Sunprene™ by mcpp

Injection Molding Design Guide

Vinika™ by mcpp

SUNPRENE® and VINIKA® compounds are high quality, flexible PVC compounds developed for various applications.

INJECTION PRESS

SUNPRENE® and VINIKA® flexible PVC compounds have been successfully molded in various types of injection molding equipment. Reciprocating screw machines provide rapid and uniform heating of the compound and reduced pressure loss through the cylinder. They offer shorter cycle times, lower molded-in stresses, and better part appearance. Machines with piggyback feed and plunger injection are generally not recommended.

SCREW DESIGN

The ease of processing of SUNPRENE® and VINIKA® compounds allows the use of general-purpose screws, which incorporate free flowing, sliding check rings. Hard chrome plating of the screw tip is desirable but not necessary. Other coatings which are offered by various injection press screw manufacturers can be used as well. Compression ratios of 1.5:1 to 3.1:1 can be used, although the mid-range compression ratio screws (2.5:1) will generally provide a wider processing range and will allow more variation of the processing conditions (e.g., back pressure, fill rate, screw speed, etc.).

Generally, length to diameter (L/D) ratios does not have a dramatic effect on the plasticizing performance of SUNPRENE® and VINIKA® compounds. Higher L/D ratios do require more attention. A minimum melt inventory in residence time is suggested in all cases, and a 24:1 L/D ratio is the recommended maximum.

NOZZLE DESIGN

Free flowing, short nozzles with an orifice of 3/16 inch diameter or larger openings are recommended for molding SUNPRENE® and VINIKA® compounds. The nozzle should be equipped with a separate controller monitored by a deep well thermocouple. Surface thermocouples are used only when space is limited. Shut off nozzles are neither required nor generally recommended.

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Mold Design

MOLD CAVITIES

Any mold which works well with good thermoplastic design is satisfactory for molding SUNPRENE® and VINIKA® compounds. Hardened P20 steel is adequate for SUNPRENE® and VINIKA® compounds, provided that its natural porosity is filled "micro seal" or that the molds are neutralized after each run with alkaline sprays. Stainless steel, although higher in cost initially than hardened steel, is the more corrosion resistant of the two materials and may offer a lower investment cost when considering lifetime maintenance expenses. Both AISI 420 and AISI 440 grades have proven satisfactory for this purpose. If hard tool steel is used, cores and cavities must use electro less nickel plating to minimize wear, metal etching, and to protect the tool from material decomposition in case of equipment malfunction or operator error.

Because hard chrome plating is porous, multiple hard plating consisting of thin layers of chrome is recommended. Wall thickness should be as uniform as possible. We recommend a minimal wall thickness of **2.5 mm** for most applications and thicker **(>3.0 mm)** sections for complex designs. The mold must have cooling as SUNPRENE® and VINIKA® compounds normally require a mold surface temperature of 50-140°F (10-60°C).

RUNNERS

Full round runners are preferred because they provide the highest volume to surface ratio, the least pressure drop, and are easiest to eject from the mold. Depending on part size and weight, typical full round runner diameters are generally 0.250-0.400 inches. Because of excessive flow restriction, the use of small diameter runners – less than 0.250 inches– should be avoided. Runners with diameters larger than 0.400 inches offer little advantage and contribute to longer cycle times and greater material usage.

Trapezoidal and half round runners can also be used to mold SUNPRENE® and VINIKA® compounds. Half round runners cut down the flow considerably and increase the possibilities of excessive cooling before the melt enters the mold. Premature cooling can require the mold to be heated, therefore increasing cycle time.

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With multiple cavity or multi-gated molds, the secondary runner should be slightly smaller in cross section than the main runner. This is done to maintain pressure and balanced flow during the injection of the material. Secondary runners should be perpendicular to the main runner, and the runner junction should be polished to remove burs and sharp edges.

The overall layout of the mold is very important to consider. A runner system should be designed to provide balanced flow to all gates and ideally designed so that the melt stock reaches all of the gates simultaneously.

GATING

SUNPRENE® and VINIKA® compounds have been successfully molded through a wide variety of gate designs. These include tab, edge, pin, submarine, and sprue type gates. Direct sprue gates are the best possible configuration for SUNPRENE® and VINIKA® compounds.

In general, the gates should have a generous cross sectional area to allow the material to flow freely with a minimum of pressure loss. Fan and tab gates are next in preference to eliminating jetting or laminar flow. Sub gates and pin gates should have a minimal opening of 0.05-0.07 inches if possible. Pin gates and submarine gates are not a problem in molding small, thin walled parts. The land length of the gate should be kept as short as possible, 0.03-0.04 inches to obtain the best combination of injection speed and cycle time. Short land lengths permit the use of higher injection speeds and will have the effect of reducing the melt viscosity for better material flow. Care should be taken as very short land lengths may result in a longer time to “freeze off” the material at the gate and, therefore, result in longer cycle times.

