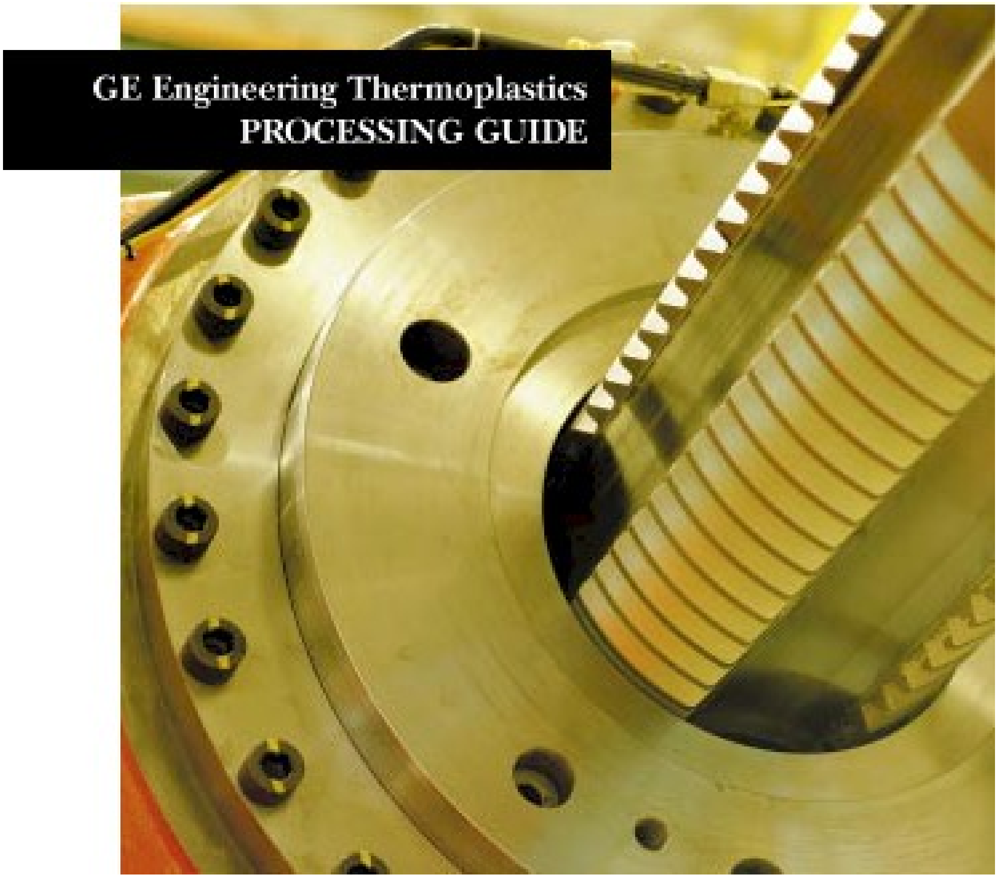
GE Plastics

# Cycolac* ABS Processing Guide




This acrylonitrile-butadiene-styrene (ABS) thermoplastic resin is widely recognized as an engineering material offering outstanding flow, toughness and dimensional stability and high temperatures. Specific CYCOLAC resin grades offer high-impact and flame-retardancy that meet regulatory and safety standards, as well as high gloss grades for aesthetic appeal.

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# Contents

## Material Description

CYCOLAC acrylonitrile-butadiene-styrene (ABS) thermoplastic resin is widely recognized as an engineering material offering a good balance of properties centering around toughness, hardness and rigidity. Resin grades in this product family consist of a blend of elastomeric component and an amorphous thermoplastic component. The elastomeric component is usually polybutadiene or a butadiene copolymer. The amorphous thermoplastic component is SAN: a copolymer of styrene and acrylonitrile.

New dimensions in processing latitude, adaptability to existing equipment, economics and desirable end-product characteristics are presented to the injection molder of CYCOLAC ABS resins. Consistent in composition and quality, dependable across the wide range of industrial conditions, this thermoplastic material incorporates the flexibility, and feasibility and assurance processors require to meet the sophistication and selectivity in marketplaces today.

Injection molded CYCOLAC resins offers a favorable price/performance relationship. Colors can also be matched to exacting requirements.

| Property | Characteristic | Typical Designations |
|---|---|---|
| Medium Impact | A group of products having high strength, high modulus, and high flow. | DFAR, AR, DSK, GPM6300, GDT6400, BDT6500 GPM5500, HP20(FDA). |
| High Impact | Products having high impact strength, and an excellent balance of properties. | T, GPM5600, HP30, (FDA Compliant). |
| Super Impact | Characterized by very high impact strength, good ductility at low temperatures, and very good hot strength. | GPM4700, GSM, L, GPT3800 |
| Flame Resistant | Flame resistant grades with good property balance. | KJB, KJU, KJW, SEA2, SEA2X, V100, VW55, VW300, VW300SP, GKX4500. |
| Electroplating | Designed for improved performance in plated applications. | EP, EPBM, ETC. |
| High Heat | Products designed to have higher deflection temperatures under load. | X11, X15, X17, X37, Z48 GHT4400, GHT3510, GHT4320 BDT5510,GDT2510. |

The following pages contain additional information on mold design and/or processing specific to CYCOLAC resin. Additional information on these subjects is included in Chapter 1 (Mold Design) and Chapter 2 (Processing) of the GE General Injection Molding Guide.

## Mold Types

Two or three plate molds are commonly used to mold components made from CYCOLAC resin depending on the part geometry, number of cavities and gating technique to be used.

Hot manifold systems can be used but require proper selection since not all types are satisfactory for molding CYCOLAC flame resistant resins. Please contact your local GE Plastics Technical Development Engineer for assistance or click onto GEP Live to contact us for more information.

Insulated Runner Molds are not suggested for use with CYCOLAC.

## Mold Materials

Standard P-20 or H-13 steel is generally preferred for CYCOLAC resins. Standardized components are suggested for ease of maintenance. Highly-polished core and cavity surfaces will help produce smooth, high-gloss parts. CYCOLAC resins are also outstanding in their reproduction of grained or textured surfaces. For improved part surface appearance and resistance to abrasion/corrosion of the tool, chrome or electroless nickel plating should be considered as an option.

## Sprues

The locator ring centers the sprue bushing on the stationary platen of the machine directly in line with the nozzle of the injection cylinder. The "O" dimension of the sprue bushing must be at least 1/32" (0.0794 cm) larger than the opening in the nozzle. Standard internal taper of the bushing is 1/2" (1.27 cm) per foot to facilitate removal of the plastic. Maximum length of the bushing should be 4" (10.16 cm). Matched radii of 1/2" (1.27 cm) or 3/4" (1.91 cm) must be used to help ensure proper seating. The internal channel must be smooth and highly polished.

Cold sprue bushings are relatively low cost, easy to install and generally require little maintenance. Heated sprue bushings, due to temperature control requirements, can also be considered, but you should work with your local GE Plastics Technical Development Engineer. The base of the sprue should have a generous cold slug well. The intersection with part or runner should have a minimum 1/16" (0.1588 cm) radius.

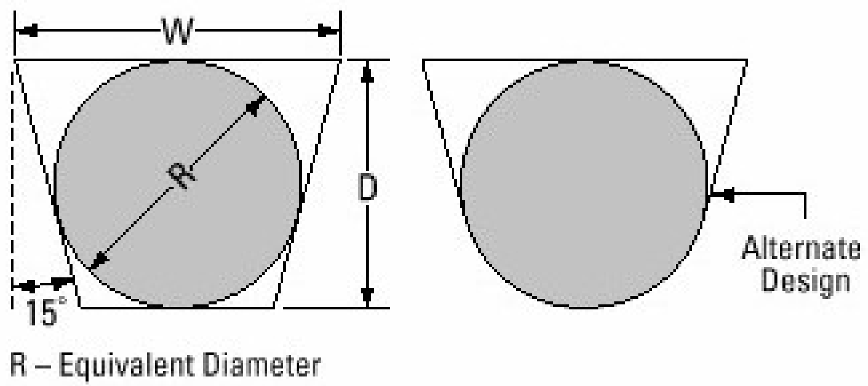
## Runners

Full-round, highly-polished runners will help provide optimum material flow and are preferred. In those instances where full-round runners are not practical, a trapezoidal runner can often be used. This type requires cutting only one mold surface. The volume of the trapezoid runner should be approximately the same as the full-round runner. Half or quarter round runners are not suggested (Table 3-1).

| Flow Length | Diameter |
|---|---|
| 10" (25.4 cm) | ⅜" (0.9525 cm) |
| 3 to 10" (7.62 to 25.4 cm) | 5⁄16" (0.7938 cm) |
| 3" (7.62 cm) or less | ¼" (0.635 cm) |
| Secondary Runner | ¼" (0.635 cm) |

Table 3-1. Flow Length

Cross sectional dimensioning of trapezoidal runners is shown in Figure 3-1




| R | W | D |
|---|---|---|
| 1/4" (0.635 cm) | 5/16" (0.7938 cm) | 1/4" (0.635 cm) |
| 5/16" (0.7938 cm) | 7/16" (1.1113 cm) | 5/16" (0.7938 cm) |
| 3/8" (0.9525 cm) | 1/2" (1.27 cm) | 3/8" (0.9525 cm) |

Figure 3-1. Trapezoidal Runners

# Gating

Most conventional gating techniques are acceptable with most CYCOLAC resins. Part geometry or appearance generally dictate gate location. It is preferable to locate the gate or gates as near as possible to the center of the part. Gating into the thickest section of the part is also desirable. Gates should be located in areas of minimal end-use stress in the part. All gates should be streamlined, generous in size and large enough to allow rapid filling of the cavity. Land length of the gate generally should not exceed 0.030" (0.076 cm).

