Celstran®

Long Fiber Reinforced Thermoplastics

Injection Molding Guide

Plastic Materials

Celstran & Injection Molding

Process & Handling

Trouble Shooting Guide

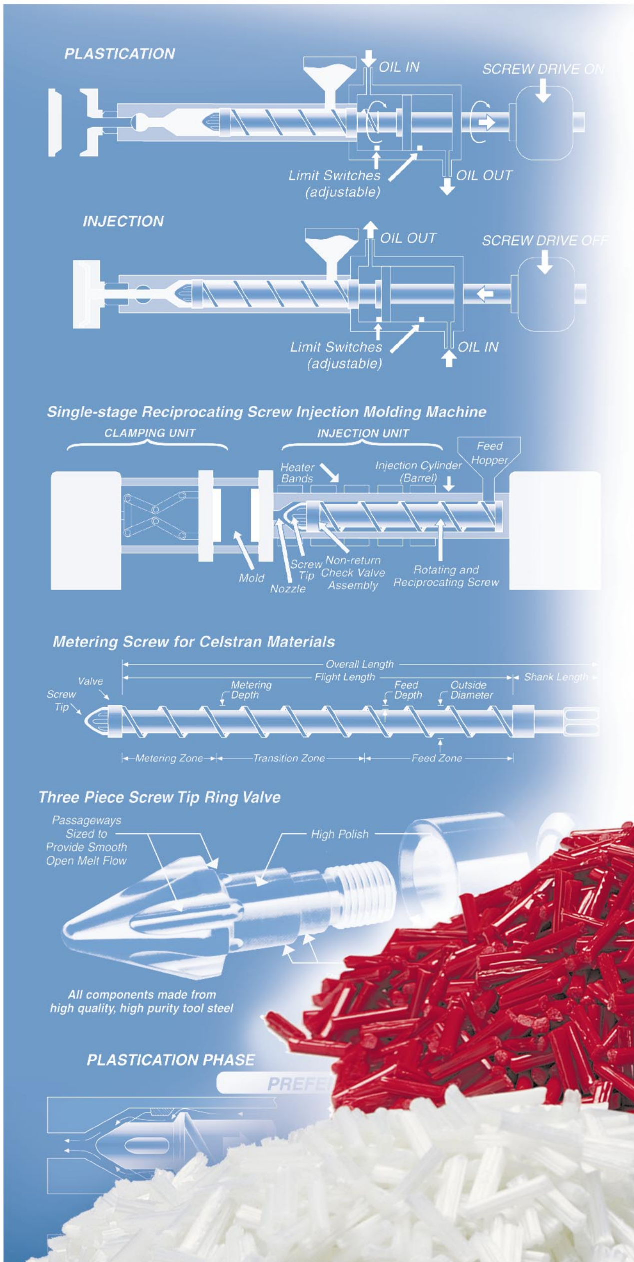

Table of Contents

Introduction

Chapter 1
Celstran Materials & Injection Molding

Chapter 2
Celstran Processing

Chapter 3
Troubleshooting Guide

List of Figures *page*

NOTICE:

Introduction

There are two generally recognized classes of plastic materials when classified by chemical structure: ***THERMOSETS,*** *having* ***cross-linked molecular chains*** *and* ***THERMOPLASTICS,*** *which are made up of* ***linear molecular chains.***

Among the thermoplastics used for injection molding processes, there are a number of broad categories of resin groups: ***General Purpose*** *resins, usually commodity grades, are often referred to as 'neat' resins due to their typical use in unmixed form.* ***Engineering*** *grades—unreinforced—are formulated for higher performance applications.* ***Filled*** *resins use a variety of other materials mixed with the resin for property or price considerations.* ***Reinforced*** *resins, typically with added glass fibers, are sold as short pellets, 3 mm long, and long fiber pellets, 11 mm long.*

Celstran *materials, originally patented in the early 1980's, were the first in the new generation of long fiber reinforced thermoplastics (LFRTP). The proprietary technology and subsequent manufacturing techniques were developed at Polymer Composites Inc., (PCI), which focuses solely on the production of* ***Celstran*** *LFRTP materials.* ***Celstran*** *LFRTP materials are used often in metal replacement applications; the automotive market is the largest. Other markets include: power tools, lawn and garden, general appliances, furniture, and medical. Short glass applications, where dimensional stability and impact properties need improvement, is another area where* ***Celstran*** *materials are considered.*

Most of the information in this publication is presented with the assumption of a "perfect" or optimum processing environment. While these conditions are preferred, variance from them can still yield good results, especially when reviewed in the developmental stages of a program. ***Celstran*** *technical representatives can help assess the key factors that will influence molding and final part results when using* ***Celstran*** *LFRTP materials.*

Thermoset Polymers

Thermoset polymers require a two-stage polymerization process: the first is done by the material supplier, resulting in a linear chain polymer with partially reacted portions. The second is done by the molder, who controls final cross-linking. Short chains with many cross-links form rigid thermosets, while longer chains with fewer cross-links form more flexible thermosets.

With all thermosets the polymerization is permanent and irreversible. The process of curing a thermoset is analogous to cooking an egg. Once cooked, reheating does not cause an egg to remelt, just as thermosets cannot be remolded. Similarly, as an egg burns from overheating, a thermoset can be overheated, resulting in broken chains and degraded properties.

Thermoplastic Polymers

Thermoplastics are fully polymerized, requiring no further chemical processing before molding. There are two kinds: ***CRYSTALLINE*** and ***AMORPHOUS***. Crystalline polymers include: polyethylene, polypropylene, polyamide (e.g., **Celanese**® nylon), acetal (e.g., **Celcon**®), PBT (polybutylene terephthalate, e.g., **Celanex**®), and PPS (polyphenylene sulfide, e.g., **Fortron**®). Amorphous polymers include ABS (acrylonitrile/butadiene/styrene), polystyrene, and polycarbonate.

Some of the differences between crystalline and amorphous polymers are:

Crystalline polymers have a relatively sharp melting point. Amorphous polymers have no true melting point, but merely soften gradually.

Crystalline have an ordered, arrangement of molecule chains. Amorphous have a random orientation of molecules, chains can lie in any direction.

Crystalline generally require higher temperatures to flow well when compared to amorphous. In molding, amorphous polymers generally do not flow as easily as crystalline.

Reinforcement of crystalline polymers with fibers increases the load-bearing capabilities considerably, particularly with highly crystalline polymers. Reinforcement with fibers marginally improves an amorphous polymer's strength at higher temperatures.

Crystalline shrink more than amorphous, causing a greater tendency for warpage. Fiber reinforcement of crystalline polymers significantly decreases warpage.

Crystalline usually produce opaque parts due to their molecular structure. Generally, amorphous polymers yield transparent, water-clear parts.

Chapter 1
Celstran Materials & Injection Molding

***Celstran** materials have a matrix resin which completely impregnates parallel reinforcing fibers which run the entire length of the pellet. **Celstran** materials can be used easily in standard machinery with slight modifications for maintaining full fiber length throughout processing.*

1.1 Celstran Long Fiber Reinforced Materials

MATERIAL MANUFACTURE

Celstran materials are long fiber reinforced thermoplastics using a number of engineering resins as matrices for the various reinforcing fibers.

The **Celstran** manufacturing process combines fibers with resins in a patented pultrusion technology to form consistently uniform materials (fig. 1). Continuous fiber rovings are pulled through, spread, and separated in an impregnation head and processing die. There, molten resin impregnates the rovings. A smooth rod of resin and fibers, is drawn out - or "pultruded" - from the processing die and then cooled. This continuous rod is then chopped into uniform pellets, typically 11 mm long and 3 mm diameter (fig. 2).

FEATURES

Celstran materials retain their fiber length during molding when processed properly. The intermingling of these long fibers in molded parts provides exceptional dimensional stability, impact resistance, and excellent high temperature performance. Fiber length retention is central to optimum part performance. See section 1.4 for preferred injection molding equipment.

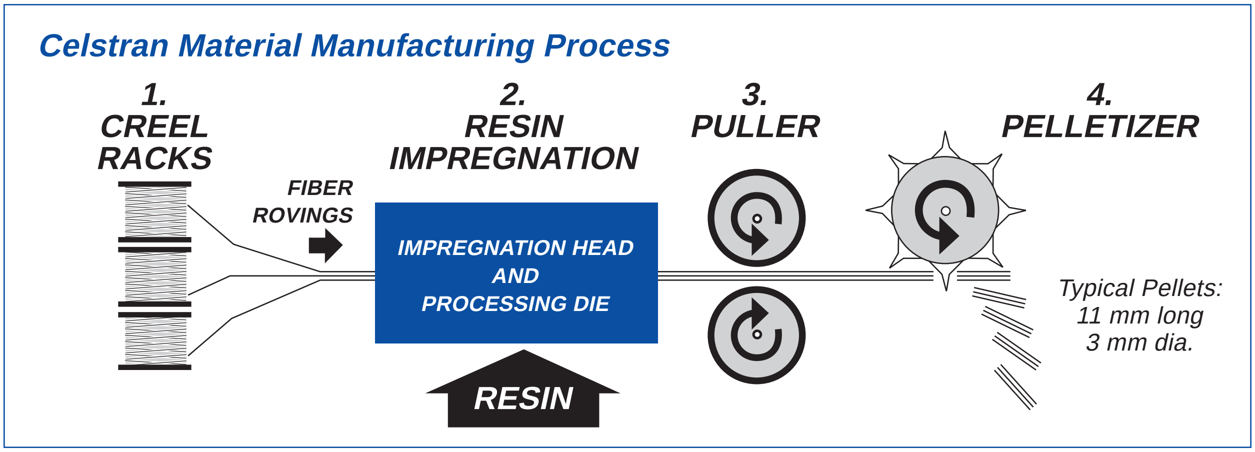

Figure 1 - ***Polymer Composites Inc. material manufacturing process schematic***

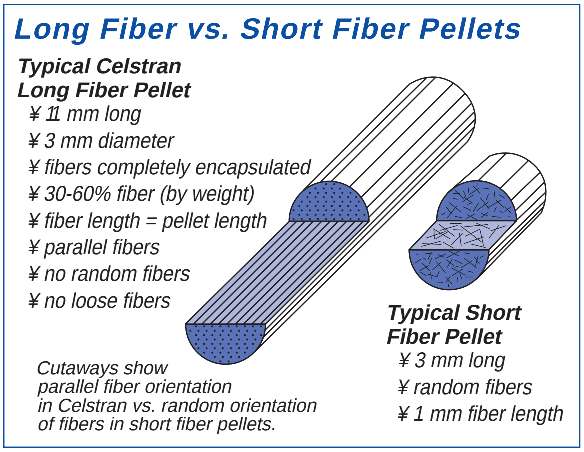

Figure 2 - ***Schematic cutaways of typical pellets***

MATERIAL GRADES

Various levels of fiber loading are available in **Celstran** materials. The most common products are reinforced with glass at 30%, 40%, 50%, and 60%, measured by weight. Other fibers available include aramid, carbon and stainless steel. Colors other than natural are available and pellet lengths other than 11 mm are manufactured on request.