In multi-gated cavities, the number of gates and gate locations are important in relation to the appearance and performance of the finished part. Gates should be located in non-critical areas since the material in the vicinity of the gate is under the highest molding stress. Gates should be located in the thickest sections of the part allowing the SUNPRENE® or VINIKA® compound to flow to the thinner sections reducing any tendency for sink marks and molded-in stresses. When gating into a thick section, the flow should be directed toward a cavity wall or deflector pin to break up the melt entering the cavity and prevent a condition sometimes referred to as “worming”.

The condition of “worming” appears as weld lines in a random pattern opposite the gate, and it is generally caused by the rapid cooling of the injected material.

If the design of the part requires a split in the flow coming from the gate, a weld line will usually result when the two flow fronts meet. Care should be taken in designing parts to keep the number of gates to a minimum. Multiple weld lines will not only detract from the part’s surface appearance, but they will also mechanically weaken the part as well.

SPRUE BUSHING

A sprue bushing with a minimal three (3) degree angle taper per meter of sprue length should be used. The entrance diameter of the bushing should always be slightly larger than the nozzle orifice diameter. In its junction with the main runner, the sprue should be slightly larger in diameter than the runner. This sizing relationship of the sprue with the main runner helps maintain balanced pressure of the melt of the SUNPRENE® and VINIKA® compounds during injection. Because high heat and long residence times result in degraded material, the use of a heated sprue bushing is not generally recommended.

COLD SLUG WELLS

During injection, the initial surge of material will cool as it goes through the sprue and runner system. This semi-solid material is generally made up of dormant material that was resident in the nozzle between injection molding shots. This semi-solid material, with the material that had remained in larger adapters, can cause surface defects in the part. To prevent this semi-solid material from entering the cavity and causing a visual defect, cold slug wells or run offs should be incorporated in the runner system. The inclusion of cold slug wells is important as they prevent semi-solid material from entering the mold cavity effecting the surface finish and strength of the product. Semi-solid material can create gate blockages, and on multi-cavity molds, cause other cavities to become over packed. Cold slug wells should be designed at the ends of and at right angles to the runners.

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VENTING

When the compound melt has flowed rapidly around pins and over sharp edges, air and gas entrapment can result from super heating of the material. This condition is sometimes referred to as "velocity burning". Velocity burning is the result of the SUNPRENE® or VINIKA® compound flashing to a very high temperature. This will result in gloss variations and non-uniform heating of the melt itself. Since this air and gas entrapment in the mold should be adequately vented to allow for gas to escape. The vents should be placed at the last area of the cavity to be filled and can also be added around the periphery of the cavity. Typical vents are slots that range from 0.250-0.500 inches wide by 0.001-0.005 inches deep. They should be located on the mating surfaces of one of the mold halves. Venting may also be accomplished by grinding small "flats" on the ejector pins. In general, a vent should be cut to a minimum depth initially and then increased to a depth as necessary. SUNPRENE® and VINIKA® compounds are produced in a variety of durometer hardness. A general rule of thumb would be to have larger vents as the compound hardness increases.

MOLD SHRINKAGE ALLOWANCES

Mold shrinkage of SUNPRENE® and VINIKA® compounds can cover a wide range. The actual shrinkage will be dependent upon the wall thickness, mold and melt stock temperatures; injection and injection hold pressures, gate size and location, and material hardness. Shrinkage is generally proportional to flow length, and it is generally less in the direction perpendicular to melt flow than it is in the direction parallel to the melt flow. Gates should be located so that the flow lengths are all equalized if possible. (See attached Shrinkage Chart).

CLAMP REQUIREMENTS

Clamping pressures depend upon wall thickness and length of flow in the part. In general, a clamp pressure to surface area ratio of 2 – 4 tons per square inch should be used. High flow materials will require >4 tons per square inch.

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Machine Requirements and Molding Conditions

MATERIAL CONSIDERATIONS AND PROCESSING

To minimize material residence time in the machine, the shot size weight should be 45 – 80% of the barrel capacity in order to provide the best results. If the shot weight is 30% or less of the total barrel capacity, material discoloration and degradation can occur. To minimize this risk, slower screw speeds, lower barrel temperatures, and decreased back pressures should be used to minimize potential molding problems. Ideal processing temperatures for SUNPRENE® and VINIKA® compounds range from 330°F - 380°F. Actual processing ranges will vary with durometer hardness and the flow characteristics of the SUNPRENE® and VINIKA® compounds. *Checking the temperature of the melt stock with a needle probe pyrometer is the most effective means of determining proper machine conditions.*

When trying to change the melt stock temperature, vary the injection speed, screw speed, and/or back pressure slightly. If adjusting these conditions does not change the temperature to the desired range, then induced heat addition or reduction by adjusting the temperatures on the nozzle and cylinder should be attempted. In most cases, back pressures of less than 100 psi is more than adequate for successful molding.