Typical gating techniques, such as sprue, standard edge, tab and tunnel (submarine) are shown in Figures 3-2 through 3-5. Single- or multiple-tab gates can minimize jetting, gate blush or strain. Tabs should be 0.500" (1.27 cm) long ´ 0.375" (0.953 cm) wide with thickness variable up to part wall thickness. The gate should be located near the center of the tab.

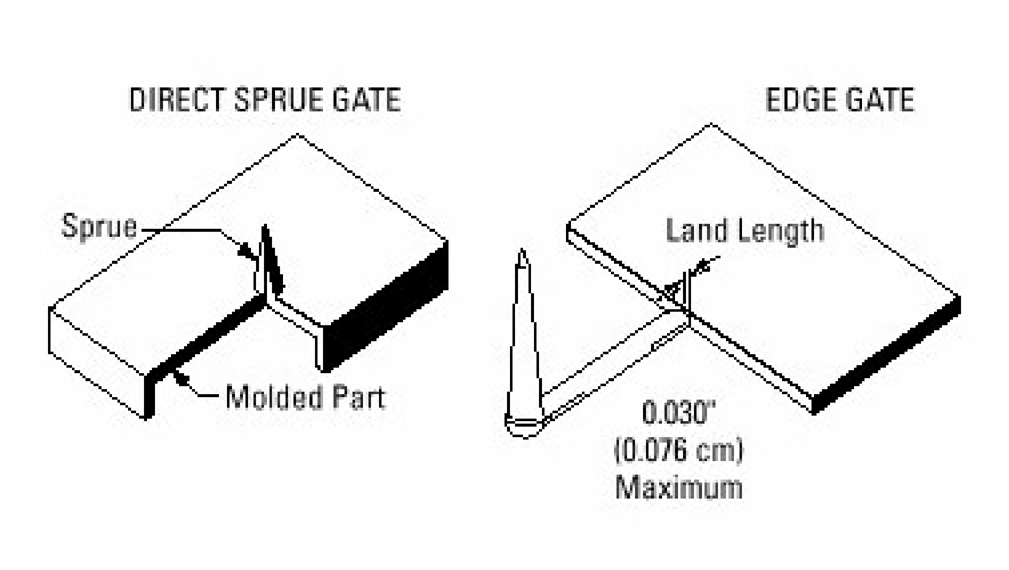



Figure 3-2. Sprue Gating.

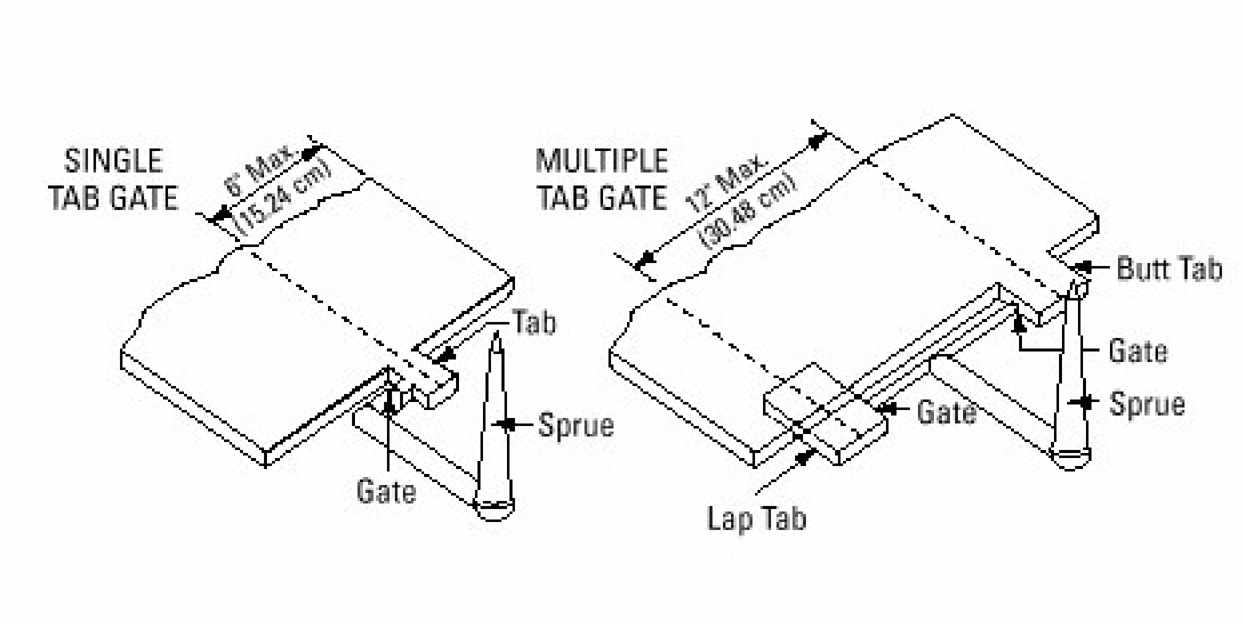



Figure 3-3. Tab Gating

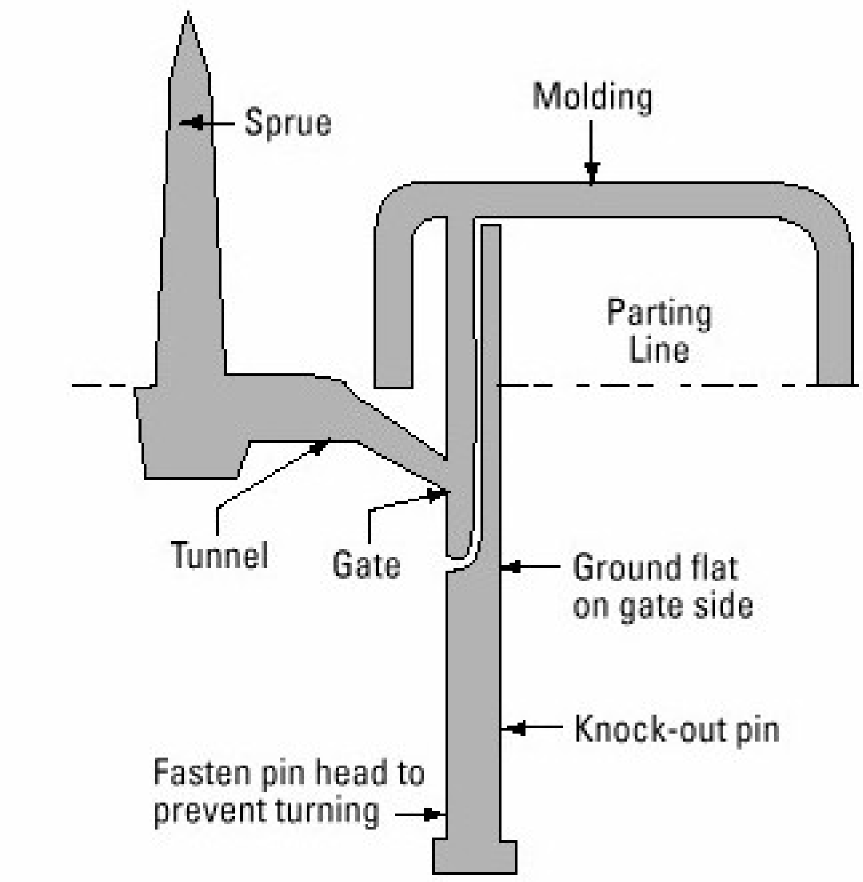



Figure 3-4. Tunnel Gating

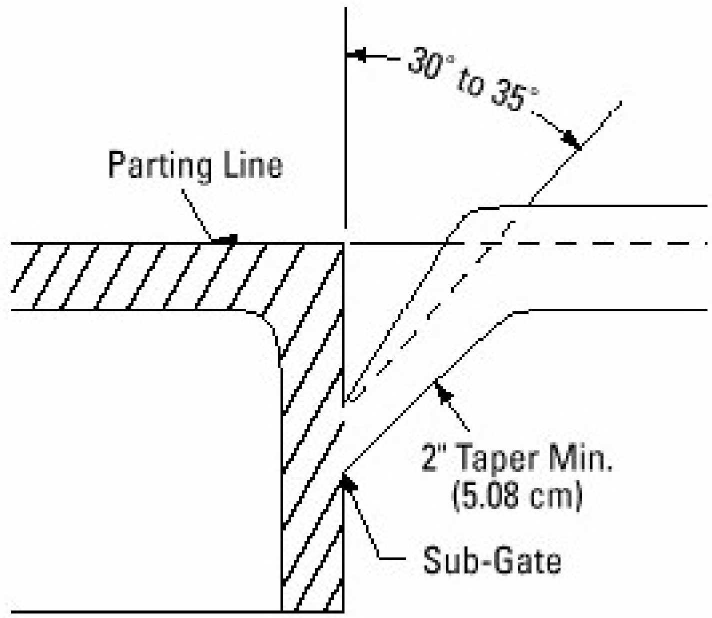



Figure 3-5. Tunnel Gate

## Cavity and Wall Taper

A minimum draft angle 0.5° is usually sufficient for adequate part release. Mold polishing should be in the direction of part ejection (draw polish) in cases of deep ribs or minimum draft. Side wall texturing will typically require additional draft of 1° per 0.001" (0.025 mm) texture depth.

