High Performance Styrenics

(NS102-1008) General Recommendations for Molding Large Transparent Parts (Four to Twelve Pound Shots)

TECHNICAL BULLETIN

The following information is provided to aid the molder in choosing the appropriate equipment on which to mold large shots in NAS 30. Starting recommendations are offered to guide the molder in establishing molding parameters for such parts. Brief comments are also included on mold design and on the effect of molding conditions on the level of stress in the molded parts.

MACHINE SIZE

Select a machine having sufficient capacity. The choice of injection molding equipment should be based on plasticating, injection and clamp capacity considerations. The shot weight should not exceed 75 percent of the machine's rated injection capacity. Clamp capacity of 2 1/2 tons per square inch of projected area is generally adequate. Machines rated from 1,000 tons/100 ounces to 2,000 tons/300 ounces may be required, depending on size and weight of the part. Screw length-to-diameter ratios of 20/1 to 24/1 are desirable.

SCREW CHARACTERISTICS

Compression ratios should be between 2.75/1 and 3.5/1. A typical constant pitch screw might have flight depths in the feed section of .500 inches, with flight depths in the metering section of 1.67 inches, for a compression ratio of 3/1. The metering section should have a minimum of four flights. Less than four has a tendency to carry over air into the melt.

The melt or transition section should have a minimum of five flights; more are desirable, but fewer than five will increase likelihood of non-uniform melting and air carry-over.

PREPARATIONS FOR MOLDING

To establish optimum conditions, the screw should be removed and physically cleaned to eliminate all foreign material. The barrel, nozzle, hopper, and all associated equipment must receive the same attention. Molds with hot-runner manifolds sometimes require disassembly in order to remove all traces of the material previously molded. Failure to perform these cleaning steps is frequently the cause of problems at start-up. The severity of such problems is, of course, related to the types of materials previously processed in the equipment, since some materials are much more difficult to purge than others.

Screws coated with thick layers of plastic from previous runs have effective flight depths and compression ratios that are significantly altered by this build-up from the original screw design. Cleaning of the screw will restore it to its original characteristics. While the screw is removed for cleaning, the diameter, flight depths, number of turns per section, L/D ratio, and compression ratio can be confirmed if the information is not otherwise available.

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Minor defects of all types, such as bubbles, dirt specks, contamination streaks, etc., are immediately apparent in a part molded from a transparent material such as NAS 30, and the need for cleanliness in equipment preparation before molding and in housekeeping practices during molding cannot be overemphasized.

Nozzles should have relatively large orifices with no restrictions, valves, or dead spots likely to cause hang-up of polymer with subsequent polymer degradation and streaking or black spots in the molded parts.

The NAS 30 pellets should be dried before molding in a dehumidifying-type dryer having a capacity sufficient to ensure residence time of two to four hours. A temperature of 185ºF (85ºC) is recommended. Avoid temperatures over 200ºF (93ºC) in order to prevent softening or melting of the pellets, which may cause bridging in the dryer or hopper.

MACHINE CONDITIONS

Barrel heater zone temperatures ranging from 370ºF (188ºC), Rear, to 420ºF (215ºC), Front, are suggested as starting conditions. The melt, as observed during extrusion with the barrel retracted from the mold, should be clear, free from contamination, and free from bubbles or foaming. The melt temperature should be approximately 420ºF (215ºC) at start-up.

The screw rpm will vary depending on the characteristics of the machine and screw; however, 30 to 60 rpm is typical.

Clamp and injection pressures near maximum are common. Back pressure of 50 to 100 psi is usually employed in order to minimize air or volatile entrapment in the melt.

Running with a "cushion" helps assure retention of pressure on the material in the mold cavity until the gate or sprue freezes off, helping to avoid bubbles or sinks and contributing to a good surface finish.

Mold temperature must be controlled; circulating water temperatures of 120ºF (49ºC) to 160ºF (71ºC) are typical. The two mold halves should be as near the same temperature as is practical in order to reduce the level of stress in the molded part.

Parts with 1/2-inch thick sections, when molded under optimum conditions, may require an overall cycle time as high as three minutes.

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MOLD

The mold must be adequately vented. Individual vents should be a maximum of 0.0015 inches deep adjacent to the cavity, with 0.060-inch land, and up to 1 inch in width. Sprue gates approximately 3/8 inch in diameter are sometimes used when gating directly into the surface of a part if the gate area will be hidden in the final assembly. Heavy fan gates are usually employed when the part is to be edge-gated. When multiple gates are employed for parts having a cut-out area, their location should be selected carefully so that any weld lines will be at the most acceptable locations.

Runners should be full round and approximately 1/2-inch diameter. Cold-slug well should be provided wherever possible. Chrome plating of the mold cavity is recommended.

EFFECT OF MOLD TEMPERATURE ON STRESS LEVEL IN MOLDED PARTS

High mold temperature allows the material to assume a more stress-free condition as it cures and sets-up. Theoretically, a mold temperature just below the heat distortion temperature of the material would result in the most stress-free part. The cycle time, however, would be extremely long, as the material would cool very slowly.

Establishment of molding conditions, therefore, usually represents a compromise between economic factors and strength characteristics of the molded part. As mold temperature is lowered to obtain a more economical cycle time, the stress level is increased and the functional strength of the part is decreased.

CONCLUSION

Molding conditions recommended in the above sections represent those typical of many furniture parts that have been molded in NAS 30.

In most cases, these processing conditions have produced parts acceptable to the end-use manufacturer, and they are believed to be the best conditions for start-up of molding operations. After start-up, conditions should be optimized consistent with the economic and performance expectations of the end-use manufacturer.

This information is intended for use only as a guide for selecting equipment with which to process NAS 30, and for establishing molding start-up conditions. This information is not intended for use in estimating production costs and it is not intended, expressed or implied, as a guarantee or warranty of performance in any specific molded part

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