MOLDING CONDITIONS

Temperatures
Rear Barrel Zone Temperature 320°-350°F
Middle Barrel Zone Temperature 320°-360°F
Front Barrel Zone Temperature 320°-380°F
Nozzle Temperature 330°-360°F
Mold Temperature 70°-140°F
Melt Temperature 320°-380°F

First Stage Injection Time 1 – 15 seconds
Second Stage Injection Time 5 – 10 Seconds
Cooling 10 – 30 Seconds
Screw RPMs 60 – 90 RPM

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MATERIAL HANDLING

SUNPRENE® and VINIKA® compounds are not moisture absorbent materials; however, if the material should display moisture-related problems during molding, it should be dried for at least two to three hours at a temperature of 160° - 180°F (71°-82°C).

SUNPRENE® and VINIKA® compounds are heat sensitive, if accidentally overheated in the barrel, both the screw, barrel and mold may have to be cleaned manually. If the condition is not severe, this may be accomplished by purging the barrel with a suitable PVC compatible purging compound.

SUNPRENE® and VINIKA® **should not** become in contact with acetal (POM) resin. Mixing of PVC and POM will cause a chemical reaction in the barrel that can harm plant personnel and damage equipment

Note: While the information in this booklet is believed to be reliable and correct, it is not intended and should not be construed as a representative or warranty, express or implied, as to results obtained or to be obtained by others who might make use of this information or with respect to the absence, existence or validity of patent rights, if any, of others involving any composition or process herein referred to; or an inducement or recommendation for the violation of any such patent rights; and responsibility and liability is therefore disclaimed.

SUNPRENE® and VINIKA®

Injection Molding Shrinkage Chart

Hardness	Shrink Range	Shrink Range
Shore A 40 – 60	.015 - .021"/"	(0.38 – 0.53 mm/inch)
Shore A 60 – 80	.013 - .018"/"	(0.33 – 0.45 mm/inch)
Shore A 80 – 90	.012 - .016"/"	(0.30 – 0.40 mm/inch)
Shore A 90 +	.003 – 0.12"/"	(0.20 – 0.30 mm/inch)

Note: Shrinkage values above relate to general value ranges and can be effected by various parameters including gating, wall thickness, processing and material formulation.

SUNPRENE® & VINIKA®

Injection Molding PVC Trouble Shooting Guide

Issue	Possible Cause	Possible Solution
Flashing	1. Injection pressure too high 2. Clamp pressure too low 3. Injection speed too fast 4. Stock temperature too high 5. Mold faces not planed parallel 6. Improper venting	1. Decrease injection pressure 2. Increase clamp pressure 3. Decrease injection speed 4. Decrease stock temperature 5. Rematch mold faces at the parting line 6. Check the venting – clean or deepen vent
Sink Marks	1. Injection pressure too low 2. Injection hold time too short 3. Cylinder temperature too high 4. Mold temperature too high 5. Cycle time too short 6. Sprue runner or gate size too small 7. Injection speed too fast 8. Nozzle temperature too high 9. Insufficient packing of material in the mold 10. Shot size too small	1. Increase injection pressure 2. Increase injection hold time 3. Decrease cylinder temperature 4. Decrease mold temperature 5. Increase cycle time 6. Increase sprue runner or gate size 7. Decrease injection fill speed 8. Decrease nozzle temperatures 9. Increase packing pressure 10.Increase shot size

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Trouble Shooting Guide (Continued)

Splay or Silver like Streaks	1. Wet material 2. Stock temperature too high 3. Nozzle temperature too high 4. Back pressure too high 5. Injection speed too fast 6. Dirty machine 7. Gates too small	1. Dry the material 2. Decrease cylinder temperature 3. Decrease nozzle temperature 4. Decrease back pressure 5. Decrease injection speed 6. Purge the machine 7. Increase gate size
Delamination	1. Purge compound left in cylinder 2. Mold temperature too low 3. Injection speed too fast 4. Gate size too small 5. Injection pressure too high 6. Restriction in the nozzle 7. Stock temperature too low	1. Purge the machine 2. Increase mold temperature 3. Decrease injection speed 4. Increase gate size 5. Decrease injection pressure 6. Check for restriction in the nozzle 7. Increase cylinder temperature
Air Bubbles	1. Injection pressure too low 2. Injection hold time too short 3. Injection speed too fast 4. Restriction in nozzle or not seated properly 5. Wet material	1. Increase injection pressure 2. Increase injection hold time 3. Decrease injection speed 4. Check for restrictions in the nozzle and reseat it 5. Dry the material

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