## Venting

Adequate venting is important to help ensure complete evacuation of melt gases and entrapped cavity air. Several techniques commonly used are illustrated in Figures 3-6 and 3-7. Type and location are normally dictated by part geometry, parting line configuration and melt flow path.

Conventional parting line vents in Figure 3-6 should be 0.002 to 0.0025" (0.051 to 0.0635 mm) deep and up to 0.5" (1.27 cm) wide with a land of 0.090 to 0.100" (0.229 to 0.254 cm) and further increased to 0.025" (0.064 cm) or greater as it vents to atmosphere. The pattern and spacing should promote complete venting.

Continuous venting can be accomplished by cutting an 1/8" (0.3175 cm) half-round groove into the mold as shown in Figure 3-7. This permits air to escape rapidly out of the mold through the short lands and large grooves.

Flats ground on knock-out pins can serve effectively as vent areas. Normally 0.002" (0.051 mm) flats are ground on both sides.

Core pins and sleeves can function as vents. As with knock-out pins, the moving action tends to make them self-cleaning.

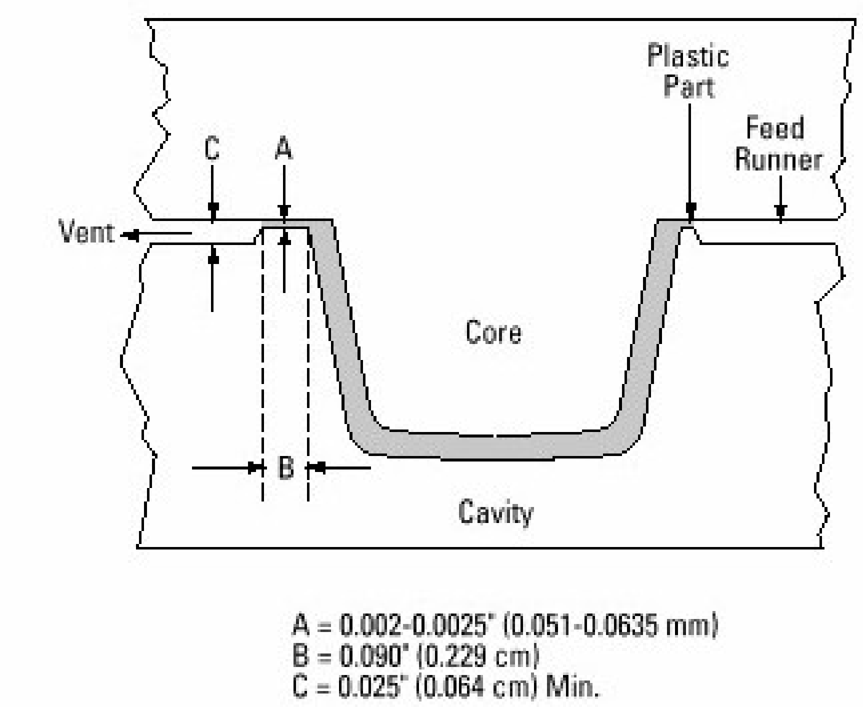



**Figure 3-6. Conventional Parting Line vent.**

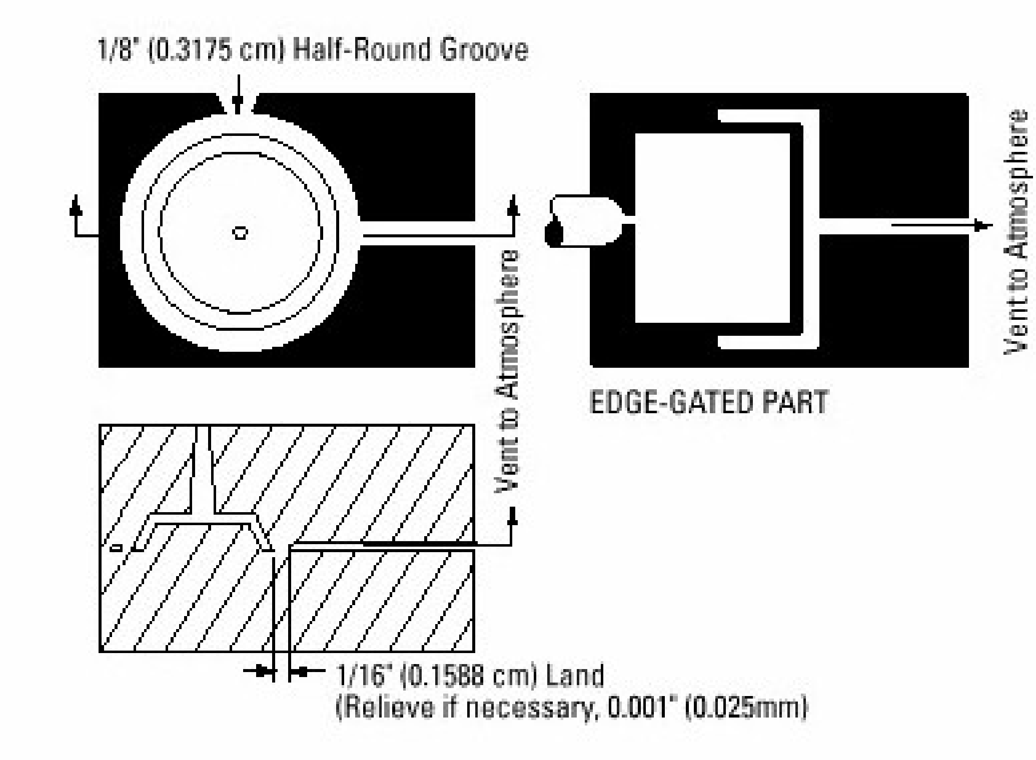



**Figure3-7. Continuous Venting Techniques.**

# Mold Temperature Control

Adequate temperature control of the core and cavity surfaces is important for producing quality parts. Dual zone or separate controllers are generally required for independent temperature control of the two mold halves. Recommended cooling channel dimensions are indicted in Figure 3-8.

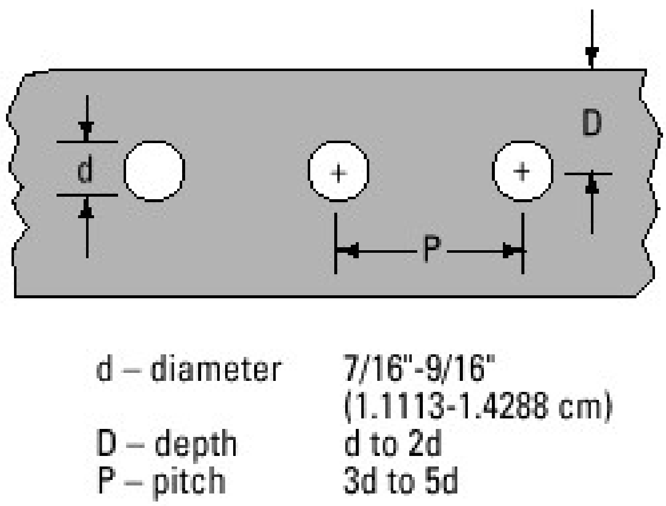



**Figure 3-8. Cooling Channel Dimensions.**

Other temperature control devices such as Logic Seal * , Thermal Pins * or bubblers can be used to aid temperature control in difficult-to-access areas.

Proper temperature control will help provide uniform heat across the tool surface. Therefore, looping of the cooling channels as shown in Figure 3-9 is not recommended practice. Water manifolds offer better control.

