LONG FIBER COMPOUNDS

Mold Design And Processing Conditions

A Guide to Processing Long Fiber Specialty Compounds

English/Standard and SI Metric

RTP Co.

Imagineering Plastics®

web site: www.rtpcompany.com

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Engineering Design Considerations

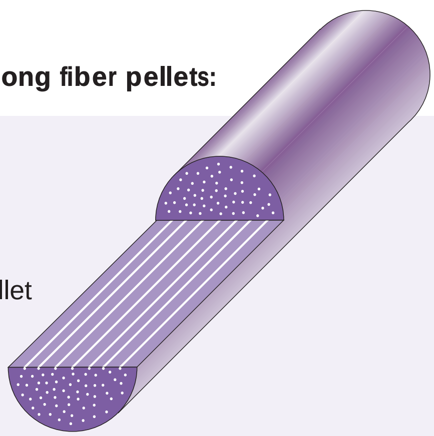
RTP Company's Long Fiber Compounds produce tough, yet lightweight injection molded parts. The property advantages of the long fibers make these materials ideal replacements for metal. The reinforcement additives such as glass, aramid, carbon, and stainless steel fibers require design considerations very similar to that required by short fiber reinforced materials. These reinforcing fibers provide the higher mechanical properties needed for metal replacement by acting in an anisotropic manner (directionally non-uniform).

To maximize the benefits of Long Fiber Compounds, gate location should be evaluated for alignment of optimum mechanical properties relative to the part's structural requirements. Other issues such as placement of weld lines in the part design need to be considered much in the same manner as short fiber reinforced materials.

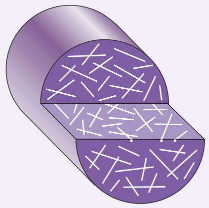
Comparison of Long & Short Fiber Pellets

Characteristics of RTP Company's long fiber pellets:

- 0.43 in/11 mm long
- 0.12 in/3 mm diameter
- Parallel fibers run length of the pellet
- 30-60% fiber by weight
- Fibers encapsulated with resin



Characteristics of short fiber pellets:



- Pellets typically 0.12 in/3 mm long
- Fibers typically 0.04 in/1 mm long
- Random fibers varying in length and orientation

Need Assistance?

For more information, please contact your local sales representative or one of our experienced technical support representatives who can assist you with:

- Evaluating mold design and setup
- Optimizing processing conditions based on material
- New material considerations
- Problem investigation and resolution

For technical assistance, Call:
(800) 433-4787 or
(507) 454-6900
or Email:
rtp@rtpcompany.com

When processed properly, Long Fiber Compounds retain their fiber length during molding. Correct processing is critical to maintaining high-quality parts; breaking the fibers during processing can result in sharply reduced material properties.

These molding guidelines are offered as suggestions and may be subject to modification, depending on your specific material or design. Please contact RTP Company's technical service representatives for assistance.

Equipment Considerations

A general purpose screw that utilizes a typical three-zone style is best for processing RTP Company Long Fiber Compounds. The screw has three sections: feed, compression, and metering. Metering should be done with an L/D ratio of 16:1 to 22:1, with a low compression ratio of 2:1 to 2.5:1.