1.2 Molding Celstran Materials

Skillful molding is central to the production of high-quality plastic parts and is essential when using **Celstran** long fiber reinforced materials. **Celstran** materials' high performance properties can be reduced sharply by conditions which break - or shorten - fiber length. Fiber length retention is not as readily seen or measured during the molding process as are surface imperfections, improper color, or dimensional irregularities. Careful control and monitoring of the following factors will preserve fiber length throughout processing, making the difference between high-quality parts and rejects.

1.3 The Molding Process

The molding process in a single-stage reciprocating screw injection molding machine is divided into two phases: the ***PLASTICATION*** phase, and the ***INJECTION*** phase (fig.3).

THE PLASTICATION PHASE:

1) Dried material is fed from the hopper into the barrel at the feed section, where it is taken up by the screw.
2) It is melted by conductive heat, shear energy and the mechanical pressure of the compression zone.
3) The molten material, or "melt", flows through the metering zone, achieving a uniform homogeneous melt.

THE INJECTION PHASE:

4) The screw comes forward, pushing the melt through the nozzle tip, runners, and gates into the cavities of the mold.

After the injection phase is compete, the screw returns to begin the plastication phase once more as the melt in the mold begins to cool and solidify. The mold is then opened and the molded part is ejected from the mold, usually with the aid of an ejection system.

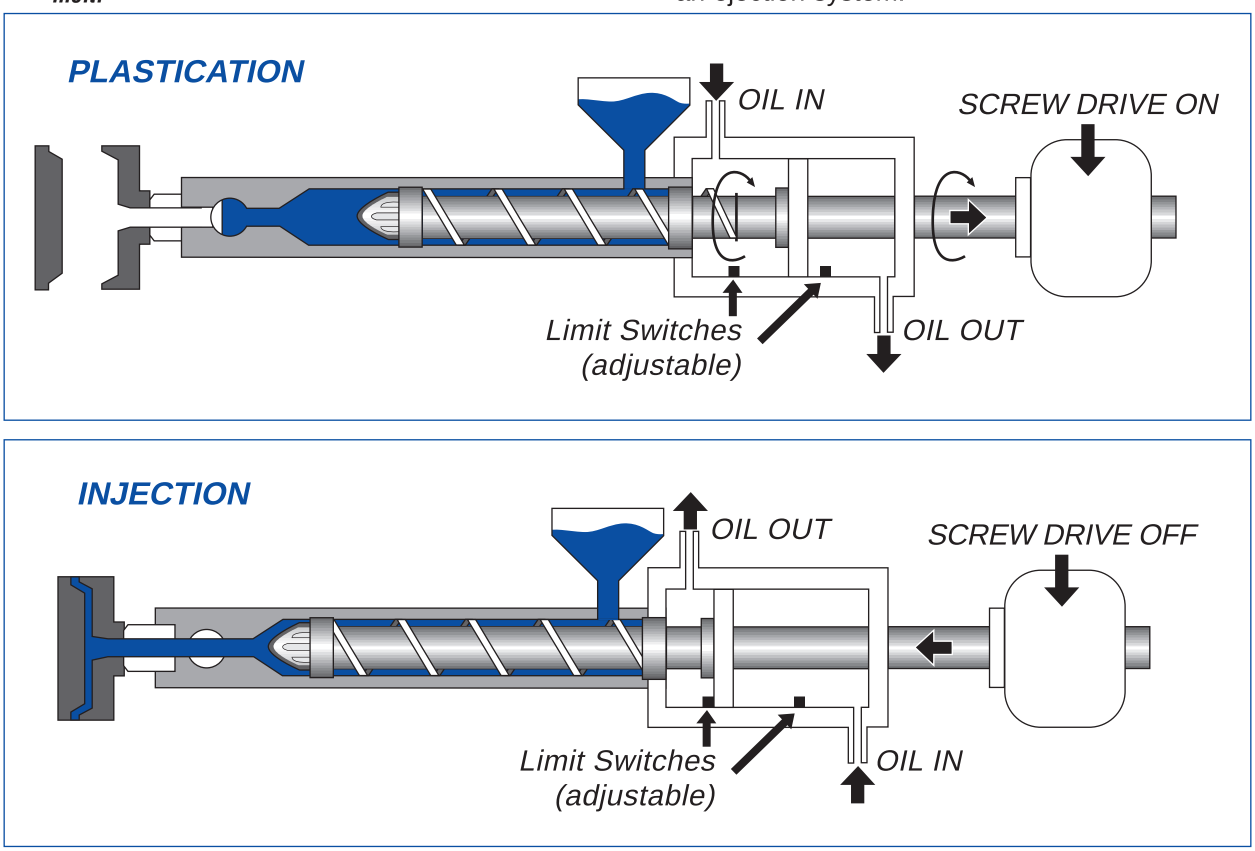

Figure 3 - ***Molding sequence of a single-stage reciprocating screw injection molding machine.***

1.4 Injection Molding Equipment

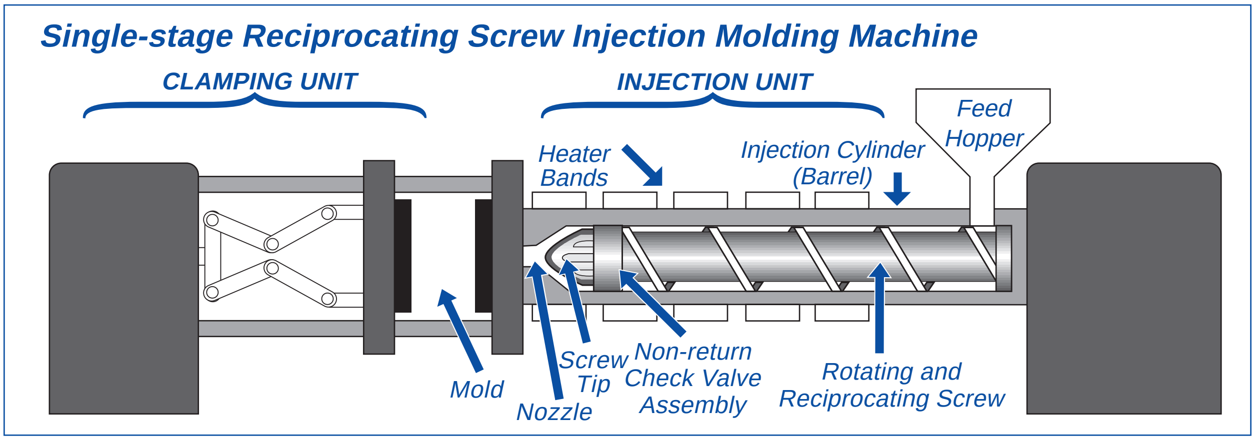

Figure 4 **- *Single-stage reciprocating screw injection molding machine schematic. (not to scale)***

Celstran materials are most successfully molded in machines of 100 tons or greater capacity. Abrasion-resistant alloys should be used in the barrel and screw. Barrels and screws made of bimetallic-carbide alloy steels such as CPM 9V or CPM10V are preferred. Preferred flight hardening alloys for screws are Colmonoy 6 or Stellite 1.

A typical molding machine has two fundamental units:(A)***CLAMPING***, and (B)***INJECTION*** (fig. 4).

CLAMPING UNITS - There are three types of clamping units: **mechanical**, **hydraulic**, and **hydromechanical**, and all, when used properly, are suitable for processing **Celstran** materials.

INJECTION UNIT - Plasticizing Capacity - Engineering resins follow a time/temperature function (i.e.,their structure and properties are changed by heat as well as the duration of the heat). Material shot weight should be sized relative to residence time of the material in the cylinder of the molding machine. The plasticizing capacity of a molding machine is optimized for **Celstran** materials with a shot weight of 40-60% of the machine's maximum capacity. **For example, to promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity.** Use additional rear zone heat for short residence time (a reverse temperature profile) and less rear zone heat for long residence time (a forward temperature profile). *NOTE: All conditions are "optimized" or "ideal" for processing **Celstran** materials. Machine and process capabilities can usually be adjusted to compensate for non-ideal conditions.*

Screw Design - A general purpose metering type screw is preferred for optimum processing of **Celstran** materials (fig. 5). This type of screw has three sections: (1) the feed, (2) the transition and (3) the metering section. The feed section has a constant root diameter. The screw slopes up in an involuted taper to the metering section which has a larger constant root diameter than the feed section.