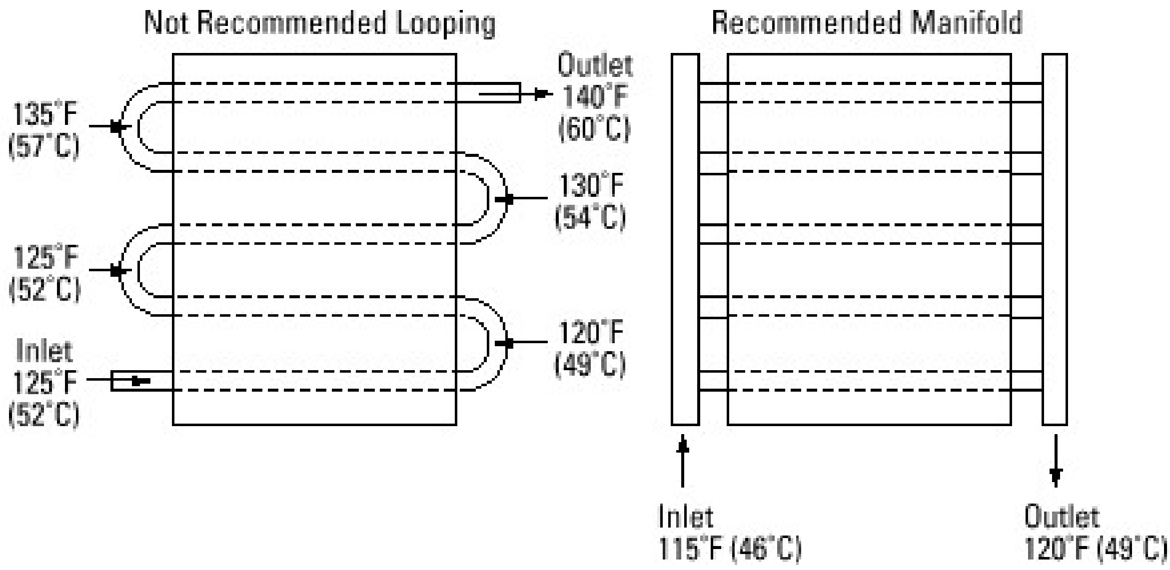



**Figure 3-9. Cooling Channels**

A large temperature differential across the mold surface creates different cooling rates and can result in molded-in stresses in the parts. For the same reason it is not generally practical to maintain more than a 40°F (22°C) difference between the core and cavity halves of the mold.

A typical mold surface for CYCOLAC flame-resistant resin is 120°F (60°C) for the cavity side. Cold molds are not recom-mended, as they can reduce flow, increase molded-in stress and may promote mold build-up deposits.

* Logic Seal is a Registered Trademark of Logic Devices, Inc. * Thermal Pins is a Registered Trademark of Noren Products, Inc.

# Equipment

CYCOLAC ABS resins have strong processing characteristics and were especially designed for injection molding. However, these resins like all thermoplastic materials , have an upper thermal window or limit and should be processed according to suggested guidelines. This is especially true with CYCOLAC flame-resistant resins which have outstanding processing characteristics, but must have proper temperature control within the latitudes specific for each grade. Temperatures in excess of those recommended could result in the release of noxious and corrosive vapors which could cause mold and equipment corrosion. It is important that machinery, processing parameters and molds be utilized under conditions which give excellent temperature control, minimizing shear heat, material hang-up and resistance to flow. Always remember that no guideline can substitute for appropriate end-use environment testing of finished part.

Standard P-20 or H-13 steel is generally preferred for CYCOLAC resins. Standardized components are suggested for ease of maintenance. Highly-polished core and cavity surfaces will help produce smooth, high-gloss parts. CYCOLAC resins are also outstanding in their reproduction of grained or textured surfaces. For improved part surface appearance and resistance to abrasion/corrosion of the tool, chrome or electroless nickel plating should be considered as an option.

### Machine Selection

# Screw Design

Because of the relatively high viscosity of the melt at processing temperature, screws with a compresby flight depth are suggested as follows:

CYCOLAC flame-resistant resins – 2.0:1 to 2.5:1

Standard CYCOLAC resins – 2.0:1 to 3.0:1

Standard "general-purpose" screws from different machine vendors vary sig-nificantly in flight depths and compression ratios for a given size, but those with sufficiently deep meter sections usually provide adequate melt-temperature control. Screws with L/D Ratios of 20:1 are preferred. Shorter screws can sacrifice melt homogeneity or output rate because the transition sections are too severe and lead can to material degradation and discoloration.

High compression/shallow flighted screws with restrictive non-return valves can be expected to produce melt temperatures in excess of actual set temperatures. Melt temperature should be measured and controlled by hand pyrometer checks of on-cycle air shots.

GE Plastics can provide information regarding a concept in injection molding screw design, a zero meter or constant transition screw, as illustrated in Figure 3-10. This design has worked well in processing many CYCOLAC resins as well as other types of thermoplastics. It provides outstanding melt temperature control and helps eliminate melt-temperature override. Table 3-2 gives flight dimensions for Zero-Meter screws of various diameters. Contact your local GE Plastics Technical Development Engineer or click onto GEP Live to contact us for more information.

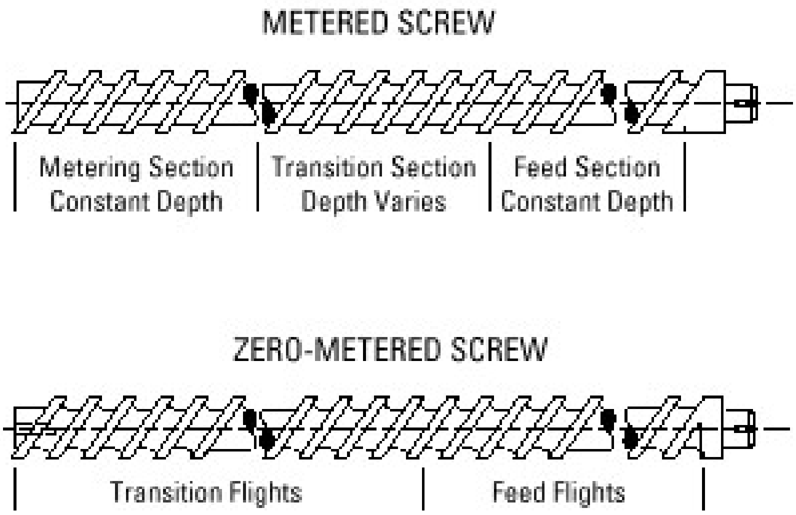



**Figure 3-10. Screw Designs.**

| Screw Diameter (in.) | Feed Depth (in.) | Front Depth (in.) | Compression Ratio (in.) |
|---|---|---|---|
| 1 | .240 | .120 | 2 |
| 1 1/4 | .270 | .132 | 2.04 |
| 1 1/2 | .297 | .142 | 2.08 |
| 1 3/4 | .317 | .150 | 2.1 |
| 2 | .340 | .157 | 2.16 |
| 2 1/2 | .384 | .170 | 2.26 |
| 3 | .420 | .181 | 2.32 |
| 3 1/2 | .450 | .187 | 2.4 |
| 3 3/4 | .465 | .190 | 2.45 |
| 4 | .480 | .193 | 2.48 |
| 4 1/2 | .510 | .199 | 2.56 |
| 5 | .537 | .203 | 2.65 |
| 5 1/4 | .550 | .205 | 2.68 |
| 6 | .595 | .210 | 2.81 |

**Table 3-2. Zero- Meter Screw Design.**

It is important to be aware of non-return valve dimensions. For a given non-return valve, these dimensions vary from one supplier to another. ABS and general-purpose screws often have significant differences in flight depths.

## Non-Return Valves

Sliding ring non-return valves (NRV) generally perform satisfactorily with CYCOLAC flame-retardant resins. For general-purpose CYCOLAC resins, ball check valves are also used. Both types should be hardened tool steel exhibiting good fatigue resistance and excellent toughness for maximum wear resistance.

Standard sliding-ring NRV's are often designed with very restrictive flow paths. High clearance sliding-ring designs are suggested. To reduce shear induced heat, the cross sectional area of any flow path in the NRV should be approximately the same as that in the last flight of a properly dimensioned screw. Check outside diameter of tip versus inside of barrel. The average tolerance between tip and barrel should not exceed 0.0015 to 0.02" (0.038 to 0/0.51 mm) per side.

Maintenance usually requires cleaning, light grinding and polishing to help ensure smoothness of the inside diameter and mating seats. The shut-off ball and seat should be replaced occasionally.

Injection molding barrels, screws, and non-return valves are made with diverse metals, alloys, and surface treatments. Some combinations provide more adequate protection than others.

## Metallurgy

Adequate metallurgical performance with screws, barrels, and non-return valves should be achievable by use of the materials listed in Table 3-3 for processing transparent grades. Consult your local GE Plastics Technical Development Engineer for further details or click onto GEP Live .

| | |
|---|---|
| Screws | 17-4PH stainless steel or equivalent with Colmony 56 crests, or equivalent. |
| Non-Return Valves | 17-4PH stainless steel, or 420 stainless steel, or equivalent. |
| Barrels | Nickel-Cobalt-Chrome alloy, or bimetallic alloy equivalent. |
| Tooling | Nickel-plated. |
| End Caps | Electroless nickel-plating of inner and outer orifice surfaces. |

**Table 3-3. Injection Molding Equipment Materials for CYCOLAC Resins**

## Nozzle Design

If the mold design requires nozzle extensions, they should be streamlined with no internal hang-up areas. The inside diameter of the nozzle extension should be 0.625 to 0.750" (1.59 to 1.91 cm). The maximum diameter may vary slightly and is usually dictated by the opening in the machine nozzle adapter. The outside diameter of the extension should be 1.5 to 2.0" (3.81 to 5.08 cm) to help provide optimum heat distribution.

Heater band placement should be uniform and less than 0.5" (1.27 cm) apart.