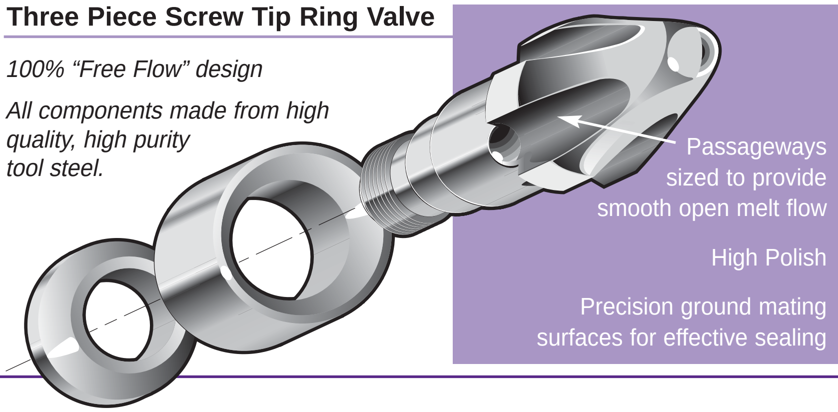
A 100% "Free Flow" fluted screw tip valve assembly is required to allow smooth melt flow. The nozzle/sprue orifice should have generous dimensions (0.250"/5.56mm) and be without sharp edges or severe convolutions. Do not use internally tapered tips or tips without a constant diameter pathway.

Material construction for screws and barrels can be the same as for standard reinforced materials.

Three Piece Screw Tip Ring Valve

100% "Free Flow" design

All components made from high quality, high purity tool steel.



Tooling Considerations

- Full round runners with a diameter of 0.25" (5.56 mm) are preferred
- Runners should have no sharp corners
- Minimum gate thickness of 0.080" (2 mm)
- Sprues as short as possible, with initial diameter of 0.25" (5.56 mm), tapered to 11/32" (8.73 mm)
- Open channel type hot runner systems are acceptable
- Use same materials for molds as for other reinforced materials

Processing Considerations

- Feed throat from hopper to machine must have sufficient opening to prevent bridging of long pellet composition
- Reverse barrel profile to "pre-soak" or "soften fibers"
- Minimum back pressure should be used, typically 25-50 psi (0.17-0.34 MPa)

Molding Temperature

Refer to the Processing Conditions for recommended starting temperatures. Normally, reinforced materials require higher mold temperatures than non-reinforced materials. This helps achieve a smoother, more blemish free surface by providing a resin rich skin on the molded part.

Minimizing Wear in Processing Equipment

Highly-filled engineering plastics can cause wear on conventional steel molds constructed with insufficient hardness. Of the factors causing wear, fiberglass content has the most influence with a Mohs hardness of 5 to 7. Comparatively, carbon fiber has a Mohs hardness of 2, and common tool steels have a hardness of 4.

Wear can be minimized by proper processing and properly hardened tool steel cavities, cores, runner systems and sprue bushings. Cavities must be vented at the end of fill to minimize trapped gasses, which could cause pitting from high temperatures. Gates can be affected by the fast injection speeds used in processing glass-filled Long Fiber Compounds. These speeds can cause high temperatures and a loss of hardness.

The mold cavity and core finish play an important role in tool longevity, and machining marks have been shown to accelerate wear. A 4 microinch (0.0001 mm) or better finish is recommended for high produc-