Typical design specifications for a preferred me-

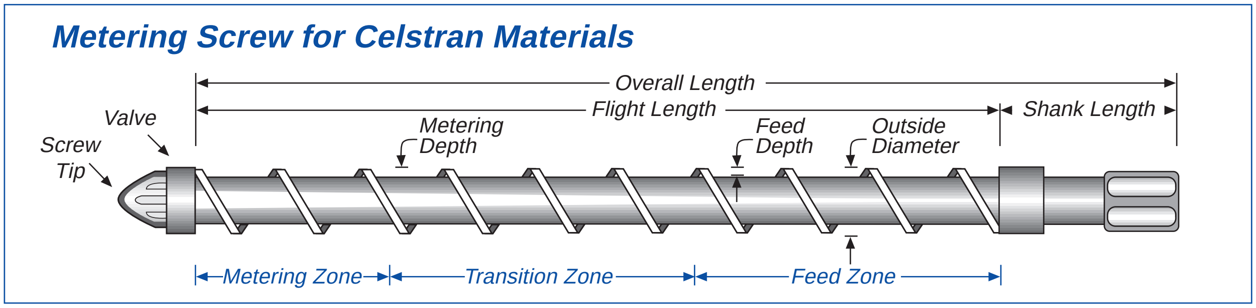

Figure 5 **- *Metering screw recommended for Celstran materials.***

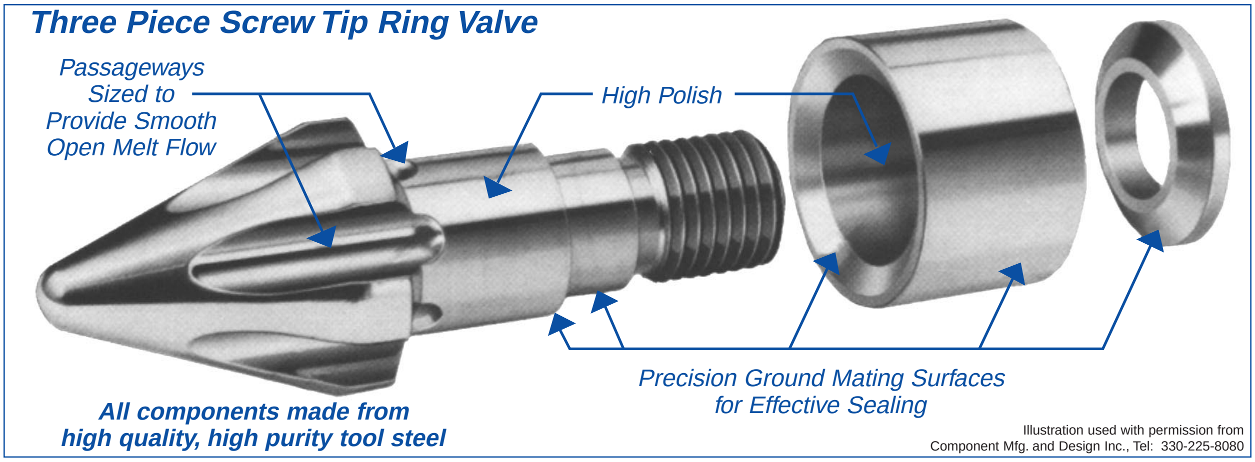

Figure 6 - ***Disassembled view of a three piece screw tip ring valve assembly showing its component parts***

tering screw design for the proper processing of **Celstran** materials should meet the following guidelines:

1) ***Zone distribution = 40% feed, 40% transition, and 20% metering.***
2) ***Compression ratio = 2:1 to 3:1.***
3) ***L/D ratio = 18:1 to 22:1.***
4) ***Preferred screw diameter = 45 mm***
5) ***Preferred Feed zone channel depth = 7.5 mm Preferred Metering zone channel depth = 3.5 mm***
6) ***Pitch = 1D***

Barrier, double wave, and vented barrel mixing screw designs are not suitable for optimum processing of **Celstran** materials and should not be used.

3-PIECE DESIGN - SCREW TIP, CHECK RING & SEAL

The screw tip should have generous passageways and flutes to provide smooth and open melt flow. Any sharp edges or severe convolutions will cause fiber degradation and should be avoided.

A free-flowing check ring non-return valve with precision ground mating surfaces on the seal is preferred for **Celstran** materials (fig. 6). Ball-check non-return valves (fig. 7) are not recommended because they restrict flow and reduce fiber length.

NOZZLE AND NOZZLE TIP

It is imperative to use a general purpose design nozzle and tip as illustrated in figure 8 (p.8). A

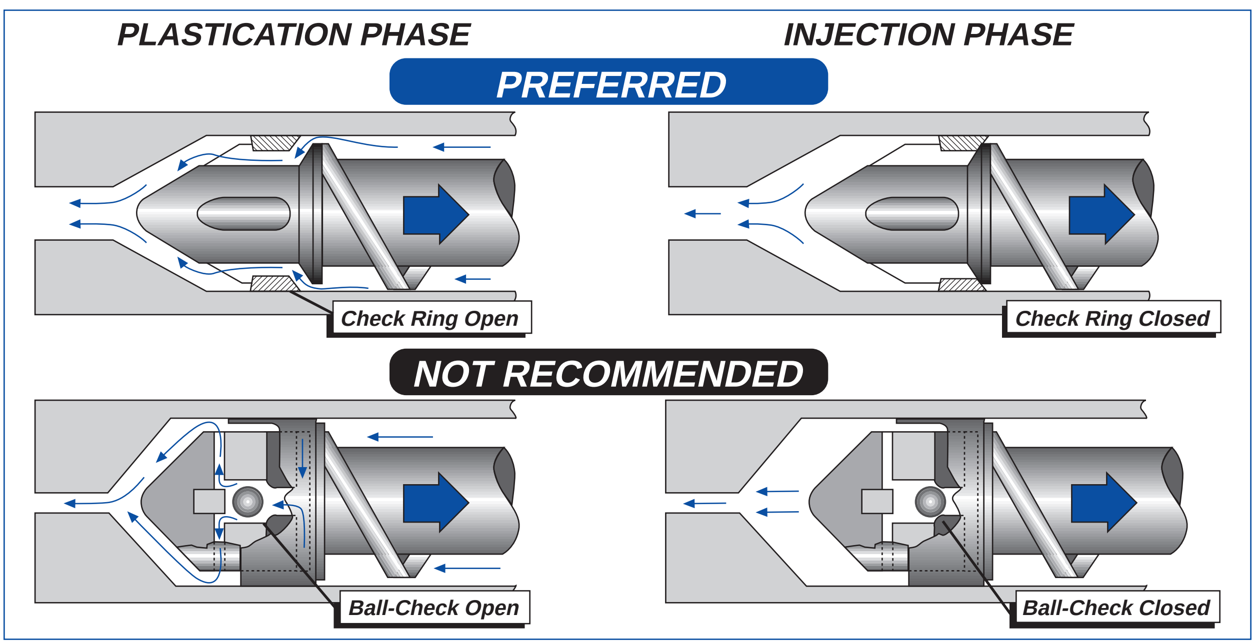

Figure 7 - ***Preferred check ring non-return valve (above), and not recommended internal ball-check non-return valve (below)***

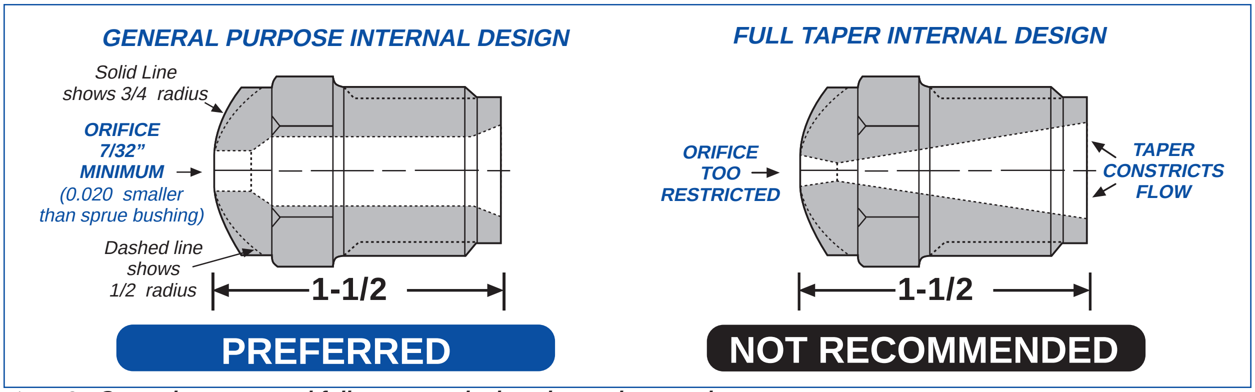

Figure 8 **- *General purpose and full taper nozzle tips - internal comparison***

generous orifice diameter will ensure the restriction-free flow of material. An orifice diam. of at least 7/32 in. (5.56 mm) is preferred and will help to streamline the material flow, allowing the long fibers to pass through undamaged. *(NOTE: The orifice should always be 0.020" smaller than the sprue bushing size.)* Do not use internally tapered tips (often called "nylon tips"), or tips without a constant diameter pathway.

1.5 Sprues, Runners, Gates, & Venting

Sprues, runners, gates, and venting are important factors in the successful molding of **Celstran** materials. The following guidelines are a general starting point for optimum processing, but specific conditions are dependent on part and material specifications. **Celstran** design engineers should be consulted for further information.

SPRUES:

- *INITIAL DIA. = 1/4 in. (5.56 mm)*
- *TAPER TO: 11/32 in. (8.73 mm)*

RUNNERS:

Full-round systems are preferred.

- *DIAMETER = 1/4 in. (5.56 mm)*

Trapezoidal runner systems are acceptable.

- *WIDTH = 1.25 x DEPTH of runner*

GATES:

Large and rectangular, at least:

- *1/4 in x 1/8 in. (6.35 x 3.18 mm)*
- *60-90% of wall thickness.*
- *WIDTH = 1.5-2.0 x DEPTH (use higher % for reinforced materials)*
- *LAND LENGTH = 1/2 GATE DEPTH*
- *Excessive land length causes jetting, insufficient causes blushing and sinks at the gate.*

VENTING:

Vent wherever possible, at parting lines, runners, ejector pins, bosses, ribs, projections, etc. Preferred dimensions are:

- *VENT LAND = 0.002 in. (0.051 mm)*
- *VENT CHANNEL = 0.005 in. (0.127 mm)*
- *RUNNER VENTS = 0.004-0.005 in. (0.102-0.127 mm) deep out to atmosphere*
- *EJECTOR PINS (per side)=0.0065 in (0.165 mm)*

1.6 Basic Design Principles

Design principles for **Celstran** materials are typical to other thermoplastic materials, but additionally, they must include factors about fiber behavior in the molding process. Fiber length and uniform dispersion throughout the finished part are influenced by these five areas of concern:

1. CONSTANT WALL THICKNESS

Maintain constant wall (nominal) thickness, including corners, ribs, and bosses. The following dimensions are preferred:

- *MINIMUM = 0.125 in. (3.18 mm)*
- *MAXIMUM = 0.375 in. (9.53 mm)*

Larger parts may require thicker walls. Thinner walls may degrade fiber length, lower impact values and increase crack propagation.

2. RADIUSED CORNERS

Radiusing all corners, inside and outside, will enhance flow and reduce stress concentration.