The nozzle tip should be heated independently to help maintain control of drooling, stringing or cold slugs. Nozzle temperature control should be a closed loop. The tip should be covered with heater bands spaced not more than 0.5" (1.27 cm) apart. Two nozzle designs shown in Figure 3-11 are suggested, but Type A is preferred. The flow path is streamlined and free from obstructions, while the reverse taper into the orifice reduces the land length to zero. The orifice diameter for general-purpose CYCOLAC resin grades should range from 0.188 to 0.375" (3/16 to 3/8") (0.478 to 0.953 cm) and for CYCOLAC flame-resistant grades from 0.250 to 0.375" (1/4 to 3/8") (0.635 to 0.953 cm). The tapered bore and orifice area should be smooth and highly polished.

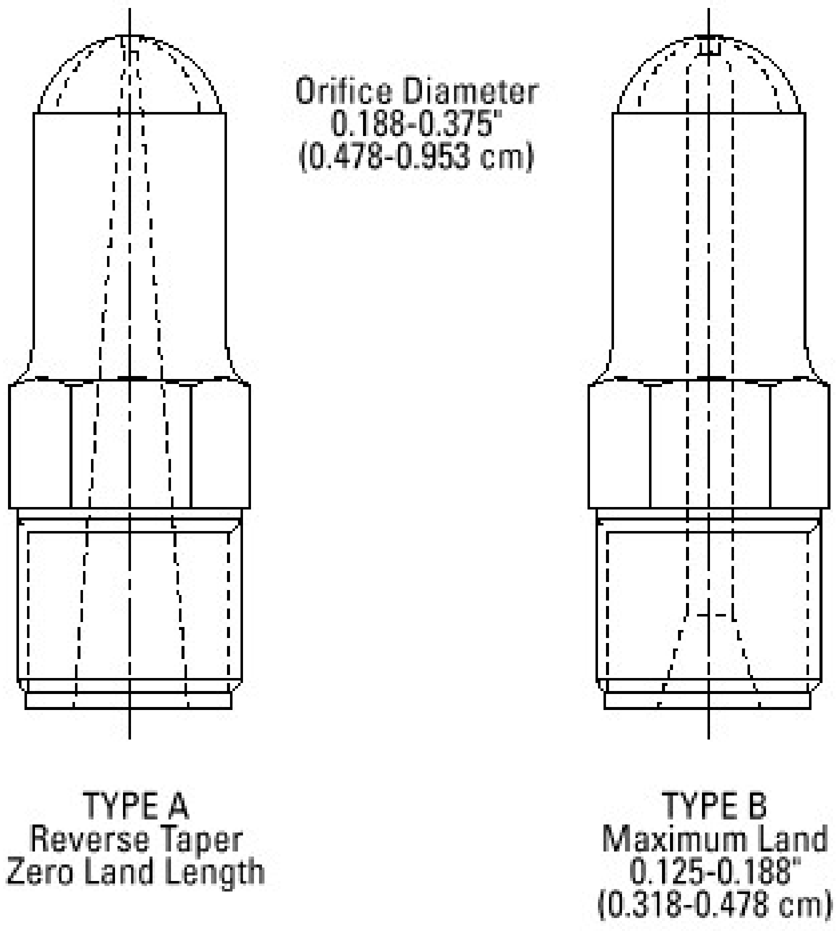



Figure 3-11. Nozzle Designs.

## Drying Parameters

Many important factors must be dealt with for proper processing of CYCOLAC resins. Temperature control is the key in both drying and molding.

CYCOLAC resin is mildly hygroscopic and absorbs moisture in direct proportion to the surrounding relative humidity; the process is reversible, i.e., wet pellets will lose moisture to air with low relative humidity.

When CYCOLAC resin is exposed to humidity, the moisture is absorbed onto the surface and into the interior of the pellet, regrind particle or molded part. Dry pellets will absorb moisture until the content reaches an equilibrium with the moisture in the air. The exact amount of moisture content depends on the relative humidity, how long the resin was exposed, and on the grade of CYCOLAC resin. Typical equilibrium moisture con-tents at 50% RH range between .25 to .65%; at 80% RH from 0.55 to 1.4%-depending on grade. How fast the equilibrium amount of moisture is absorbed depends on particle size and temperature; smaller particles and higher temperatures cause more rapid absorption.

Processing undried CYCOLAC resin can result in splay, splash marks or silver streaking on molded parts.

For CYCOLAC resin grades the suggested moisture level for processing is:

General-purpose molding grades; 0.1% moisture. Plating grades; 0.05% moisture.

Uniformity of drying is important. A few underdried pellets in the dry feed to the molding machine can cause bubbles and splay.

## Drying Variables

Proper drying of CYCOLAC resin requires an awareness and control of the key variables that can affect the drying rate and ultimate dryness.

The higher the initial moisture content, the longer will be the drying time required.

### Initial Moisture Control

Large particles take longer to dry than small ones. For example, doubling the weight of the particle will increase the drying time by about 60%.

### Particle Size

The dew point is a measure of the relative humidity in the dryer. The lower the dew point, the less residual moisture will be in the pellet for a given drying time. This has most effect in the later stage of drying (see Figure 3-12). However, there is a trade-off between dew point and drying temperature. Because of the way most dryers are designed, dryers with very low dew points dry well but they dry slowly. A dew point of 0°F (-18°C) should suffice for most drying applications. Super-low dew points are not an advantage to drying if the pellet temperature is too low to take advantage of them.

### Dryer Dew Point

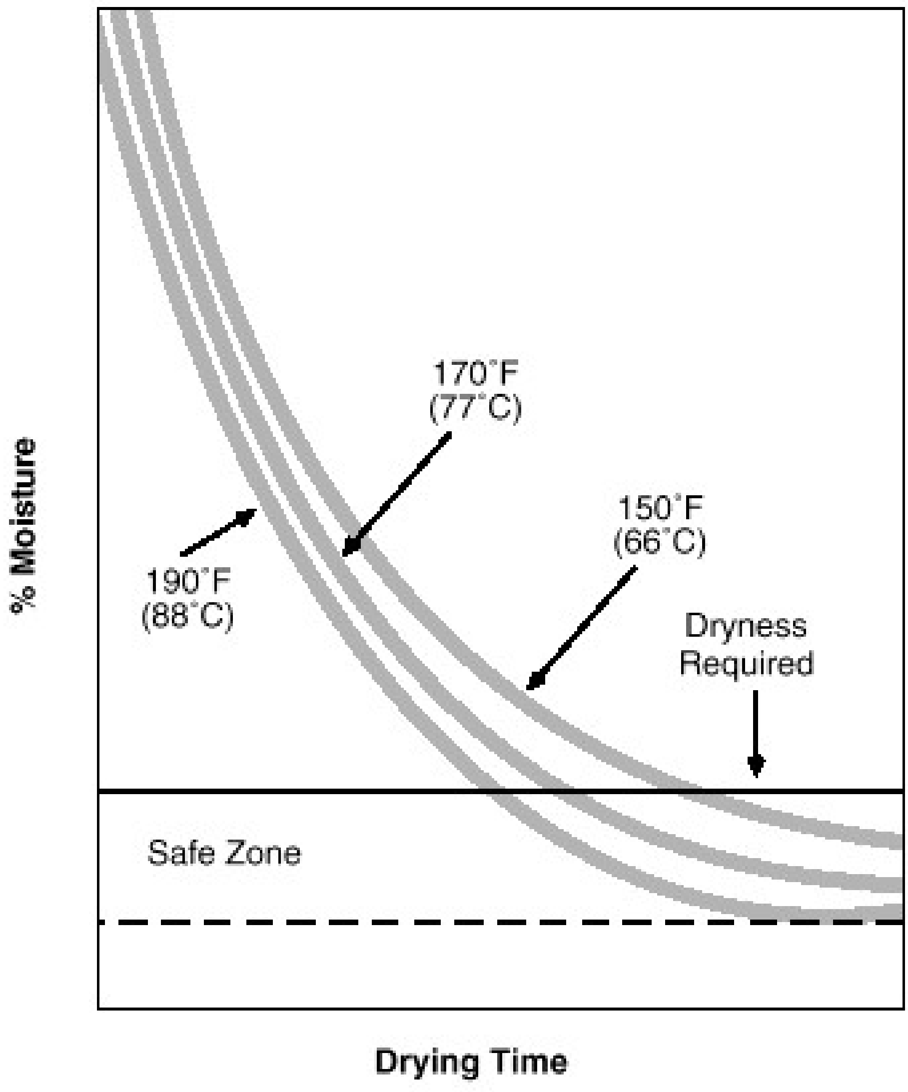



Figure 3-12. Drying Variables

## Drying Temperature

The pellet temperature is the most important consideration in providing for efficient drying rates. Hot pellets dry faster (Figure 3-12). Increasing the drying temperature 20°F approximately doubles the drying rate (or halves the drying time). For example, if a particular grade of CYCOLAC resin takes 3 hours to dry at 190°F (88°C) to achieve good processing, it would take 6 hours at 170°F (77°C).