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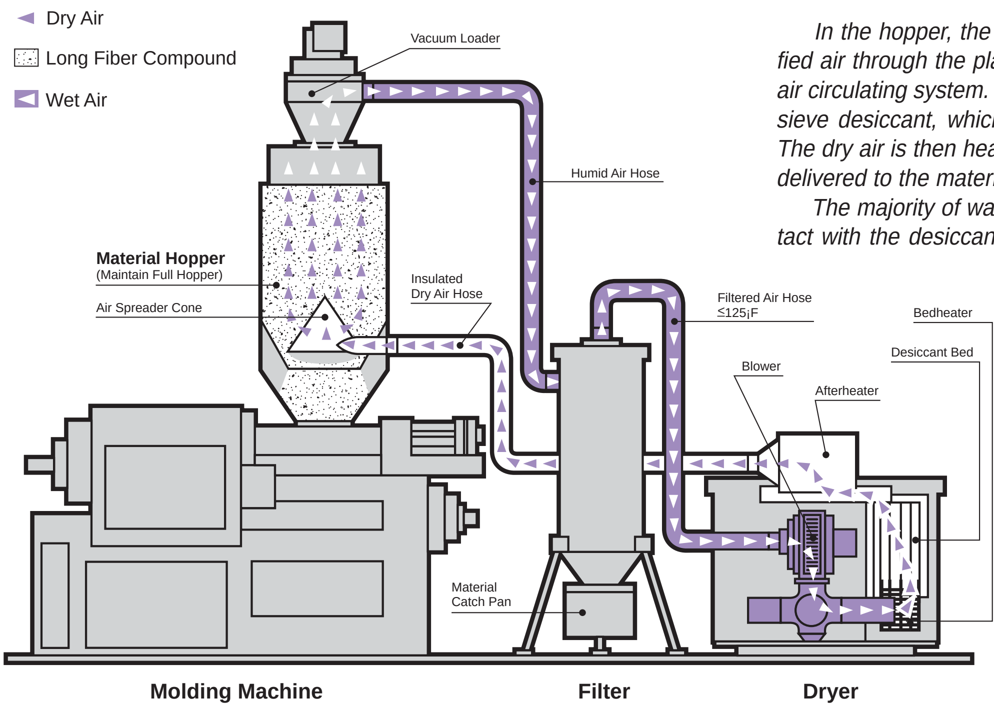
Typical Dehumidifying Closed Systems for Drying Long Fiber Compounds



In the hopper, the drying units force hot dehumidified air through the plastic granule by way of a closed air circulating system. The moisture is removed by the sieve desiccant, which traps the moisture molecules. The dry air is then heated to a preset temperature and delivered to the material in the insulated hopper.

The majority of water is absorbed in the initial contact with the desiccant bed. When the bed becomes saturated, it is regenerated by heating to more than 500°F (290°C), purging itself of moisture. Properly maintained dryer systems give consistently dry resin, higher yields, and improved stream time, which can yield greater profits. Desiccants should be replaced every two years, and dryer filters should be checked and cleaned once each shift to insure adequate air flow to the bed.

(continued from page 3)

tion cores and cavities. Gates should be hardened and replaceable to obtain mold longevity.

Many tool steels are able to resist the erosion caused by glass filled materials. The choice of tool steel is dictated by economics, location within the mold and life expectancy required. The following are tool steels with good abrasion resistance:

- A-2 Steel resists serious abrasion when hardened to 58-60 Rockwell C(Rc)
- D-2 Steel contains more chromium, is more resistant to abrasion, and is somewhat harder to machine than A-2. D-2 is limited to smaller components due to its brittleness.

Mold plating is an excellent way to improve the service life of a mold. Effective abrasion-resistant coatings include electroless nickel plating, slow deposition dense chrome, and nye-carb plating.

For long production molds, A-2 or D-2 tool steel hardened to Rockwell C~60+ is recommended. Of these, A-2 steel is a little more flexible and forgiving. For low volume runs, S-7 and H-13 are acceptable softer steels.

Drying Long Fiber Compounds

Moisture may be present in some materials, either on the surface or absorbed by the resin system. Without proper drying, this moisture may be converted to steam in the injection cylinder and cause blisters, splay, internal voids, and lamination of the molded part's surface. Undried hygroscopic materials can suffer degradation of properties.

Regrind

Regrind materials may be used to a maximum level of 5% without significantly changing Long Fiber Compound properties. Higher percentages reduce average fiber length, negatively affecting impact resistance and other structural properties. Accurately mix ground runners, sprue, and rejects with the virgin pellets, being careful to keep the mixture free of contamination.