- *INTERNAL RADIUS=1/2 nominal wall thickness*
- *GENEROUS RADII, where possible, will help maintain consistent wall thickness in corners.*
- *BOSS corner radii relieve stress from fasteners.*
- *RIB corner radii will improve filling & packing.*

3. DRAFT ANGLE

Always use the maximum allowable draft angle, a minimum of 1/2° per side. Other adequate draft factors are:

- *TEXTURES - require proportionately more draft*
- *RIBS & BOSSES - to reduce ejection pressure*
- *SHRINKAGE - Material "grips" the mold core as it shrinks while it cools. Ejection damage can result from inadequate draft angles.*

4. PROJECTIONS

Projections must be properly designed to function well and to minimize stress on the wall. Fundamental design guidelines include:

- *THICKNESS - < 90% of nominal wall thickness*
- *HEIGHT - 2.5-4.0x nominal wall thickness*
- *BOSSES - always treat them as projections*

5. KNIT (WELD) LINE LOCATION

Knit (or weld) lines occur where two flow fronts meet in the mold, such as holes and any depression deeper than 60% of wall thickness.

- *LOCATION - Noncritical places*
- *VENTING - Generous venting and overflow tabs can help increase knit line strength by eliminating any gas (air) in the mold.*

1.7 Warpage Considerations

To minimize warpage, the following guidelines should be observed:

- *WALL THICKNESS - Maintain uniformity*
- *RIBS & GUSSETS - Use them appropriately*
- *RUNNERS - Balance systems for even filling*
- *TEMPERATURES - Uniform for even cooling*
- *GATES - Sized to avoid premature freeze-off*
- *STRESS - Avoid molded-in stresses*
  - *Minimize flow lengths*
  - *Use proper fill time and pressure*
  - *Use adequate holding times and pressures*

1.8 Shrinkage Considerations

Shrinkage in parts molded of **Celstran** materials exhibit anisotropic shrinkage - they shrink less in one direction-longitudinally - in the direction of the flow - than in the other direction-transversely - across the flow. The long fiber inhibits shrinkage by taking up volume along its orientation, which tends to follow the flow. Across the flow, the polymer's shrinkage properties tend to dominate.

Data for **Celstran** materials' shrinkage rates in test parts are listed in Figure 9. The molding of the test parts was done under the "preferred conditions" as described in this guide, and tested in accordance with ASTM D-955. The data as listed provide a good starting point for the development phase of a design project. Final performance, however, is highly dependent on the individual part, for further information, consult a qualified **Celstran** design engineer. Call toll-free **1-888-235-7872**.

***SHRINKAGE DATA** (Inch per Inch)*

MATERIAL GRADE:	LONGITUDINAL	TRANSVERSE
POM-G40-01	0.0005–0.001	0.003–0.005
PA6-GF30-01	0.0005–0.001	0.003–0.004
PA6-GF40-01	0.0005–0.001	0.0025–0.003
PA6-GF50-01	0.0005–0.001	0.002–0.003
PA66-GF30-02	0.001–0.002	0.003–0.004
PA66-GF40-02	0.001–0.002	0.002–0.003
PA66-GF50-02	0.001–0.0015	0.0015–0.0025
PA66-GF60-02	0.0005–0.001	0.001–0.002
TPU-GF30-01	0.0005–0.001	0.0015–0.0025
TPU-GF40-01	0.0005–0.001	0.001–0.002
TPU-GF50-01	0.0005–0.001	0.0005–0.001
TPU-GF60-01	0.0005–0.001	0.0005–0.001
PPS-G40-01	0.002–0.003	0.004–0.005
PPS-G50-01	0.001–0.002	0.003–0.004
PET-G40-02	0.002–0.003	0.004–0.005
PET-G50-01	0.001–0.002	0.003–0.004
PBTG40-01-4	0.001–0.002	0.004–0.005
PBTG50-01-4	0.001–0.002	0.003–0.004
PP-GF30-01	0.001–0.002	0.002–0.003
PP-GF40-01	0.0005–0.001	0.001–0.002
PP-GF50-01	0.0005–0.001	0.0005–0.001
PCG40-02-4*	0.0015–0.002	0.001–0.002

Figure 9 ***- In Celstran LFRTP materials, shrinkage is less longitudinally, due to the fibers' volume taking up space.***
** PC/ABS grade, gray in color.*
All other rates are as tested with natural-colored materials. Any additives, such as colorants, flame retardants, etc., may increase shrinkage rates.

Chapter 2

Celstran Processing

*To consistently produce high-quality parts with **Celstran** long fiber reinforced materials, preprocessing storage, handling, drying, and feeding conditions must be closely monitored. General characteristics, processing data and special considerations are included for standard products in each resin group of **Celstran** materials.*

2.1 Storage of Celstran Materials

Proper packaging and storage is essential for optimum processing of **Celstran** materials. Warm and dry conditions are preferred. Cold causes surface condensation on the materials; warm humid conditions can lead to moisture absorption. All **Celstran** materials should be protected from moisture, although some resins are more susceptible to moisture problems than others.

Celstran materials are usually shipped in one of four package types, according to resin type and customers' handling and storage requirements.:

1. *55 lb (25 kg) bags - plastic and foil laminated bags, for hygroscopic matrix resins.*

2. *1,102 lb (500 kg) Gaylord pallet cartons - plastic and foil laminated lined, for hygroscopic matrix resins.*

3. *55 lb (25 kg) bags - plastic-lined, for non-hygroscopic matrix resins.*

4. *1,102 lb (500 kg) Gaylord pallet cartons - plastic lined, for non-hygroscopic matrix resins*

Bulk truck shipment of materials is also available.

2.2 Celstran Material Handling

The best transfer method for **Celstran** materials is a typical pneumatic system with a filter, although filterless systems are also available. With any system, smooth inner walls are preferred.

An alternative to pneumatic systems is the hose-auger system. Its benefits are: no filter, low maintenance, and no need for compressed air. Disadvantages are its larger floor space needs and any modifications to adapt to dryers and hoppers.

2.3 Feeding of Celstran Materials

The size and geometry of feed throats can be critical with machines of less than 150 tons. A smooth hopper to throat transition is necessary for a good flow, free of dead spots. Inside seams must be flush. A circular section is preferred to square or rectangular, and feed throat temperatures of 90-110 ˚F (32.2-43.3 ˚C) are preferred.

Hopper types do not pose problems generally, and some, such as spiral hoppers, enhance free flow. Hopper magnets can cause pellet bridging, but if necessary, plate, rare earth, and in-line types are preferred. With a hopper dryer, proper clearance must exist between the outside of the dispersion cone and the hopper interior.

2.4 Use of Regrind Celstran Materials

Where warranted, usually for cost reduction, up to 5% **Celstran** regrind materials may be used with no significant change in properties. Higher levels decrease structural properties, particularly impact resistance, because average fiber length is reduced.

Runners, sprues, and rejects should be clean, ground, and carefully mixed with virgin material.

2.5 Celstran Stainless Steel Materials

Celstran S materials are conductive, long stainless steel fiber reinforced thermoplastic molding materials offering protection against electrostatic discharge (ESD) and electromagnetic and radio frequency interference (EMI/RFI).

Molding machine settings for best fiber dispersal in **Celstran S** stainless steel materials are:

- *BACK PRESSURE - Minimum (50-100 psi)*
- *SCREW SPEED - Low (50-100 rpm)*
- *INJECTION SPEED - Slow to medium*
- *MELT TEMP. - Keep at high end of preferred*

NOTE: Do not use hopper magnets with any **Celstran S** stainless steel materials. Call toll-free **1-888-235-7872.**

2.6 Celstran as a Blending Concentrate

Celstran materials may be blended with unfilled, recycled or other materials for improving stiffness, impact, dimensional stability and/or improved heat distortion properties. In addition, some off-spec. materials, rather than being discarded, can be reclaimed with **Celstran** blending. Blending can be an effective strategy for lowering costs while achieving higher property values than with many virgin unreinforced materials.

Celstran PEHD-GF60-01 (PEHD, with 60% glass fiber by weight), blended with unreinforced, recycled, PEHD at 6%, 10%, and 15% total glass by weight, yields significant improvement in flexural modulus (stiffness). At 15% glass, stiffness is increased by 300% (fig. 10). Tensile strength, tensile modulus, flexural strength, and heat distortion temperature properties are similarly improved.

Impact properties of unreinforced acetal materials are significantly improved when blended with **Celstran** long fiber reinforced acetal materials (fig. 11). Impact value improvement at low temperatures is greater than at room temperature.

Toughness or impact properties of polypropylene are dramatically improved (fig. 12) when blended with **Celstran** long fiber reinforced PP, transforming it into an exceptionally cost-effective, high performance material.

Deflection temperature under load (DTUL) can be significantly improved when **Celstran** PET is blended with recycled, unreinforced PET(fig. 13). Recycled PET can also yield impact properties equal or greater than virgin unreinforced PET when blended with **Celstran** PET material.