Thus, for fast and efficient drying, the pellet temperature should be that listed in Table 3-4 for each material. Lower drying temperatures will slow down drying. Temperatures less than 160°F (71°C) create drying rates so slow as to be impractical. Higher drying temperatures risk caking. Proper temperature control and air flow are the key to maximizing drying rates while minimizing caking (See Equipment Chapter.)

| CYCOLAC Resin Type | Min. Drying Time (Hrs.) | Drying Temp. (°F) | Suggested Maximum% Moisture |
|---|---|---|---|
| General-Purpose Molding Grades | 2-4 | 190-200 | 0.1 |
| General-Purpose Extrusion Grades | 4 | 190-200 | 0.02 |
| Flame-Retardant Grades | 2 | 180-190 | 0.1 |
| High-Heat Grades | 4 | 190-220 | 0.1 |
| Plating Grades | 4 | 190-200 | 0.05 |
| Blow Molding Grades | 4 | 190-200 | 0.02 |

For grade-specific drying information, check product data sheets or call GE Plastics Technical Sales Service 1-800-845-0600, or contact your local GE Plastics Technical Engineer.

**Table 3-4. Typical Drying Time and Temperatures for CYCOLAC resin.**

## Drying Time

Pellets (and regrind) take time to dry because the moisture was absorbed into the particle, and must diffuse to the surface before being removed. This diffusion rate is very temperature-dependent, and since large particles have longer diffusion paths, they take longer to dry. The drying time required depends on the factors noted above. Also, the drying curve “flares out” as shown in Figure 3-12, in the Drying Variables Section. This means that the rate slows down as the particle becomes dryer.

It is important that the typical drying times noted in Table 3.4, in the Drying Temperature Section assume that the pellets are up to drying temperature before the “clock starts.” Drying time taken to get the pellets up to drying temperature does not practically contribute to the effective overall drying.

## Drying Equipment

Tray drying is not recommended because pellet heat-up is slow and non-uniform. Also, the dewpoint in a hot air dryer might not be low enough for the moisture removal required for critical applications. If tray dryers must be used, the pellet depth in the tray should not exceed 2." Drying times longer than those noted in Table 3.4 might be required to make up for the poorer efficiency.

Desiccant-type dehumidifying hopper dryers are suggested. A diagram of a typical closed loop desiccant dryer is shown in Figure 3-13.

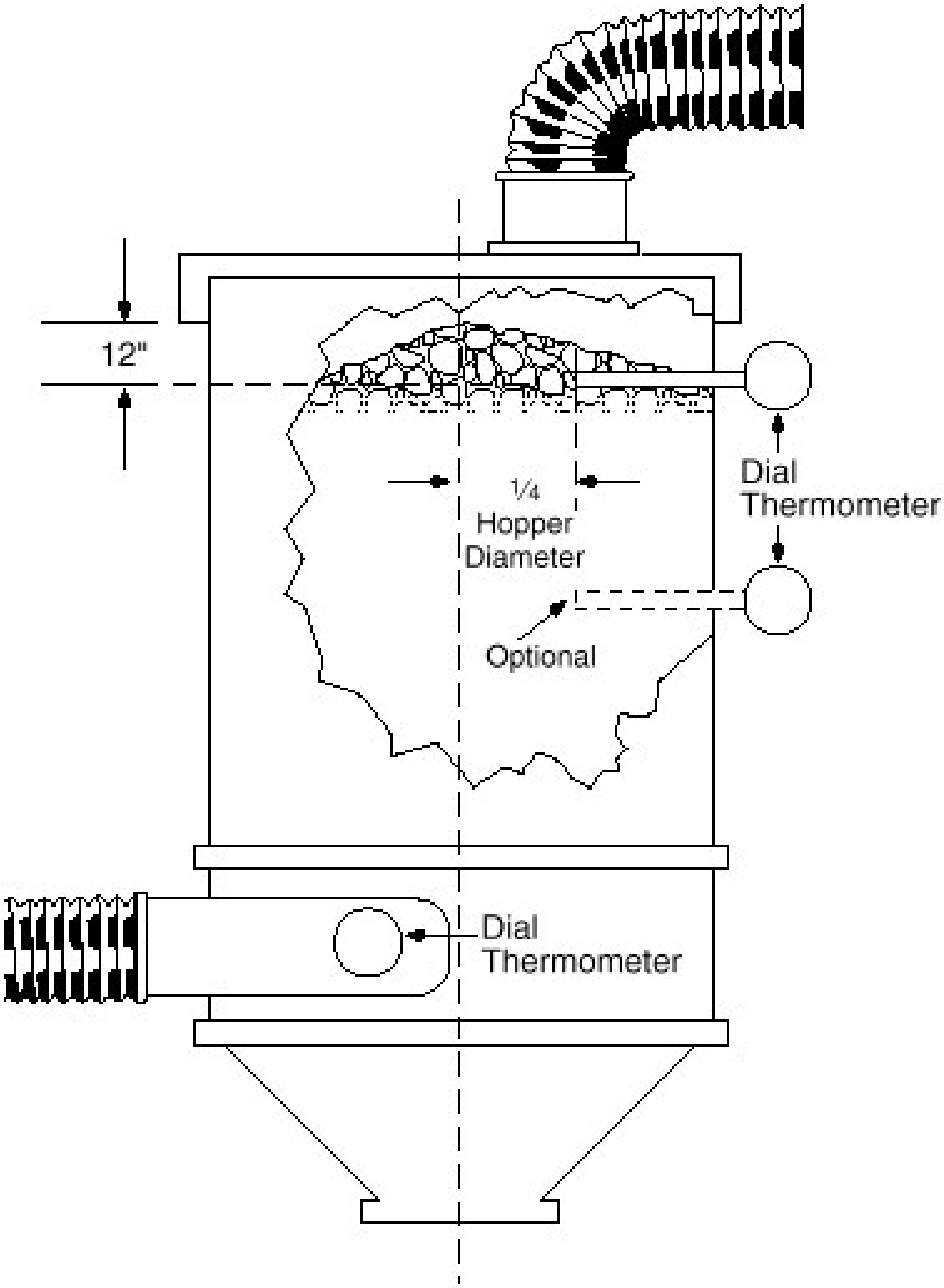



**Figure 3-13. Closed Loop Desiccant Dryer.**

Preferably these should be mounted directly on the molding machine to avoid moisture regain. If “floor” dryers are used, attention should be paid to how the dry pellets are transferred to the molding machine hopper. Pickup of ambient moisture begins immediately on exposure. As little as 15 minutes of expo-sure on a humid day can cause moisture defects. Avoid fluidizing transfer lines that use ambient air, and keep a lid on the machine hopper.

**The following are critical points about dehumidifying hopper dryers:**

1. For optimum drying rates the inlet air temperature should be the drying temperature specified in Table 3.4, in Drying Temperature Section. Depending on the particular dryer design and location of the temperature control thermocouple, the inlet may actually be much colder than the setting. To help ensure the proper inlet temperature, a calibrated dial thermometer should be placed in the hopper inlet. Because of heat losses in the hose it will be necessary to set the controller higher.
2. Some dryer temperature controllers have wide temperature swings as the heaters cycle. Since excessive pellet temperature can cause caking, a safe set temperature will result in a low “average” drying temperature and slow drying rates. To avoid this situation the controller should have + or - 3°F control capability.
3. Air flow is critical. If the air flow is low, there can be large temperature gradient from bottom to top of the hopper (e.g., 190°F in, 130°F out (88°C, 54°C), or an average of 160°F). Even if the temperature is appropriate at the inlet with low air flow, the pellets can be too cold to dry less than half way up the hopper. Thus the true “hot residence

time” is not sufficient to keep up with production.

The popular rule of 1 CFM air flow per lb/hour of pellet feed assumes that the pellets do not get up to maximum drying temperature until they are ready to exit the hopper. Thus they actually have zero residence time at the drying temperature.

**Nevertheless, since most dryers are designed by this rule, one must make the best of it by doing the following:**

- Stop all air leaks. Desiccant dryers must be closed loop. Watch for leaks “in” at the top of the hopper where there is suction, especially at dormant autoloaders.
- Keep filters clean. Inspect daily
- Check for plugged desiccant beds.
- Repair crushed hoses.

A good way to monitor air flow is to put a dial thermometer into the side of the hopper 12" (30 cm) down from the top of the pellet bed and in from the wall approximately one-fourth the hopper diameter. With good air flow, that thermometer should register 160°F (71°C) or higher.

## Drying Regrind Material

Regrind particles are usually larger than as-received pellets. Since regrind drying rates will therefore be much slower, attempts should be made to prevent regrind from regaining moisture. Also, regrinding usually creates considerable fines which can quickly plug the dryer filters and slow drying rates.

## Molding Flame-Resistant Grades

The term “flame-resistant” identifies those grades of CYCOLAC resin which meet specific laboratory test requirements. The testing authority, procedures and results are identified in supporting technical literature. Ratings from these testing laboratories are not intended to reflect hazards created by the resins under actual fire conditions.

CYCOLAC flame-resistant resins are not suggested for oral or food contact applications, potable water or medical devices requiring intimate contact of the plastic with life-critical fluids.

In particular, CYCOLAC flame-resistant resins should be processed according to recommended procedures. At no time should the melt temperature of a flame-retardant grade of CYCOLAC resin exceed 475°F (246°C). Temperatures in excess of those recommended could result in the release of noxious and corrosive vapors which could cause mold and equipment corrosion.

