusion can be fed back into the process on a continuous basis if the material has been prepared and, more importantly dried in the proper manner.

After use, semi-finished products made of Durethan® BKV315Z H2.0 polyamide resin, which do not contain any pollutants, can be mechanically recycled. If the product to be recycled is a co-extruded structure or contains materials other than BKV315Z H2.0, care must be taken to insure that the mechanical properties of the final blend are not negatively impacted. Semi-finished products that are not pollutant free can be chemically recycled or incinerated for energy recovery.

Typical Properties* of Black Colored and Heat Stabilized Resins	Test Conditions	Test Method		Units		ASTM		ISO	
		ASTM	ISO	ASTM	ISO	DAM	COND	DAM	COND
RheologicalProperties									
Melt volume-flow rate	270°C; 5kg		ISO 1133		cm^3/10 min			3.0	
Mold shrinkage, parallel	280°C/MT 80°C		ISO 2577		%			0.66	
Mold shrinkage, normal	280°C/MT 80°C		ISO 2577		%			0.92	
Post-shrinkage, parallel	120°C; 4h		ISO 2577		%			0.10	
Post-shrinkage, normal	120°C; 4h		ISO 2577		%			0.10	
MechanicalProperties									
Tensile modulus	1 mm/min	D638	ISO 527-1,-2	psi	MPa	783,000	362,000	5,400	2,500
Yield stress	50 mm/min	D638	ISO 527-1,-2	psi	MPa	15,200	8,700	105	60
Yield strain	50 mm/min	D638	ISO 527-1,-2	%	%	3.5	11	3.5	11
Stress at break	5 mm/min	D638	ISO 527-1,-2	psi	MPa	15,200	8,000	105	55
Strain at break	5 mm/min	D638	ISO 527-1,-2	%	%	5.0	19	5.0	19
Charpy impact strength	23°C		ISO 179-1eA		kJ/m^2			70	105
	-30°C		ISO 179-1eU		kJ/m^2			70	80
Charpy notched impact strength	23°C		ISO 179-1eA		kJ/m^2			15	30
	-30°C		ISO 179-1eA		kJ/m^2			7	10
Izod impact strength	23°C		ISO 179-1U		kJ/m^2			55	90
	-30°C		ISO 179-1U		kJ/m^2			60	60
	23°C		ISO 179-1C		kJ/m^2			55	85
	-30°C		ISO 179-1C		kJ/m^2			55	55
Izod notched impact strength	23°C	D256	ISO 180-1A	ft-lb/in	kJ/m^2	3.2	6.4	15	30
	-30°C	D256	ISO 180-1A	ft-lb/in	kJ/m^2	1.5	1.6	7.0	8.0
Flexural modulus	2 mm/min	D790	ISO 178	psi	MPa	610,000	304,000	4,200	2,100
Flexural strength	2 mm/min	D790	ISO 178	psi	MPa	22,000	10,000	160	75
Flexural strain at flexural strength	2 mm/min	D790	ISO 178	%	%	5.0	5.0	5.5	7.5
Flexural stress at 3.5% strain	2 mm/min		ISO 178		MPa			140	55
Ball indentation hardness			ISO 2039-1					140	
Thermal Properties									
Melting temperature	10°C/min		ISO 11357-1,-3		°C			222	
Deflection temperature under load	1.80 MPa	D648	ISO 75-1,-2	°F	°C	~340		~170	
	0.45 MPa	D648	ISO 75-1,-2	°F	°C	~400		~205	
	8.00 MPa		ISO 75-1,-2		°C			60	
Coefficient of linear thermal expansion, parallel	23 to 55°C		ISO 11359-1,-2		10E-4/K			0.4	
Coefficient of linear thermal expansion, transverse	23 to 55°C		ISO 11359-1,-2		10E-4/K			1.2	
Burning behavior, UL	1.6 mm	UL 94			Class			HB**	
	3.2 mm	UL 94			Class			HB**	
Other Properties									
Density		D792	ISO 1183	kg/m^3		1,200		1,200	
Glass fiber/glass fill/filler content			ISO 3451-1		%			15	
Bulk density			OSO 60		kg/m^3			~700	
Processing Conditions for Test Specimens									
Injection molding									
Melt temperature			ISO 294		°C			280	
Mold temperature			ISO 294		°C			80	
Injection velocity					mm/s			200	

** These items are provided as general information only. They are approximate values and are not part of the product specifications.*

*** Developmental products (noted as such or designated by the letters DP, KU or KL in the grade name) are not considered part of the LANXESS line of standard commercial products. Complete commercialization and continued supply are not assured.*

The purchaser/user agrees that LANXESS reserves the right to discontinue supply at anytime.

This literature from LANXESS AG, Germany, was not designed for primary distribution in the United States. Additional information may be available from LANXESS Corp. Readers should refer to the LANXESS Guidelines for Products used in the U.S. listed below.

LANXESS Guidelines for Products Used in the U.S.

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

Flammability
Flammability results of materials are based on small-scale laboratory tests for purposes of relative comparison and are not intended to reflect the hazards presented by this or any other material under actual fire conditions.

Applications
As with any product, the use of a LANXESS product in a given application must be tested (including but not limited to field testing) in advance by the user to determine suitability.

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Regrind Usage
Where end-use requirements permit, regrind may be used with virgin material in the 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 the LANXESS resin. 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.

Health and Safety Information
Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the LANXESS products mentioned in this publication. For materials mentioned which are not LANXESS products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of 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 and product labels.* Consult your LANXESS Corporation representative or contact the Product Safety and Regulatory Affairs Department at LANXESS.

Note: The information contained in this publication is current as of May 2005. Please contact LANXESS Corp. to determine whether this publication has been revised.

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