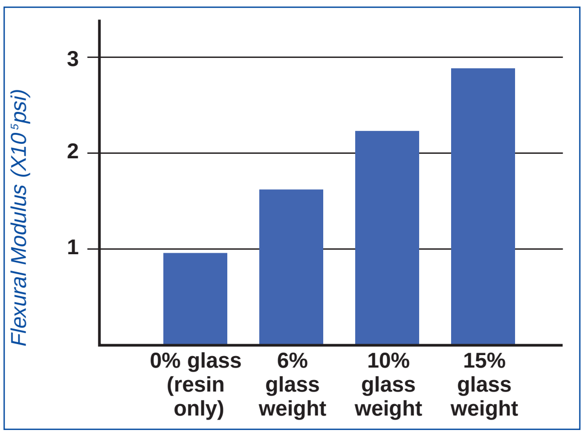

Figure 10 - ***Flexural modulus of recycled PEHD compared with Celstran® PEHD-GF60-01 blended to total glass weights of 6%, 10%, and 15%.***

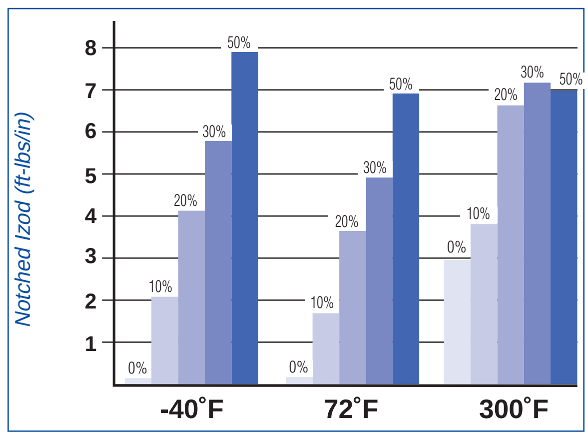

Figure 12 - ***Notched Izod properties measured at various temperatures for unreinforced polypropylene, and Celstran® long fiber reinforced PP materials at 10%, 20%, 30%, and 50% glass levels.***

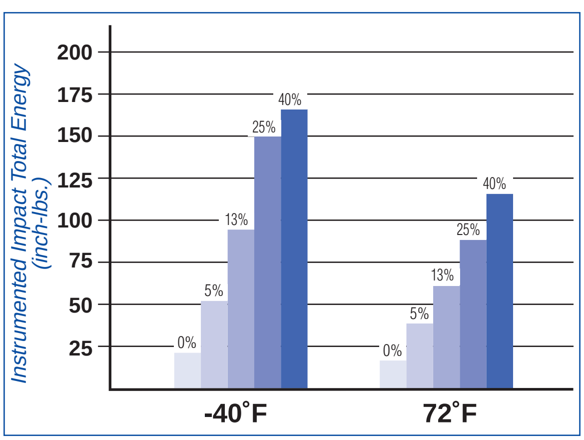

Figure 11 - ***Impact properties at -40˚F and -72˚F for unreinforced acetal, acetal blended with Celstran® to 5%, 13%, and 25% glass weights, as well as straight 40% glass Celstran® acetal material.***

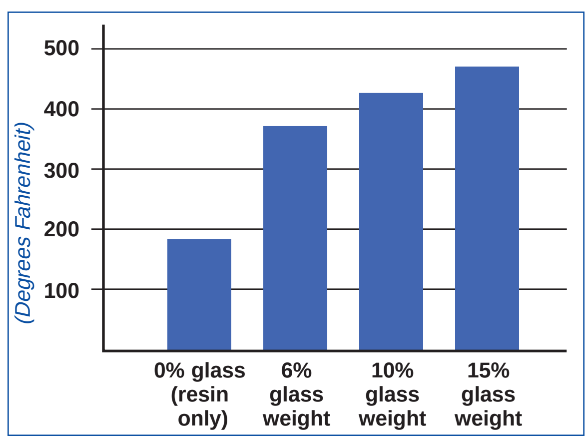

Figure 13 - ***Deflection Temperature Under Load (DTUL) of recycled, unreinforced PET and as blended to 6%, 10%, and 15% total glass weight with Celstran® PET-GF50-02.***

2.7 Drying Celstran Materials

It is important to use properly dried materials when molding thermoplastic parts; improper moisture levels are a common cause of processing and quality assurance problems. Undried hygroscopic materials can suffer degradation of properties. Non-hygroscopic materials should be dried to eliminate any surface moisture condensation.

DRYING EQUIPMENT AND PROCESS

The preferred setup for preprocessing drying equipment for **Celstran** materials is shown in the schematic illustration below (fig. 14).

A pneumatic loader (1) drops material into the insulated drying hopper on demand. Drying begins as heated, dehumidified air enters the drying hopper (2), penetrating the material and carrying moisture vapor up to the return line outlet. The moisture-laden air passes through a filter (3). This filter must be kept clean. A blower (4) forces the moisture-laden air through on-stream desiccant cartridges (5), where moisture is trapped. The dehumidified air is then reheated (6) and delivered back to the drying hopper.

While the on-stream desiccant cartridges are removing moisture, another set is being regenerated (5A) by a separate regeneration blower (7) and heater (8). The regenerated cartridges are switched on-stream as they are needed, maintaining a continuous drying process.

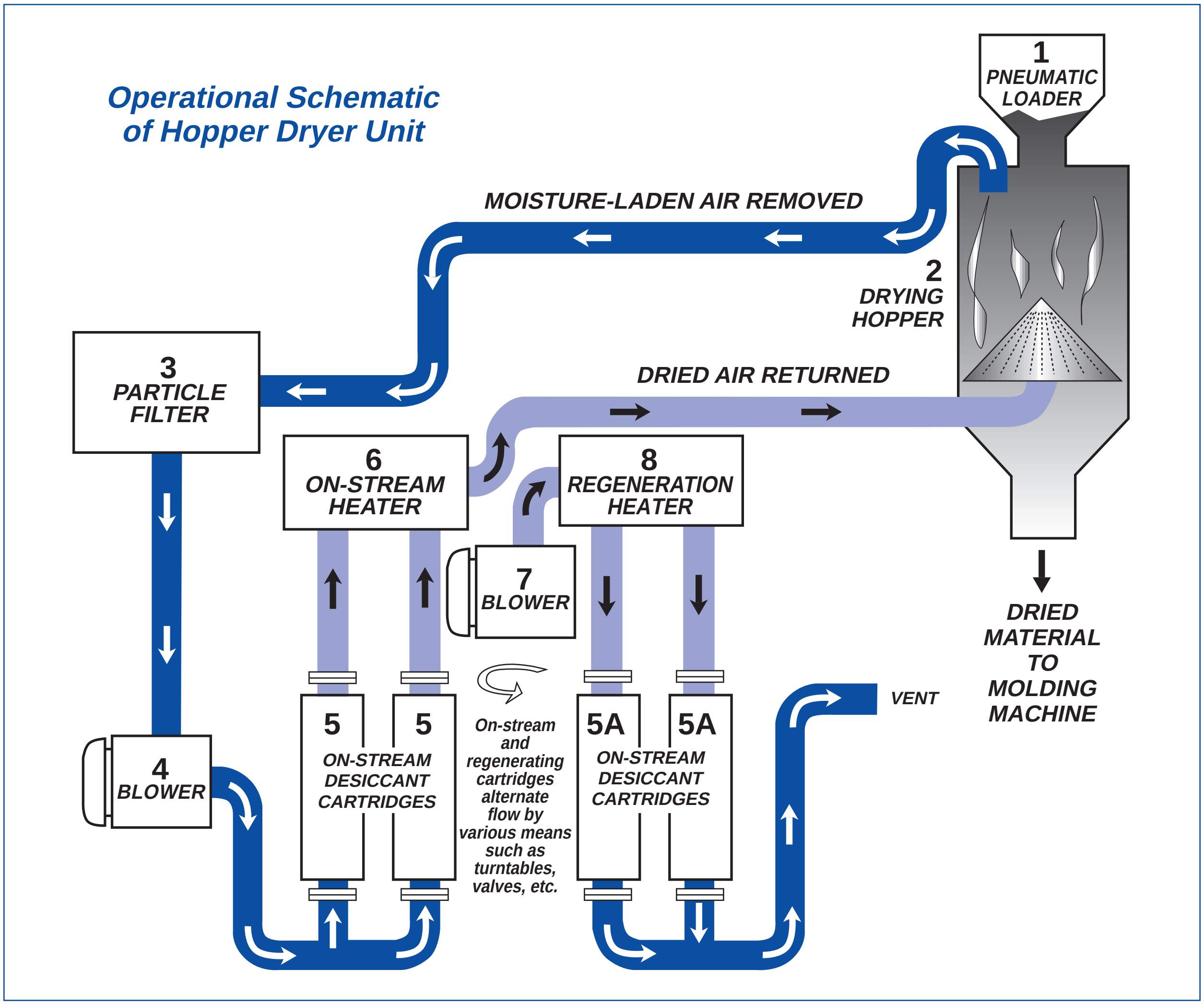

Figure 14 - ***Hopper dryer unit operational schematic***

2.8 Celstran Long Fiber Reinforced Nylon PA6/6 Materials

CHARACTERISTICS

Celstran long fiber reinforced nylon PA6/6 material is a crystalline engineering thermoplastic well-suited to applications requiring toughness and strength. Compared to nylon PA6 materials, it has a higher melting point and lower moisture absorption properties. In addition, it has excellent temperature, abrasion, and good natural lubricity. Its chemical resistance is mixed, with an excellent tolerance to alkali environments, but a poor candidate for most acid exposures. It is often used as a low-cost replacement for die-cast metal parts.

GRADES

Celstran long fiber reinforced nylon PA6/6 materials are currently available in 30%, 40%, 50%, and 60% glass fiber loadings in general purpose (01) or heat stabilized nylon PA6/6 (02) and easy mold (07). Carbon fiber and aramid fiber reinforced grades are also available. (**Celstran** carbon fiber reinforced nylon PA6/6 materials are available in flame retardant (-10) grade.) **Molding processing requirements are identical for all grades.**

DRYING CONDITIONS

Celstran long fiber reinforced nylon PA6/6 materials should be dried for a minimum of 4 hr at 175 ˚F (79.5 ˚C). Note that the material can be over-dried and may discolor.

START-UP CONDITIONS

The following table (fig. 15) shows the preferred processing temperatures for **Celstran** long fiber reinforced nylon PA6/6 materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

***PROCESSING TEMPERATURES±10 ˚F** (±5.55 ˚C)*						
MATERIAL GRADE:	REAR ZONE	CENTER ZONE	FRONT ZONE	NOZZLE	MELT	MOLD
PA66-GF30-02	540 *(282.2)*	550 *(287.8)*	560 *(293.3)*	550 *(287.8)*	560 *(293.3)*	200 *(93.3)*
PA66-GF40-02	550 *(287.8)*	560 *(293.3)*	570 *(298.9)*	560 *(293.3)*	570 *(298.9)*	200 *(93.3)*
PA66-GF50-02	560 *(293.3)*	570 *(298.9)*	580 *(304.4)*	570 *(298.9)*	580 *(304.4)*	200 *(93.3)*
PA66-GF60-02	570 *(298.9)*	580 *(304.4)*	590 *(304.0)*	580 *(304.4)*	590 *(304.0)*	200 *(93.3)*

Figure 15 ***- Processing temperatures for Celstran long fiber reinforced nylon PA6/6 materials.***

INJECTION SPEED: ***Approx. 2-3 in/s (50.8-76.2 mm)***

INJECTION PRESSURE: ***Medium to Maximum***

BACK PRESSURE: ***30-50 psi***

SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***

CYCLE TIME: ***Part dependent. Check for fully filled and packed out parts. A full molded part does not necessarily mean a "good" part.***

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

SPECIAL CONSIDERATIONS

Use a general purpose design nozzle tip. Do not use a tapered, or "nylon" tip.