The degradation mechanism is very time/temperature dependent and involves the total heat history of the CYCOLAC resin. The melt temperature may, in some instances, be within the desired range at the nozzle, but significantly higher as it enters the cavity due to shear heat. This excess heat can normally be controlled by proper gate and land dimensioning, slower injection rate or lower injection pressure, and/or reducing back pressure.

All operating personnel should be familiar with instructions on packages, material safety data sheets and proper processing information.

In case of accidental thermal degradation, a noxious yellow/ green gas may be evolved. Purge the barrel, shut off machine, quench purge shot in water. Evacuate personnel from the immediate area until ventilation has removed odor and gases. Call GE Plastics (413)448-5800, contact your local GE Plastics Technical Development Engineer or click onto GEP Live for assistance.

## Melt Temperature

Melt temperature should be checked frequently and maintained within the recommended melt temperature range to promote optimum part appearance and mechanical properties.

Increased melt temperatures can reduce viscosity and increase resin flow, thus providing for longer flow for thin wall sections and producing lower residual stress.

Melt temperature should be checked with a calibrated hand pyrometer. Do not rely on machine-set temperature indicators to monitor actual melt temperature.

# Mold Temperature

As a general guideline, the standard grades of CYCOLAC resin are molded at different temperatures – the lower temperatures for the low viscosity resins and the highest temperatures for the high viscosity grades. Generally, melt temperature should be 20°F (-7°C) above the minimum fill temperature for a specific part.

Mold temperatures are important in determining final part fin-ish and molded-in stress levels. Cold molds are more difficult to fill necessitating high injection pressure and melt temperature. Heated molds generally produce a part with a better finish and lower molded-in stress. Because of the high heat distortion, parts are ejected more easily at higher temperatures.

Typical Molding Processing Parameters for Cycolac are presented in Table 3-5

Molding Conditions

| | | AR GSM L | | DSK GPM6300 GPM7300 HP20 | | GHT4400 X11 | | GDT2510 GHT3510 GHT4320 X15 X17 X37 Z48 | | DFAR GPM4700 GPM5500 GPM5600 GPT5500 HP30 LDM T | | KJB KJT KJU KJW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Processing Parameters** | **Units** | **(min.)** | **(max.)** | **(min.)** | **(max.)** | **(min.)** | **(max.)** | **(min.)** | **(max.)** | **(min.)** | **(max.)** | **(min.)** | **(max.)** |
| Drying Temperature | °F(°C) | 180(82) | 200(93) | 180(82) | 190(88) | 190(88) | 200(93) | 200(93) | 210(99) | 180(82) | 200(93) | 180(82) | 190(88) |
| Drying Time (Normal) | h | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 |
| Drying Time (Max.) | h | – | 8 | – | 8 | – | 8 | – | 8 | – | 8 | – | 6 |
| Maximum Moisture | % | – | 0.10 | – | 0.10 | – | 0.10 | – | 0.10 | – | 0.10 | – | 0.10 |
| Melt Temperature | °F(°C) | 450(232) | 500(260) | 400(204) | 475(246) | 450(232) | 525(274) | 475(246) | 525(274) | 425(218) | 500(260) | 380(193) | 450(232) |
| Nozzle | °F(°C) | 450(232) | 500(260) | 400(204) | 475(246) | 450(232) | 525(274) | 475(246) | 525(274) | 425(218) | 500(260) | 380(193) | 450(232) |
| Front Zone | °F(°C) | 440(227) | 470(243) | 400(204) | 440(227) | 450(232) | 490(254) | 470(243) | 490(254) | 420(216) | 460(238) | 410(210) | 430(221) |
| Middle Zone | °F(°C) | 410(210) | 440(227) | 390(199) | 410(210) | 410(210) | 440(227) | 440(227) | 460(238) | 400(204) | 440(227) | 390(199) | 410(210) |
| Rear Zone | °F(°C) | 370(188) | 400(204) | 370(188) | 390(199) | 380(193) | 410(210) | 390(199) | 410(210) | 370(188) | 410(210) | 340(171) | 360(182) |
| Mold Temperature | °F(°C) | 120(49) | 160(71) | 120(49) | 160(71) | 120(49) | 180(82) | 120(49) | 180(82) | 120(49) | 160(71) | 120(49) | 160(71) |
| Back Pressure | psi(MPa) | 50(0.3) | 100(0.7) | 50(0.3) | 100(0.7) | 50(0.3) | 100(0.7) | 50(0.3) | 100(0.7) | 50(0.3) | 100(0.7) | 50(0.3) | 100(0.7) |
| Screw Speed | rpm | 30 | 60 | 30 | 60 | 30 | 60 | 30 | 60 | 30 | 60 | 30 | 60 |
| Shot to Cylinder Size | % | 50 | 70 | 50 | 70 | 50 | 70 | 50 | 70 | 50 | 70 | 50 | 70 |
| Clamp Tonnage | tons/in$^2$ | – | – | – | – | – | – | – | – | – | – | – | – |
| Vent Depth | in | 0.0015 | 0.0020 | 0.0015 | 0.0020 | 0.0015 | 0.0020 | 0.0015 | 0.0020 | 0.0015 | 0.0020 | 0.0015 | 0.0020 |

**Table 3-5. Typical Processing Parameters for Cycolac Resins**

## Fill Speed

Fill speeds will vary depending on part geometry, gate design and runner dimensions. Slow to moderate fill speeds are generally recommended, in the range of 2 to 15 seconds.

## Injection Pressure

Injection pressure and holding pressure should be adjusted to mold full parts consistently with acceptable appearance. Many factors affect injection pressure such as stock temperature, part geometry, nozzle size, mold temperature, runner and gate dimensions; however, primary injection pressures of 8,000 to 12,000 psi (55 to 83 MPa) are typically sufficient, but can go to 20,000 psi (138 MPa) if required. Generally, if equipment and processing conditions are optimum, injection pressures in the lower range will produce better parts. Once the cavities are filled, the primary injection pressure should drop off immediately to “holding” pressures in the range of 4,000 to 8,000 psi (28 to 55 MPa), to obtain gate freeze-off without back flow. Maintain a cushion of approximately 1/8" (0.3175 cm) after injection to help provide good dimensional reproducibility and weld line integrity.

## Clamp Pressure

A clamp pressure of 2 to 3 tons (907 to 1361 kilograms) per square inch (square centimeter) of projected area is generally suggested. With three-plate molds the runner area should be calculated as part of the total projected area.

## Screw Operation

**While compression ratio and L/D ratios are very important, particular attention should be given to operating the screw. Screw rpm and back pressure can be used to assist in melt temperature control. Screw speed should be slow and adjusted to allow complete recovery just prior to mold opening. A general guideline would be:**

- 2 to 4" (5.08 to 10.16 cm) diameter – 40 to 60 rpm
- 5 to 6" (12.7 to 15.24 cm) diameter – 20 to 30 rpm

A low back pressure of 50 to 100 psi (0.35 to 0.70 MPa) will normally provide adequate control of shot size, feed and melt flow.

Back pressures that are too high can cause high melt temperatures. Back pressures that are too low can cause splay due to trapped air and “screw augering.”

## Shot Weight/Barrel Capacity

The weight of the shot should be 50 to 80% of the barrel capacity. Long residence time in the barrel can cause color shift or degradation of the plastic melt. If shot sizes require less than 50% of the barrel capacity, steps should be taken to minimize heat history on the melt. Minimal heat history can be provided by: reduced screw rpm, steep temperature profile descending from front to rear, overall lower barrel temperatures, minimum back pressure and holding the screw in a forward position with low pressure as long as possible, retracting just in time for the mold-open cycle.

## Cushion

The use of a small cushion [1/8 inch (3.18 mm) suggested] reduces material residence time in the barrel and allows for machine variations.

## Cycle Time

When adjusting cycle times, it is generally better to use a fast injection speed and a minimum holding time to help achieve gate freeze-off and a short cooling time.

The fastest possible ram travel time is preferred for most parts. The thickest wall section of the part normally sets the cycle time. Figure 3-14 illustrates the overall cycle time prediction as a function of wall thickness. A runner/sprue section could exceed the part wall thickness and extend cycle times shown in Figure 3-14. This should be a consideration before the tool is built, as well as during actual molding.