English/Standard Measurements

Polymer	Processing Temperatures (°F) Rear	Center	Front	Melt	Mold	Pressures (psi) Injection	Back	Drying Time @ Temp. (°F)	Dew Point (°F)	Moisture Content
RTP 100 Series PP	420-450	410-440	400-430	410-480	100-170	10,000-15,000	25-50	4 hrs @ 180	-20	0.02%
RTP 200 Series Nylon 6/6	500-545	490-535	480-525	520-570	150-255	5,000-18,000	25-50	2-4 hrs @ 175	0	0.20%
RTP 200A Series Nylon 6	480-520	450-510	430-500	470-520	130-200	10,000-18,000	25-50	2 hrs @ 180	-20	0.20%
RTP 200B Series Nylon 6/10	540-560	530-550	525-540	530-570	180-250	10,000-18,000	25-50	2 hrs @ 175	0	0.02%
RTP 200D Series Nylon 6/12	480-520	450-510	430-500	470-520	130-200	10,000-18,000	25-50	2 hrs @ 180	-20	0.20%
RTP 300 Series PC	570-610	550-580	530-560	550-600	180-250	10,000-18,000	25-50	2-4 hrs @ 175	-20	0.02%
RTP 400 Series PS	430-460	420-450	400-430	410-480	100-150	10,000-15,000	25-50	2 hrs @ 180	N/A	N/A
RTP 700 Series HDPE	350-390	370-420	390-440	380-450	70-150	10,000-18,000	25-50	2 hrs @ 175	-20	0.20%
RTP 1000 Series PBT	470-495	460-485	450-475	460-520	150-250	10,000-18,000	25-50	4 hrs @ 250	-20	0.02%
RTP 1100 Series PET	480-520	470-570	460-500	480-560	275-350	10,000-15,000	25-50	4 hrs @ 300	-40	0.04%
RTP 1300 Series PPS	590-610	570-590	550-570	595-625	275-350	10,000-15,000	25-50	6 hrs @ 300	N/A	0.04%
RTP 1400 Series PES	670-700	660-690	650-680	660-750	275-350	10,000-18,000	25-50	4 hrs @ 300	-25	0.04%
RTP 2100 Series PEI	670-720	660-700	650-680	660-720	250-325	10,000-18,000	25-50	4 hrs @ 275	-20	0.02%
RTP 2200 Series PEEK	720-780	685-725	650-690	680-750	325-450	10,000-18,000	25-50	3 hrs @ 300	-20	0.02%
RTP 2300 Series RTPU	420-450	410-440	400-430	430-470	125-200	10,000-15,000	25-50	6 hrs @ 225	-25	0.01%
RTP 4000 Series PPA	590-615	580-605	570-595	580-625	275-325	10,000-18,000	25-50	4 hrs @ 250	-25	0.05%
RTP 4500 Series PK	520-540	495-515	465-485	465-540	180-300	10,000-18,000	25-50	4 hrs @ 140	-25	0.02%

Injection and Screw Speeds: A slow injection speed of 0.5-1"/second and a screw speed of 30 to 70 RPM are recommended for all polymers in the above chart.