Dry to 0.18% moisture content prior to molding.

Do not immerse PA66-10 (flame retardant) air purge materials in water.

2.9 Celstran Long Fiber Reinforced Nylon PA6 Materials

CHARACTERISTICS

Celstran long fiber reinforced nylon PA6 material is a crystalline engineering thermoplastic which is similar to nylon PA6/6 materials in toughness and strength, but with a slightly lower tolerance to heat. It flows more easily than nylon PA6/6, making complex part filling - especially in thin sections - easier. Its chemical resistance is mixed, with an excellent tolerance to alkali environments, but a poor candidate for most acid exposures. It has significantly higher mechanical properties than short glass reinforced nylon PA6, and is easy to process.

GRADES

Celstran long fiber reinforced nylon PA6 materials are currently available in 30%, 40%, 50%, and 60% glass fiber loadings in general purpose (01) or heat stabilized (03) resins. Carbon fiber reinforced grades are also available. **Celstran** carbon fiber reinforced nylon PA6 materials are available in flame retardant (-10) grade. **Molding processing requirements are identical for all grades.**

DRYING CONDITIONS

Celstran long fiber reinforced nylon PA6 materials should be dried for a minimum of 4 hr at 175 ˚F (79.5) ˚C). Note that the material can be over-dried and may discolor.

START-UP CONDITIONS

The following table (fig. 16) shows the preferred processing temperatures for **Celstran** long fiber reinforced nylon PA6 materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

PROCESSING TEMPERATURES±10 ˚F *(±5.55 ˚C)*						
MATERIAL GRADE:	REAR ZONE	CENTER ZONE	FRONT ZONE	NOZZLE	MELT	MOLD
PA6-GF30-01	500 *(260.0)*	510 *(265.5)*	520 *(271.1)*	520 *(271.1)*	520 *(271.1)*	200 *(93.3)*
PA6-GF40-01	510 *(265.5)*	520 *(271.1)*	530 *(276.6)*	530 *(276.6)*	530 *(276.6)*	200 *(93.3)*
PA6-GF50-01	520 *(271.1)*	530 *(276.6)*	540 *(282.2)*	540 *(282.2)*	540 *(282.2)*	200 *(93.3)*
PA6-GF60-01	530 *(276.6)*	540 *(282.2)*	550 *(287.8)*	550 *(287.8)*	550 *(287.8)*	200 *(93.3)*

Figure 16 ***- Processing temperatures for Celstran long fiber reinforced nylon PA6 materials.***

INJECTION SPEED: ***Approx. 2-3 in/s (50.8-76.2 mm)***

INJECTION PRESSURE: ***Medium to Maximum***

BACK PRESSURE: ***30-50 psi***

SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***

CYCLE TIME: ***Part dependent. Check for fully filled and packed out parts. A full molded part does not necessarily mean a "good" part.***

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

SPECIAL CONSIDERATIONS

Use a general purpose design nozzle tip. Do not use a tapered or "nylon" tip.

Dry to 0.18% moisture content prior to molding.

Do not immerse PA6-10 (flame retardant) air purge materials in water.

2.10 Celstran Long Fiber Reinforced Polypropylene (PP) Materials

CHARACTERISTICS

Celstran long fiber reinforced PP material is a crystalline engineering thermoplastic offering a lower-cost material comparable to short glass reinforced nylon in appropriate temperature applications but with much higher impact strength. It can be used as a replacement for glass in mat thermoplastic sheet (GMT) applications, offering design, processing, and cost advantages.

GRADES

Celstran long fiber reinforced PP materials are currently available in 30%, 40%, and 50% glass fiber loadings. **Celstran** PP materials are manufactured with four resin grades: chemically-coupled PP (02), chemically-coupled and heat stabilized PP (03), high-performance (09), and easy flow (10). **Molding processing requirements are identical for all grades.**

DRYING CONDITIONS

Celstran long fiber reinforced PP should be dried for a minimum of 2 hr at 200 ˚F (93.3 ˚C).

START-UP CONDITIONS

The following table (fig. 17) shows the preferred processing temperatures for **Celstran** long fiber reinforced PP materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

***PROCESSING TEMPERATURES±10 ˚F** (±5.55 ˚C)*						
MATERIAL GRADE:	REAR ZONE	CENTER ZONE	FRONT ZONE	NOZZLE	MELT	MOLD
PP-GF30-02	390 *(198.9)*	400 *(204.4)*	410 *(210.0)*	400 *(204.4)*	410 *(210.0)*	150 *(65.5)*
PP-GF40-02	400 *(204.4)*	410 *(210.0)*	420 *(215.5)*	410 *(210.0)*	420 *(215.5)*	150 *(65.5)*
PP-GF50-02	410 *(210.0)*	420 *(215.5)*	430 *(221.1)*	420 *(215.5)*	430 *(221.1)*	150 *(65.5)*

Figure 17 ***- Processing temperatures for Celstran long fiber reinforced polypropylene materials.***

INJECTION SPEED: ***Approx. 2 in/s (50.8 mm)***

INJECTION PRESSURE: ***Low to Medium***

BACK PRESSURE: ***30-50 psi***

SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***

CYCLE TIME: ***Part dependent. Check for fully filled and packed out parts. A full molded part does not necessarily mean a "good" part.***

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

2.11 Celstran Long Fiber Reinforced Thermoplastic Polyurethane (TPU) Materials

CHARACTERISTICS

Celstran long fiber reinforced TPU material is an amorphous engineering thermoplastic with crystalline-like properties. It has very high impact strength, excellent chemical resistance, good abrasion resistance, good dimensional stability, and very low moisture absorption. It can be molded into complex parts with good surface finish and is well-suited to a variety of demanding applications in challenging environments.

GRADES

Celstran long fiber reinforced TPU materials are available in two grades: standard TPU (01) and heat stabilized TPU (04). TPU (04) grades are currently available only in 40% and 60% glass loadings. Heat stabilized TPU (04) exhibits a Tg approximately 80 ˚F (26.7 ˚C), greater than that used in the standard TPU (01) grade. The 04 grade will dry and process differently. Please see drying and processing sections.

DRYING CONDITIONS

Celstran long fiber reinforced TPU (01) should be dried a minimum of 4 hr at 175 ˚F (79.4 ˚C). Heat stabilized TPU (04) requires at least 4 hr at 250 ˚F (121.1 ˚C). A dryer with an after-cooler is preferred. The return air from the dryer hopper to the desiccating unit should be below 130 ˚F (54.4 ˚C). The desiccant cannot remove moisture at higher air temperatures, because it is, in effect, constantly regenerating. If the return air is above 150 ˚F (65.5 ˚C), there will be no drying. Moisture analysis should be done prior to molding all grades of TPU and should not exceed 0.02%. Note that if TPU is over-dried, it may discolor and will be difficult to process.

START-UP CONDITIONS

The following table (fig. 18) shows the preferred processing temperatures for **Celstran** long fiber reinforced TPU materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

***PROCESSING TEMPERATURES±10 ˚F** (±5.55 ˚C)*						
MATERIAL GRADE:	REAR ZONE	CENTER ZONE	FRONT ZONE	NOZZLE	MELT	MOLD
TPU-GF30-01	460 *(237.8)*	470 *(243.3)*	480 *(248.9)*	470 *(243.3)*	480 *(248.9)*	160 *(71.1)*
TPU-GF40-01	470 *(243.3)*	480 *(248.9)*	490 *(254.4)*	480 *(248.9)*	490 *(254.4)*	160 *(71.1)*
TPU-GF50-01	480 *(248.9)*	490 *(254.4)*	500 *(260.0)*	490 *(254.4)*	500 *(260.0)*	160 *(71.1)*
TPU-GF60-01	490 *(254.4)*	500 *(260.0)*	510 *(265.5)*	500 *(260.0)*	510 *(265.5)*	160 *(71.1)*
HIGH HEAT GRADES:						
TPU-GF40-04	490 *(254.4)*	500 *(260.0)*	510 *(265.5)*	500 *(260.0)*	510 *(265.5)*	225 *(107.2)*
TPU-GF60-04	500 *(260.0)*	510 *(265.5)*	520 *(271.1)*	510 *(265.5)*	520 *(271.1)*	225 *(107.2)*

Figure 18 ***- Processing temperatures for Celstran long fiber reinforced polyurethane TPU materials.***

INJECTION SPEED: ***Approx. 2 in/s (50.8 mm)***
INJECTION PRESSURE: ***Medium to Maximum***
BACK PRESSURE: ***30-50 psi***
SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***
CYCLE TIME: ***Part dependent. Check for fully filled and packed out parts. A full molded part does not necessarily mean a “good” part.***

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

SPECIAL CONSIDERATIONS

Melt temperature should not exceed 520 ˚F (271.1 ˚C).

If the drying unit has no after-cooler, dry TPU-04 material for 6-8 hr at 180 ˚F (82.2 ˚C).

Dry to 0.02% moisture content prior to molding.

Over-drying will lead to processing difficulties.

2.12 Celstran Long Fiber Reinforced Polyphenylene sulfide (PPS) Materials

CHARACTERISTICS

Celstran long fiber reinforced PPS material is a crystalline engineering thermoplastic with excellent high temperature performance and chemical resistance combined with inherent flame resistance, excellent mechanical properties, and excellent dimensional stability. It is generally used in applications that take advantage of its high temperature and/or its corrosive environment tolerance. This material can be easily molded into thin wall sections.

GRADES

Celstran long fiber reinforced PPS materials are currently available in 40% and 50% glass fiber loadings. Carbon fiber reinforced grades are also available.

DRYING CONDITIONS

Celstran long fiber reinforced PPS should be dried for a minimum of 4 hr at 270 ˚F (132.2 ˚C). The use of an after-cooler may be necessary. Please see: DRYING CONDITIONS for PU materials (p. 16). Note that the material can be over-dried and may discolor.

