CONDITIONING OF PARTS MADE FROM DURETHAN POLYAMIDE RESIN

LANXESS Energizing Chemistry

Product Information

Moisture Absorption

Because of its unique chemical structure, polyamide, or nylon, absorbs moisture from the atmosphere. When this moisture absorption occurs, the nylon experiences a certain degree of swelling resulting in dimensional changes in molded parts. In addition, moisture acts as a plasticizer in nylon, which means that the physical properties of nylon moldings are affected by the amount of moisture they contain. Because of the changes that result from moisture absorption, it is important to properly account for its effects. A detailed discussion of these effects is available in the LANXESS Product Information Bulletin, "Moisture Absorption in Durethan Polyamide Parts."

All nylon parts will absorb moisture after they are molded. This process is known as conditioning. If the nylon is allowed to absorb moisture from its environment without the aid of accelerated techniques, the conditioning process is known as passive conditioning. If techniques are employed to accelerate the rate of moisture absorption, the conditioning process is referred to as active conditioning. The rate at which the conditioning occurs, either passive or active, is dependent upon such factors as the moisture content of the surrounding medium, temperature, part thickness and resin crystallinity. The conditioning time required for passive conditioning can be quite long. Depending on part thickness, it is not uncommon for many days or even months to elapse before the part achieves an equilibrium moisture content.

Since it is inevitable that the nylon part will absorb moisture and that changes in dimensions and physical properties will occur, it is frequently desirable to subject nylon parts to active conditioning so that these changes occur prior to the part being put into service.

Active Conditioning

There are numerous active conditioning methods that can be employed. Each has both advantages and disadvantages, and the particular method used is usually dictated by factors such as economics, space limitations, time and the end-use application of the part. The various methods and their advantages and disadvantages are summarized in Table 1. To determine the amount of moisture absorbed by the part, one can measure weight gain rather than using one of the usual moisture content tests that will destroy the sample.

Table 1. Active Conditioning Methods

Method	Conditions	Advantages	Disadvantages
Saturated steam	200°–212°F (93°–100°C) 100% Relative humidity	• Fastest method	• Discoloration of part due to oxidation • Deposit buildup on part due to monomer extraction • Increased warpage due to postcrystallization • Uneven distribution of moisture in part
Hot water storage	120°–195°F (93°–100°C)	• Fast • Economical	• Same problems as above when the higher temperatures within the recommended range are used, i.e., 195°F (90°C) • Water-spotting of part
Cold water storage	65°–14°F (20°–40°C)	• Economical • Simple	• Longer conditioning times
Packaging in PE bags containing some water	Variable ambient	• Most economical • Conditioning occurs during storage and/or shipping	• No control over conditions • Special packaging bags may be required
Tropical climate	104°F (40°C) 90%–98% Relative humidity	• Best method • Thorough and even distribution of moisture	• Expense of equipment

The most commonly used method of active conditioning is to immerse the molded parts in either hot or cold water until the required moisture content has been reached. However, this conditioning process causes the moisture to be distributed unevenly with more moisture on the surface of the part and less in the core. Since the dimensions and properties depend upon the even distribution of moisture, this can cause some problems. However, the differences are frequently small, so that use of this method is reasonable.

The use of tropical climate conditioning is recommended for parts molded from Durethan nylon, since this method provides a relatively fast, effective and controlled conditioning process with a minimization of the disadvantages noted above. In addition, tropical climate conditioning insures a more uniform and thorough moisture distribution in the part compared to more vigorous methods, such as saturated steam and hot water storage, which saturate the surface of the part but can leave the center of the part essentially dry.

Tables 2 and 3 illustrate the active conditioning time required to reach a specified moisture level as a function of wall thickness. Samples of nylon 6 resin were immersed in water at 68°F (20°C), 104°F (40°C) and 140°F (60°C). The samples include Durethan B 31 SK resin (an unreinforced nylon 6) and Durethan BKV 30 H resin (a 30% glass-fiber-reinforced nylon 6).

Approximate time, in hours, required to reach the indicated moisture level as a function of wall thickness and immersion temperature.

Table 2. Moisture Content* of Durethan B 31 SK Resin (Unreinforced Nylon 6)