S.I. Metric Measurements

Polymer	Processing Temperatures (°C) Rear	Center	Front	Melt	Mold	Pressures (MPa) Injection	Back	Drying Time @ Temp. (°C)	Dew Point (°F)	Moisture Content
RTP 100 Series PP	216-232	210-227	204-221	210-249	37-77	69-103	1.75-3.5	4 hrs @ 82	-29	0.02%
RTP 200 Series Nylon 6/6	260-285	254-279	249-274	271-299	65-122	34-124	1.75-3.5	2-4 hrs @ 79	-18	0.20%
RTP 200A Series Nylon 6	249-271	232-266	221-260	243-271	54-93	69-124	1.75-3.5	2 hrs @ 82	-29	0.20%
RTP 200B Series Nylon 6/10	282-293	277-288	274-282	277-299	82-124	69-124	1.75-3.5	2 hrs @ 79	-18	0.02%
RTP 200D Series Nylon 6/12	249-271	232-266	221-260	243-271	54-93	69-124	1.75-3.5	2 hrs @ 82	-29	0.20%
RTP 300 Series PC	299-321	288-304	277-293	288-316	82-121	69-124	17.5-3.5	2-4 hrs @ 79	-29	0.02%
RTP 400 Series PS	221-238	216-232	204-221	210-249	38-66	69-103	1.75-3.5	2 hrs @ 82	N/A	N/A
RTP 700 Series HDPE	177-199	188-216	199-227	193-238	21-66	69-124	1.75-3.5	2 hrs @ 79	-29	0.20%
RTP 1000 Series PBT	243-275	238-252	232-246	238-271	65-121	69-124	1.75-3.5	4 hrs @ 121	-29	0.02%
RTP 1100 Series PET	249-271	243-299	238-260	313-329	93-149	69-103	1.75-3.5	4 hrs @ 149	-71	0.04%
RTP 1300 Series PPS	309-321	299-309	288-299	313-329	135-177	69-103	1.75-3.5	6 hrs @ 149	N/A	0.04%
RTP 1400 Series PES	343-360	349-366	343-360	349-399	135-177	69-124	1.75-3.5	4 hrs @ 149	-32	0.04%
RTP 2100 Series PEI	354-383	349-371	343-360	349-382	121-163	69-124	1.75-3.5	4 hrs @ 135	-29	0.02%
RTP 2200 Series PEEK	382-416	362-385	343-366	360-399	163-232	69-124	1.75-3.5	3 hrs @ 149	-29	0.02%
RTP 2300 Series RTPU	216-232	210-227	204-221	227-271	52-93	69-103	1.75-3.5	6 hrs @ 107	-32	0.01%
RTP 4000 Series PPA	309-324	304-318	299-313	304-329	135-163	69-124	1.75-3.5	4 hrs @ 121	-32	0.05%
RTP 4500 Series PK	271-282	257-268	240-251	240-282	82-148	69-124	1.75-3.5	4 hrs @ 60	-32	0.02%

Injection and Screw Speeds: A slow injection speed of 12.7-25.4 mm/second and a screw speed of 30 to 70 RPM are recommended for all polymers in the above chart.

SUGGESTED REMEDIES *Perform in numerical order by column*	Blisters	Brittleness	Excessive Flash	Gas Burns	Oversized Part	Poor Surface Finish	Poor Weld Lines	Short Shots	Silver Streaking	Sink Marks	Undersized Part	Voids	Warping
	PROBLEM												
Change Gate Location							8						6
Clean Mold Faces			4	5		6							
Clean Vents	5			2			5	11				12	
Check for Material Contamination	6	4							4				
Check for Uneven Mold Temperature													1
Check Mold Faces for Proper Fit			5										
Dry Material	1	6	6	6		7			1			11	
Increase Amount of Material							4	1		8	7	10	
Increase Back Pressure						5		6			6		
Increase Clamp Pressure			2										
Increase Cooling Time										10			9
Increase Holding Pressure						8		12		11	1		
Increase Injection Hold Time							2			2	2	2	
Increase Injection Pressure						2	1	2		1		1	2
Increase Injection Speed						3	9	3	2		8		
Increase Injection Time										12	5		
Increase Mold Temperature		7			5	1	3	7			9	8	3
Increase Size of Gates								8	6	4	10	4	
Increase Size of Runners								9		5	11	5	
Increase Size of Sprue								10		6		6	
Increase Size of Vent				4			6	4					
Locate Gates Near Heavy Cross Sections										7		7	
Raise Material Temperature					7	4	10	5			4		
Redesign Ejection Mechanism													10
Reduce Amount of Regrind		5											
Reduce Back Pressure		2							7				
Reduce Cylinder Temperature	2	1	8	3	4				3				7
Reduce Holding Pressure			7		3								8
Reduce Injection Pressure			3		2								
Reduce Injection Speed	3		1	1	1	9	7		8	3		3	
Reduce Mold Temperature										9	3	9	4
Reduce Molded Stress		8											5
Reduce Overall Cycle Time					6								
Reduce Screw Speed	4	3							5				

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