START-UP CONDITIONS

The following table (fig. 19) shows the preferred processing temperatures for **Celstran** long fiber reinforced PPS materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

***PROCESSING TEMPERATURES±10 ˚F** (±5.55 ˚C)*						
MATERIAL GRADE:	REAR ZONE	CENTER ZONE	FRONT ZONE	NOZZLE	MELT	MOLD
PPS-GF40-01	570 *(298.9)*	580 *(304.4)*	590 *(310.0)*	570 *(298.9)*	590 *(310.0)*	300 *(148.9)*
PPS-GF50-01	580 *(304.4)*	590 *(310.0)*	600 *(315.5)*	580 *(304.4)*	600 *(315.5)*	300 *(148.9)*

Figure 19 - ***Processing temperatures for Celstran long fiber reinforced PPS materials.***

INJECTION SPEED: ***Approx. 2 in/s (50.8 mm)***

INJECTION PRESSURE: ***Medium to Maximum***

BACK PRESSURE: ***30-50 psi***

SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***

CYCLE TIME: ***Part dependent. Check for fully filled and packed out parts. A full molded part does not necessarily mean a "good" part.***

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

SPECIAL CONSIDERATIONS

Due to highly crystalline structure of the PPS polymer, it is important to follow the preferred mold and melt temperatures to maintain its mechanical properties. Residence times of more than three minutes may lead to polymer degradation.

Dry PPS material to 0.02% moisture content prior to molding.

Oil or electric mold heaters are necessary to maintain mold temperatures with PPS materials.

2.13 Celstran Long Fiber Reinforced Acetal (POM) Materials

CHARACTERISTICS

Celstran long fiber reinforced acetal material is a crystalline engineering thermoplastic with high strength, stiffness, and toughness over a broad range of conditions. It has exceptional dimensional stability, good abrasion resistance, inherent lubricity, low creep at elevated temperatures, and good corrosion resistance. It has excellent processing characteristics and is easily molded into thin sections. **Celstran** acetal materials are often used as concentrates to improve the impact or wear properties of unfilled acetal.

GRADES

Celstran long fiber reinforced acetal materials are currently available in 40% glass fiber loading . Aramid reinforced grades are also available.

DRYING CONDITIONS

Celstran long fiber reinforced acetal should be dried for a minimum of 3 hr at 180 ˚F (82.2 ˚C). Note that the material can be over-dried and may discolor.

START-UP CONDITIONS

The following table (fig. 20) shows the preferred processing temperatures for **Celstran** long fiber reinforced acetal materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

***PROCESSING TEMPERATURES±10 ˚F** (±5.55 ˚C)*

MATERIAL GRADE:	REAR ZONE	CENTER ZONE	FRONT ZONE	NOZZLE	MELT	MOLD
POM-GF40-01	380 *(193.3)*	390 *(198.9)*	400 *(204.4)*	400 *(204.4)*	400 *(204.4)*	180 *(82.2)*
Blend (13% glass)	370 *(187.8)*	380 *(193.3)*	390 *(198.9)*	390 *(198.9)*	390 *(198.9)*	180 *(82.2)*
Blend (25% glass)	375 *(190.6)*	385 *(196.1)*	395 *(201.7)*	395 *(201.7)*	395 *(201.7)*	180 *(82.2)*

Figure 20 ***- Processing temperatures for Celstran long fiber reinforced acetal materials.***

INJECTION SPEED: ***Approx. 2 in/s (50.8 mm)***

INJECTION PRESSURE: ***Low to Medium***

BACK PRESSURE: ***30-50 psi***

SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***

CYCLE TIME: ***Part dependent. Check for fully filled and packed out parts. A full molded part does not necessarily mean a “good” part.***

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

SPECIAL CONSIDERATIONS

See MSDS for **Celstran** long fiber reinforced acetal (POM) materials for detailed safety information (accompanying each shipment and available on request from manufacturer).

Do not heat material to temperatures above 460 ˚F (240 ˚C). Do not allow material to remain over 5 minutes in heating cylinder of the machine at temperatures of 380 ˚F (193 ˚C) and above without molding or purging.

If overheating is observed or suspected, reduce the cylinder temperature and purge the material into a bucket of water to cool it and minimize fumes. Stay clear of the nozzle and the machine hopper as much as possible. Use a face shield, safety glasses and gloves. When purging, vent the molding area to adequately remove fumes - which include formaldehyde.

Always purge machine thoroughly before and after using any acetal materials.

Never process acetal materials where they may come in contact with polyvinyl chloride (PVC) materials.

When using blended materials, special care should be taken to avoid segregation in the feed hopper.

2.14 Celstran Long Fiber Reinforced Polyethylene Terephthalate (PET) Materials

CHARACTERISTICS

Celstran long fiber reinforced PET material is a crystalline engineering thermoplastic with high strength, stiffness, low creep at elevated temperatures, exceptional dimensional stability, and resistance to a wide range of chemical attack. Unlike unreinforced or short fiber reinforced PET, it has very high impact strength.

Celstran PET is often used as a concentrate, blended with either “neat” virgin or recycled PET. Blending significantly increases strength, impact, stiffness, and deflection temperature under load (DTUL) properties.

GRADES

Celstran long fiber reinforced PET material is currently available in 50% glass fiber loading (black only), in the standard grade (01), and 40% glass fiber loading with a nucleated resin grade (02).

DRYING CONDITIONS

Celstran long fiber reinforced PET should be dried for a minimum of 4 hr at 300 ˚F (148.9 ˚C).

START-UP CONDITIONS

The following table (fig. 21) shows the preferred processing temperatures for **Celstran** long fiber reinforced PET materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

***PROCESSING TEMPERATURES±10 ˚F** (±5.55 ˚C)*						
MATERIAL GRADE:	**REAR ZONE**	**CENTER ZONE**	**FRONT ZONE**	**NOZZLE**	**MELT**	**MOLD**
PET-GF40-02	530 *(276.7)*	540 *(282.2)*	550 *(287.8)*	540 *(282.2)*	550 *(287.8)*	300 *(148.9)*
PET-GF50-01	520 *(271.1)*	530 *(276.6)*	540 *(282.2)*	530 *(276.6)*	540 *(282.2)*	300 *(148.9)*

Figure 21 ***- Processing temperatures for Celstran long fiber reinforced PET materials.***

INJECTION SPEED: ***Approx. 2 in/s (50.8 mm)***

INJECTION PRESSURE: ***Low to Medium***

BACK PRESSURE: ***30-50 psi***

SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***

CYCLE TIME: ***Part dependent. Check for fully filled and packed out parts.***
A full molded part does not necessarily mean a “good” part.

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

SPECIAL CONSIDERATIONS

Close adherence to mold temperatures is essential to retain the high level of crystallinity (and therefore the structural properties) of the PET polymer. Oil or electric mold heaters are necessary to maintain mold temperatures.

Moisture content is critical with PET materials. The maximum preferred moisture level is 0.015%.

When using blended materials, special care should be taken to prevent segregation in the feed hopper.

2.15 Celstran Long Fiber Reinforced Polyethylene (PEHD) Materials

CHARACTERISTICS

Celstran long fiber reinforced PEHD material is a crystalline engineering thermoplastic with a high glass fiber loading. It is typically used as a concentrate, blended with either "neat" virgin or recycled PEHD. Blending offers significantly increased strength, stiffness, and dimensional stability over unreinforced PEHD.

BLOW MOLDING - Another use for **Celstran** concentrate is blending with "neat" PEHD to increase the melt stiffness of the parison. As with injection molded parts, the stiffness and strength properties of the finished blow-molded part are also improved. The additional stiffness allows parts to be ejected from the machine earlier than with unreinforced parts. This reduces cycling times, speeds production, and can offer cost savings if fixturing can be eliminated.

GRADES

Celstran long fiber reinforced PEHD material is currently available in 60% glass fiber loading.

DRYING CONDITIONS

Celstran long fiber reinforced PEHD should be dried for a minimum of 2 hr at 200 ˚F (93.3 ˚C).

START-UP CONDITIONS

The following table (fig. 22) shows the preferred processing temperatures for **Celstran** long fiber reinforced PEHD materials. **To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity:**

PROCESSING TEMPERATURES±10 ˚F *(±5.55 ˚C)*						
MATERIAL GRADE:	**REAR ZONE**	**CENTER ZONE**	**FRONT ZONE**	**NOZZLE**	**MELT**	**MOLD**
PEHD-GF60-01	400 *(204.4)*	405 *(207.2)*	410 *(210.0)*	400 *(204.4)*	410 *(210.0)*	150 *(212.4)*
Blend (5% glass)	375 *(190.6)*	380 *(193.3)*	385 *(196.1)*	375 *(190.6)*	385 *(196.1)*	150 *(212.4)*
Blend (10% glass)	375 *(190.6)*	380 *(193.3)*	385 *(196.1)*	375 *(190.6)*	385 *(196.1)*	150 *(212.4)*
Blend (20% glass)	385 *(196.1)*	390 *(198.9)*	395 *(201.7)*	385 *(196.1)*	395 *(201.7)*	150 *(212.4)*
Blend (30% glass)	385 *(196.1)*	390 *(198.9)*	395 *(201.7)*	385 *(196.1)*	395 *(201.7)*	150 *(212.4)*

Figure 22 ***- Processing temperatures for Celstran long fiber reinforced polyethylene (PEHD) materials.***

INJECTION SPEED: ***Approx. 2 in/s (50.8 mm)***

INJECTION PRESSURE: ***Low to Medium***

BACK PRESSURE: ***30-50 psi***

SCREW SPEED: ***30-50 rpm***

CUSHION/PAD: ***1/4 in (6.35 mm)***

CYCLE TIME: ***Part dependent. Check for fully filled and packed out part.***
A full molded part does not necessarily mean a "good" part.

Mold temperatures should be verified with a pyrometer.

After the machine temperatures are stabilized, and after purge shots (2-10, depending on machine size), readjust for proper melt temperature.

SPECIAL CONSIDERATIONS

When using blended materials, special care should be taken to prevent segregation in the feed hopper.

2.16 Preferred Shutdown

When a machine is being shut down from molding **Celstran** long fiber reinforced materials, the machine should be purged with polyethylene or polypropylene. When the heating cylinder is completely purged of **Celstran** material the machine may be shut down.

