

SILICONE MOLDING COMPOUNDS

Processing Guide

Chemistry and Features

Silicones are best known for their extreme temperature properties. Silicone resins usually are formulated to contain a three-dimensional network of siloxane linkages. They have good chemical and electrical properties. They find their largest use in electrical applications. Silicone molding compounds have high arc resistance, high dielectric strength, low dielectric constant and dissipation factor, good resistance to corona and electric breakdown. These properties are retained after exposure to moisture and elevated temperature. Some silicones are used in 600F service temperature.

Flow Rheology

Compounds based on Silicone resins are designed to process well in several types of molding equipment. Compounds are available in a variety of flow ranges, from very stiff for compression molding to very soft for transfer molding. Their plasticities are normally measured by a special transfer molding procedure known as Mesa Spiral Flow. This test provides an indication of the relative ability of the compound to flow and fill molds. Brabender torque rheometer measurements are sometimes utilized to characterize both flow and curing properties.



Figure 2: Mesa Spiral

Storage

Compounds based on Silicone resin possess greater reactivity, and therefore cold storage of these materials is recommended. Normal storage life is about 6 months when kept at or below 40°F (4°C). The material should be brought to room temperature before containers are opened to prevent the introduction of condensed moisture from the atmosphere.

Preforming or Screw Plasticating

Silicone compounds can be charged directly into the mold cavity in granular form. This practice may be desirable in the case of single cavity compression molds for large components, as well as with presses utilizing automatic powder loading. The compound should be accurately weighed or volumetrically metered for each molding cycle.

For the production of small and medium-sized parts with multi-cavity compression molds or transfer molds, preforms are generally preferred. Preforms can be made in many shapes and sizes by compaction of the molding material in a die. Preforms are easier to handle and can be more readily preheated than loosely packed bulk material.

Granular Silicone compounds are easily preformed by any of the usual types of hydraulic or mechanical preforming presses or screw plasticating machines. Screw plastication combines both preforming and preheating in one process.

Automatic preformers require free-flowing granular compounds in order to maintain weight consistency and rapid cycles. Materials with the lowest bulk densities, such as those containing long glass fibers, cannot usually be preformed automatically in conventional equipment. These often require auxiliary feeding equipment or a manual weighing and pressing operation.

Preheating

The molding compounds should be heated before being loaded into the mold. This reduces the time required to bring the material to a plastic state and allows shorter molding cycles than are possible with cold material. Preheating can increase productivity by 20 to 40% depending on the geometry of the part and the material being molded. The preheated material also flows more easily and uniformly and generally requires less pressure. Other benefits of preheating include smoother molded surfaces and enhanced physical properties.

The most commonly used preheating methods are dielectric (HF) heating of a densely packed perform or frictional heating using a screw plasticator.

Preheat temperature is one of the most critical molding parameters. The temperature should be optimized to provide the easiest flow. This usually means raising the temperature of the compound until obvious pre-cure or short shots occur in molding, and then dropping back 10 to 15°F.

Molding Methods

In general, Silicone compounds can be processed by several conventional thermoset molding methods, such as compression, and transfer molding. Typically silicones are not suitable for injection molding.

Transfer or plunger molding is a predominant method used with Silicone compounds. This method is particularly useful for parts that contain molded-in inserts. Strength may be somewhat lower and shrinkage somewhat higher than that of parts molded by compression. The magnitudes of these differences are dependent on runner and gate design plus the flow pattern in the mold cavity.

In transfer molding, a sound molding requires complete cavity filling and adequate packing before gelation. Mold filling time should neither be too short, to avoid trapping air or overheating material through friction, nor too long, to avoid gelation before the cavity is completely packed. If molding conditions do not allow sufficient packing

pressure, part strength will be compromised. Other properties including dimensions are affected by cavity packing pressure as well.

The curing time should be long enough for the part to be ejected from the mold without distortion.

Mold cavities should be well polished and plated with hard chrome to ensure easy release. A draft of ½ degree on cavity surfaces that are perpendicular to the mold parting line will facilitate easy part demolding. All transfer molds must be properly vented at the parting line, and knock-out pins may need axial flat faces to provide more venting for deep recesses.

Suggested Start-Up Conditions

Molding conditions may vary depending on the shape of the part, mold design, and composition of the material. Suggested start-up conditions and approximate curing times are provided in Figure 3.

Postcuring and Degassing

Molded parts normally never attain complete cure under commercial conditions. In most cases, conditions are established which produce an acceptable degree of cure and attendant physical properties when the parts are removed from the mold. It is not necessary to postcure molded parts unless a specific application requires that resistance to high-temperature or chemical exposures be maximized or that the by-products of the curing initiators be driven off.

The retention of physical properties at elevated temperatures is governed by the T_g . For maximum thermal stability and retention of physical properties at high temperatures, molded parts can be postcured. This should be performed in a forced-draft oven having good temperature control and outside venting.

Optimum postcuring conditions are determined by the specific application requirements. When determining the oven temperature cycle, it is important to note that lower temperatures generally result in less thermal stress and less discoloration of the part. Most cycles begin at 275°F (135°C) and the temperature is gradually raised to avoid exceeding the T_g . The rate of

temperature rise should be as fast as permissible without visual signs of degradation such as blistering or cracking. A final oven temperature of 175°C is usually sufficient to complete the crosslinking reactions without significant discoloration. For applications requiring minimum outgassing, the final oven temperature should be at least equal to the maximum service temperature and the parts should be

baked from 4 to 6 hours at this final temperature or until the rate of weight loss is negligible.

Technical Assistance

Please contact your Sumitomo Bakelite representative if technical assistance is desired.

Figure 3: Suggested Start-Up Conditions

COMPRESSION/TRANSFER	PARAMETER SETTINGS
<p style="text-align: center;"> Preforming Pressure Preheat Temperature Preheating Time (HF) Mold Temperature Molding Pressure – Compression -Transfer Cure Time </p>	<p style="text-align: center;"> 8,000-12,000 psi (544-816 bar) 180-200°F (82-93°C) $\leq 45 \text{ s}$ 280-300°F (138-149°C) 2,000-8,000 psi (136-544 bar) 4,000-8,000 psi (272-544 bar) 60-90s (per 3.2 mm thickness) </p>