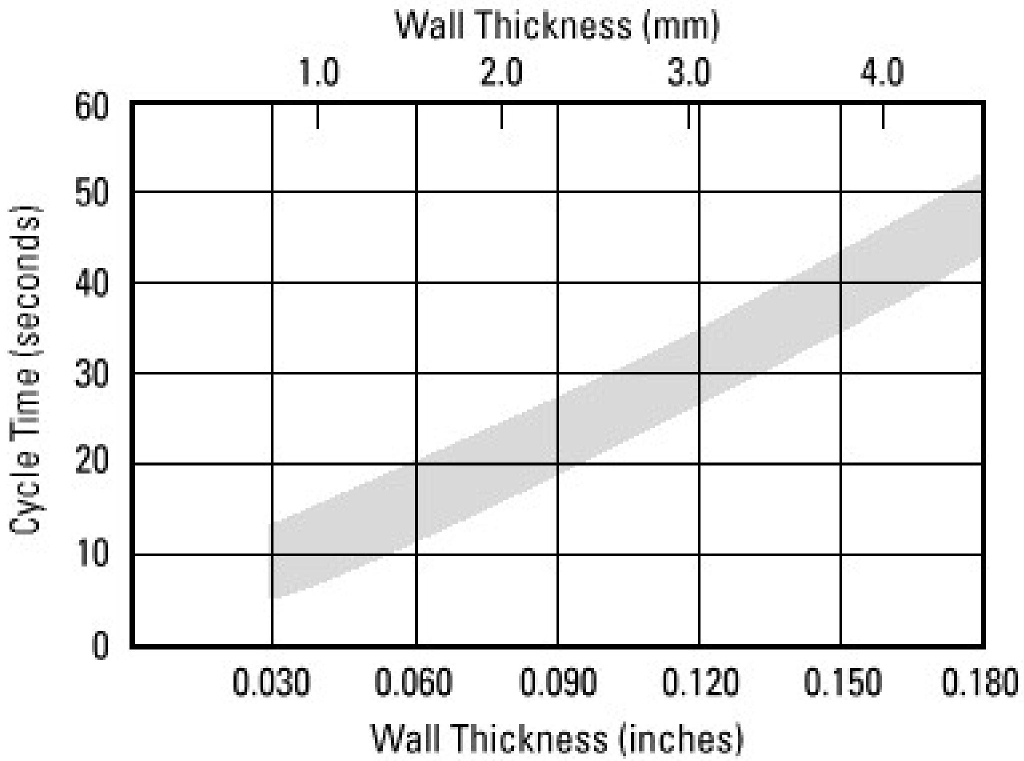



**Figure 3-14. Typical Cycle Time Vs. Wall Thickness for CYCOLAC Resins**

# Effect of Wall Thickness on Flow Length

Variables affecting melt flow length include wall thickness, mold temperature, injection pressure, melt temperature, and material composition.

Diskflow (or radial flow) results are obtained from mold filling computer simulation. An example of Diskflow is given below in Figure 3-15.

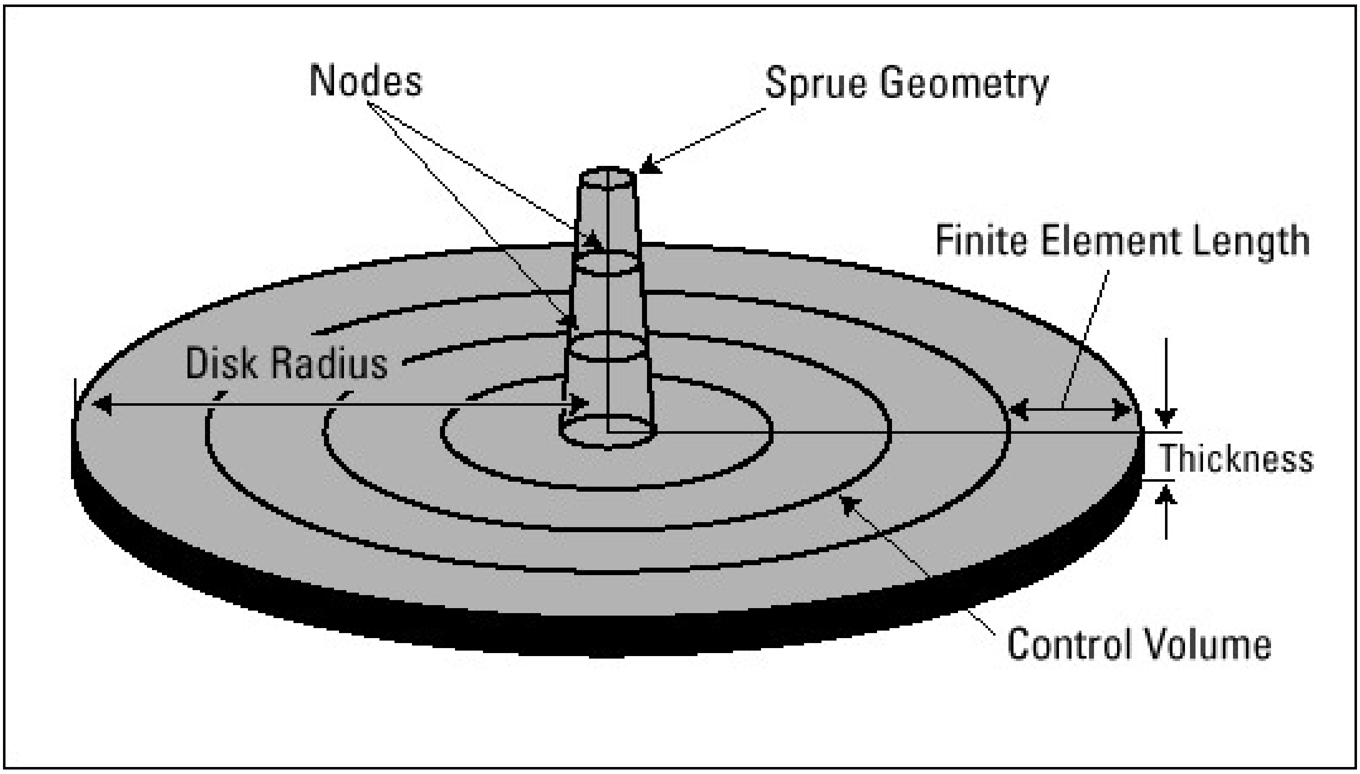



**Figure 3-15. Diskflow Model**

Shown is the relationship of flow length versus wall thickness at a given capacity pressure (pressure at sprue) and melt temperature. Diskflow radial flow results are normally conservative and may underpredict the flow lengths of many applications where flow is not entirely radial.

# Downtime

For any normal shutdown, or if mechanical problems require that CYCOLAC flame-resistant resins remain in the molding machine for as long as five to thirty minutes (depending on grade), lower the barrel, nozzle and melt temperature to approximately 200°F (93°C) and purge with a standard grade of CYCOLAC ABS resin or similar purge to prevent material degradation. When ready to resume operations, increase indicator settings to required level, purge the barrel, check melt with pyrometer and continue normal operations.

If the shutdown is overnight or longer, reduce temperatures, purge the machine with a standard grade of CYCOLAC resin and shut off. When operations are resumed, raise temperature to recommended melt temperature settings, purge the machine, check melt with pyrometer and resume normal operations with dried material.

For prolonged shutdown or storage, molds should be cleaned and coated with a neutralizer and dehydrator containing a rust inhibitor. A suggested procedure is the IMS two-step mold surface treatment.

# Purging

Purging operations should be done with the safety shield in the down position to cover the barrel end and nozzle to contain possible splatter or blow-back of molten plastic.

Adequate purging can usually be accomplished with the nozzle in place or removed. Removal of the nozzle will allow complete cleaning and inspection for roughness or foreign objects.

To change from one CYCOLAC flame-resistant resin color to another simply purge with the following color until the color change is complete and continue normal molding operation.

To change from CYCOLAC flame-resistant resin to some other grade of CYCOLAC resin or another thermoplastic resin, it is necessary to completely remove the flame-resistant resin prior to increasing any heat settings.

To change from a thermoplastic resin requiring high melt temperatures to a flame-resistant resin, purge the system with standard CYCOLAC resin and lower the temperatures. Purge with the flame-resistant resin until change is complete, make final stock temperature adjustment and continue molding.

Purging for shutdown should include complete removal of the CYCOLAC flame-retardant resin with either a standard CYCOLAC resin or other thermoplastic. Reduce temperature settings and continue to purge until indicators show a reduction, the follow normal shutdown procedures.

A standard grade of CYCOLAC resin is normally the best purge material, since CYCOLAC resin is not compatible with other polymer types. If other thermoplastics are used for purging, they must be completely removed prior to startup of normal molding operations.

The molten purge mass should be pressed out immediately and submersed in cold water to completely cool before removing waste receptacle. All purging operations should be carried out with adequate ventilation.

After purging, the screw should be left in the forward position until ready for heatup to start the next job.

Routine maintenance and cleaning of equipment should include frequent purging with natural ABS or SAN.

If prolonged shutdown is required, reduce barrel temperature below 350°F (176°C), remove the material from the machine and purge with natural ABS or SAN. Continue until hopper is empty and barrel temperature has dropped below 350°F (176°C).

# Regrind

Sprues, runners and short shots of CYCOLAC resin molded under proper conditions can be reclaimed as Class A material. Heavy-duty grinders with 0.312 to 0.375" (0.793 to 0.953 cm) screens are recommended. Clean, non-degraded regrind up to 20% level can be reprocessed with virgin pellets of the same grade.

Key factors to consider are: keep regrind material clean, do not contaminate with other grades of CYCOLAC resin or other thermoplastics and keep regrind material dry by storing in closed containers, such as boxes/drums with polyethylene liners.

Remember that large particle size regrind will require much longer drying times than virgin pellets.

# Mold Buildup

Mold buildup is a characteristic common to many types of thermoplastics, including some grades of CYCOLAC flame-retardant resins. Proper processing conditions can minimize this occurrence. Various types of cleaning agents are available; consult your local GE Plastics Technical Development Engineer, or click on to GEP Live for recommendations and proper use procedures. Molds need to be inspected frequently for evidence of buildup or vent clogging.

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