Wall Thickness in	(mm)	Moisture Content 0.5%	1.0%	1.5%	2.0%	2.5%	3%
Immersion at 68°F (20°C)							
0.039	(1.0)	0.3	1.4	3.1	5.5	8.5	12.3
0.059	(1.5)	0.8	3.1	6.9	12.3	19.2	27.6
0.078	(2.0)	1.4	5.5	12.3	21.8	34.1	49.1
0.098	(2.5)	2.1	8.5	19.2	34.1	53.3	76.8
0.118	(3.0)	3.1	12.3	27.6	49.1	76.8	110.5
0.137	(3.5)	4.2	16.7	37.6	66.9	104.5	150.4
0.157	(4.0)	5.5	21.8	49.1	87.3	136.5	196.5
0.177	(4.5)	6.9	27.6	62.2	110.5	172.7	248.7
0.196	(5.0)	8.5	34.1	76.8	136.5	213.2	307.0
Immersion at 104°F (40°C)							
0.039	(1.0)	0.1	0.4	0.8	1.5	2.3	3.3
0.059	(1.5)	0.2	0.8	1.8	3.3	5.1	7.4
0.078	(2.0)	0.4	1.5	3.3	5.8	9.1	13.1
0.098	(2.5)	0.6	2.3	5.1	9.1	14.2	20.5
0.118	(3.0)	0.8	3.3	7.4	13.1	20.5	29.5
0.137	(3.5)	1.1	4.5	10.0	17.8	27.9	40.1
0.157	(4.0)	1.5	5.8	13.1	23.3	36.4	52.4
0.177	(4.5)	1.8	7.4	16.6	29.5	46.1	66.3
0.196	(5.0)	2.3	9.1	20.5	36.4	56.9	81.9
Immersion at 140°F (60°C)							
0.039	(1.0)	0.02	0.1	0.2	0.4	0.6	0.9
0.059	(1.5)	0.1	0.2	0.5	0.9	1.4	2.0
0.078	(2.0)	0.1	0.4	0.9	1.6	2.5	3.6
0.098	(2.5)	0.2	0.6	1.4	2.5	3.9	5.6
0.118	(3.0)	0.2	0.9	2.0	3.6	5.6	8.0
0.137	(3.5)	0.3	1.2	2.7	4.9	7.6	10.9
0.157	(4.0)	0.4	1.6	3.6	6.4	9.9	14.3
0.177	(4.5)	0.5	2.0	4.5	8.0	12.6	18.1
0.196	(5.0)	0.6	2.5	5.6	9.9	15.5	22.3

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

Approximate time, in hours, required to reach the indicated moisture level as a function of wall thickness and immersion temperature.

Table 3. Moisture Content* of Durethan BKV 30 H Resin (30% Glass-Fiber-Reinforced Nylon 6)

Wall Thickness in	(mm)	Moisture Content 0.5%	1.0%	1.5%	2.0%
Immersion at 68°F (20°C)					
0.039	(1.0)	0.7	2.8	6.3	11.1
0.059	(1.5)	1.6	6.3	14.1	25.1
0.078	(2.0)	2.8	11.1	25.1	44.6
0.098	(2.5)	4.4	17.4	39.2	69.6
0.118	(3.0)	6.3	25.1	56.4	100.2
0.137	(3.5)	8.5	34.1	76.8	136.4
0.157	(4.0)	11.1	44.6	100.3	178.2
0.177	(4.5)	14.1	56.4	126.9	225.5
0.196	(5.0)	17.4	69.7	156.7	278.4
Immersion at 104°F (40°C)					
0.039	(1.0)	0.2	0.7	1.7	3.0
0.059	(1.5)	0.4	1.7	3.8	6.7
0.078	(2.0)	0.7	3.0	6.7	11.9
0.098	(2.5)	1.2	4.6.	10.4	18.6
0.118	(3.0)	1.7	6.7	15.0	26.7
0.137	(3.5)	2.3	9.1	20.5	36.4
0.157	(4.0)	3.0	11.9	26.7	47.5
0.177	(4.5)	3.8	15.0	33.8	60.1
0.196	(5.0)	4.6	18.6	41.8	74.3
Immersion at 140°F (60°C)					
0.039	(1.0)	0.1	0.2	0.5	0.8
0.059	(1.5)	0.1	0.5	1.0	1.8
0.078	(2.0)	0.2	0.8	1.8	3.2
0.098	(2.5)	0.3	1.3	2.8	5.1
0.118	(3.0)	0.5	1.8	4.1	7.3
0.137	(3.5)	0.6	2.5	5.6	9.9
0.157	(4.0)	0.8	3.2	7.3	13.0
0.177	(4.5)	1.0	4.1	9.2	16.4
0.196	(5.0)	1.3	5.1	11.4	20.3

Troubleshooting

During the conditioning of nylon, some problems may develop which may cause imperfections in the parts. Table 4 describes some of the commonly encountered problems and their solutions or methods of prevention. This information should be used as a general guide only. Our many years of experience with nylon resin enables us to recommend solutions to additional problems you may encounter. To discuss your specific concern or part conditioning in more detail, contact a LANXESS technical service representative at 800-LANXESS.

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.

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Table 4. Troubleshooting Guide for Correcting Mistakes During Conditioning

Problem	Solution
Rusting of metal parts	Condition with the addition of 0.2–0.5% hexamethylenetetramine.
Discoloration of part	Condition with the addition of 0.2–1.0% sodium bisulfite.
White deposit on part surface	Wipe parts with isopropanol after conditioning, or reduce the conditioning temperature.
Releasing of heat stabilizer	Reduce the conditioning temperature.
Twisting of molded parts	Optimize design and processing conditions, and condition with a lower temperature.

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

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