2.17 Safety Precautions for Molding Celstran Materials

For the safety of all personnel involved in the molding area, the following safety precautions should be followed when **Celstran** long fiber reinforced materials are being molded:

1. *Safety glasses should be worn by all personnel in the molding area.*
2. *Overheating (usually caused by excessive temperatures or holdup times) should be avoided.*
3. *The molding machine should not be left unattended. If molding is to be stopped for more than a few minutes, the machine should be purged with production material to prevent degradation of the material standing in the barrel, or if a further delay occurs, the shutdown procedures described in Section 2.16 should be followed.*
4. *The Material Safety Data Sheets (MSDS) should be studied carefully by all molding personnel.*
5. *Purging can create fumes. To minimize human exposure and properly limit environmental release, appropriate venting systems should be used. For most materials, immediate quenching of purged materials in water (with adequate precautions to avoid steam burns) will minimize fuming into the environment.* ***Do not immerse PA6/PA66-10 (flame retardant) air purge materials in water.***
6. *To the best of our knowledge the information contained in this publication is accurate; however, we do not assume any liability whatsoever for the accuracy or completeness of such information. Moreover, there is a need to reduce human exposure to many materials to the lowest practical limits in view of possible long-term adverse effects. To the extent that any hazards may have been mentioned in this publication, we neither suggest nor guarantee that such hazards are the only ones which exist. We recommend that anyone intending to rely on any recommendation or to use any equipment, processing technique, or material mentioned in this publication should satisfy himself that he can meet all applicable safety and health standards. We strongly recommend that users seek and adhere to the manufacturer's or supplier's current instructions for handling each material they use. Infringement of any patents is the sole responsibility of the user.*

Chapter 3
Troubleshooting Guide

Many processing problems are caused by easily corrected conditions, such as inadequate drying, incorrect temperatures and/or pressures, etc.

The solutions given in the following pages should be tried in the order in which they are listed. They are prioritized according to their simplicity, cost, and/or time savings, depending on the problem. Such changes can very easily improve a molder's productivity and efficiency.

3.1 Fiber Length Degradation

The key to Celstran materials' high performance in finished parts is the retention of fiber length throughout processing. Typical visual evaluation of parts when using Celstran materials is inconclusive for determining final fiber length. The best method for showing fiber lengths in finished parts is to burn away the resin in a suitable muffle furnace and visually examine the fibers. Another, less precise method, preferred by some molders for its speed, is to burn away the resin with a hand-held torch (with adequate ventilation).

Because of the length and high fiber content of Celstran materials, the remaining fibers will be densely interwoven, largely retaining the original part's shape. This fiber structure is called a "burn-off". The burn-off, in addition to indicating the overall final fiber lengths, is also useful in showing how efficiently the material fills the part in potentially difficult areas, i.e., thin sections or other constricted flow demands. Any extraordinary breakage of fibers in such areas may indicate a problem requiring a processing change to improve material flow. Extreme cases of fiber breakage that cannot be remedied by processing changes indicate that mold or part design modifications may be necessary.

3.2 Short Shots, Pit Marks, and Surface Ripples

(These problems indicate that the part is not being packed out or that there is leaking through the check ring.)

SOLUTIONS: ***Check for a proper cushion and increase/decrease feed if necessary.***
Increase the injection pressure.
Increase the injection speed.
Increase the booster time.
Increase the melt temperature by raising the cylinder temperature(s).
Raise the mold temperature.
Check the cavity vents for blockage (trapped gas prevents the part from being filled).
Increase the size of the sprue/runners/gates.

3.3 Flashing

SOLUTIONS: ***Check mold for obstructions.***
Decrease injection pressure/speed.
Decrease injection hold time/booster time.
Reduce the material temperature.
Check to see that the mold is closed and clamped properly.
Check parting line of mold for wear.
Check the press platens for parallelism (i.e., lack of parallelism between platens).
Move the mold to a larger (clamp) press.

3.4 Splay Marks, Silver Steaks, & Splash Marks

(Some materials do not show these symptoms, even though the molding conditions are not proper, e.g., PBT [polyester]).

SOLUTIONS: ***Dry the material before use.***
Check for contamination.
Check for drooling.
Lower the nozzle temperature.
Raise the mold temperature.
Decrease the injection speed.
Reduce the material temperature.
Shorten the overall cycle time.
Open the gate(s).

3.5 Nozzle Problems

NOZZLE DROOL

SOLUTIONS: *Lower the nozzle temperature.*
Increase the decompression time.
Reduce the material temperature.
Reduce the back pressure.
Decrease the mold open time.
Dry the material.

NOZZLE FREEZE-OFF

SOLUTIONS: *Increase the nozzle temperature.*
Decrease the cycle time.
Increase the mold temperature.
Use a nozzle with a larger orifice.

3.6 Discoloration

(As expected, this problem is very difficult to discern with black or darkly colored materials.)

SOLUTIONS: *Check screw and barrel temperature.*
Purge the heating cylinder.
Reduce the material temperature.
Lower the nozzle temperature.
Shorten the overall cycle time.
Check the hopper and feed zone for contamination.
Move the mold to a press with a smaller shot size.
Provide additional vents in the mold.

3.7 Burn Marks

SOLUTIONS: *Decrease the injection speed.*
Decrease the booster time.
Increase the venting in the mold cavity.
Alter the position of the gate.
Increase the gate size.
Check the melt temperature.

3.8 Sticking Problems

STICKING IN THE CAVITY

SOLUTIONS: *Decrease the injection pressure.*
Decrease the injection speed.
Decrease the booster time.
Decrease the injection hold time.
Increase the mold close time.
Lower the mold temperature.
Decrease the cylinder and nozzle temperature.
Check the mold for undercuts and/or insufficient draft.

STICKING ON THE CORE

SOLUTIONS: *Increase the injection pressure.*
Increase the booster time.
Increase the injection speed.
Decrease the mold close time.
Decrease the core temperature.
Check the mold for undercuts and/or insufficient draft.

STICKING IN THE SPRUE BUSHING

SOLUTIONS: *Check the sizes and alignment of the holes in the nozzle/sprue bushing.*
Decrease the injection pressure.
Decrease the injection hold time.
Increase the mold close time.
Increase the nozzle temperature.
Provide a more effective sprue puller.
Check sprue bushing for wear, undercuts or any abrasions

3.9 Weld Lines

SOLUTIONS:
Increase the mold temperature.
Increase the material temperature by raising the cylinder temperature settings.
Vent the cavity in the weld area.
Increase the injection pressure.
Increase the injection hold time.
Increase the injection speed.
Provide an overflow well adjacent to the weld area.
Change the gate location to improve the flow pattern.

3.10 Sinks and Voids

SOLUTIONS:
Increase the injection pressure. (for sinks)
Decrease the injection speed. (for voids)
Increase the hold time.
Use a booster and a maximum injection speed.
Raise the mold temperature. (do this only with voids)
Lower the mold temperature. (do this only with sinks)
Decrease the cushion/pad. (should be 1/8-1/4 in [3.18-6.35 mm])
Increase the size of the sprue/runners/gates.
Relocate the gates nearer the heavy sections.

3.11 Warpage and Part Distortion

SOLUTIONS:
Equalize the temperature in both halves of the mold. (eliminate hot spots)
Observe the mold for uniformity (or lack thereof) of part ejection.
Check for proper handling of parts after ejection.
Increase the injection hold time.
Increase or decrease the pressure as appropriate.
Reduce the mold temperature.
Increase the mold close time.
Reduce the material temperature.
Try differential mold temperatures to counteract warp.
Review the part design.
Use fixtures if neccesary

3.12 Brittleness

(This problem is especially important to control in PET [polyester] because brittleness indicates material degradation.)

SOLUTIONS:
Dry the material before use.
Check for contamination.
Reduce the material temperature.

3.13 Delamination

SOLUTIONS:
Check for and eliminate any contamination.
Raise the temperature of the mold and/or material.
Dry the material.
Increase the injection speed.
Purge the machine.

3.14 Poor Dimensional Control

SOLUTIONS:
Set a uniform cycle time.
Maintain a uniform feed/cushion from cycle to cycle.
Fill the mold as rapidly as possible.
Increase the gate size.
Balance the layout of the runners, gates, and cavity.
Reduce the number of cavities in the mold.
Add vents.
Check the machine's hydraulic and electrical systems for erratic performance.
Use fixtures if neccesary

3.15 Un-melted Pellets

SOLUTIONS:
Increase the melt temperature.
Dry/preheat the material.
Move the mold to a machine with a larger shot capacity.

NOTES

NOTES

Troubleshooting Check List

Ten Most Critical Factors for Preserving Fiber Length in Celstran Materials

1. **Screw Type and Design**
   General Purpose - Low Compression - Deep Flights

2. **3-piece Screw Tip Design**
   Deep Passages to Promote Free Flow - 100% Free-flow Check Ring

3. **Screw Rotation Speed & Back Pressure**
   Minimize in Range Indicated - Slow Speed - Low Pressure

4. **Temperature Control**
   Ensure Accuracy at All Points. To promote a homogeneous melt, it may be best to profile temperatures according to shot size and barrel capacity.

5. **Injection Speed & Pressure**
   Minimize in Range indicated

6. **Streamlined Flow**
   Clear of Obstructions

7. **Nozzle, Sprue, & Runner**
   Sizes and Shapes as Preferred

8. **Gate Size**
   Use Preferred Size and Range

9. **Drying**
   Follow Resins' Drying Conditions

10. **Regrind**
    5% or Less for Best Results

For optimum fiber length retention, all of these factors must be followed.

Celstran®

Ticona Customer Service

1-800-526-4960

www.celstran.com

Customer service is always close at hand. Call or visit our web site to obtain more information.

- The widest selection of long fiber reinforced thermoplastic materials
- Customer design support using CAD to optimize application performance with Celstran materials
- Application engineers providing value chain management from Celstran selection to molding support to end-use specification
- Sampling and technical service
- Marketing specialists to guide you through the process

Ticona

Ticona Celstran
4610 Theurer Boulevard
P.O. Box 30010
Winona, MN 55987
Phone: 1-507-454-4150
Fax: 1-507-457-4040

Ticona
90 Morris Avenue
Summit, NJ 07901
Customer Service
1-800-526-4960
Technical Information
1-800-833-4882
Fax: 1-908-598-4169

Ticona GmbH
D-65926 Frankfurt/Main
Germany
Phone: +49-69-305-4653
Fax: +49-69-305-26872