ARCEL™
ADVANCED FOAM RESIN

Tooling and Part Design Guide

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NOVA Chemicals

INTRODUCTION

NOVA Chemicals manufactures ARCEL resins at its North American facility located in Beaver Valley (Monaca), Pennsylvania and also in Ningbo, China, near Shanghai, which is operated under a long-term manufacturing agreement with Loyal Chemical Industrial Corporation. The Beaver Valley and Ningbo sites are certified under the International Organization for Standardization (ISO) 9001 quality standard. The Beaver Valley site is also certified under the ISO 14001 environmental standard. Supporting the manufacturing and sales of our products is our technology center at Beaver Valley, which also hosts a pilot demonstration plant. NOVA Chemicals has sales offices located throughout the world.

NOVA Chemicals' ARCEL resin consists of small spherical beads (primarily polystyrene and ethylene vinyl acetate copolymer) typically 0.03 - 0.08 inches (0.8 - 2.0 mm) in unexpanded diameter. ARCEL resin contains 5% - 12% by weight of isopentane; a volatile, flammable blowing agent. The pentane concentration may vary for developmental products, new products, and off-spec materials.

As a Responsible Care® company, NOVA Chemicals works to ensure the safest possible management of chemical products throughout their life cycle from the planning of new products through their manufacture, distribution, use and ultimate disposal. In support of our Responsible Care® commitment, NOVA Chemicals has compiled this document as a general guide to help our customers safely handle, store and process our ARCEL resin. The information provided in this Guide is believed to be accurate as of the publication date of this Guide. NOVA Chemicals does not warrant or represent the information given to be accurate or complete, and expressly disclaims all implied warranties and conditions including those of merchantability and fitness of product(s) for a particular purpose. The information contained herein is subject to change without notice and NOVA Chemicals disclaims any obligation to update the information contained herein. Responsibility for use, transportation, storage, processing, handling and disposal of the products described herein is that of the purchaser or end user.

This Guide is intended for use in conjunction with NOVA Chemicals' Material Safety Data Sheet (MSDS) for ARCEL resin. Essential information relating to the safe handling, transporting, storing and use of ARCEL resin is detailed in the MSDS. It is important to note that government legislation/regulations and industry standards/codes for building, fire protection/prevention, environment, health and safety, processing, use and transporting of products such as ARCEL resin must always be observed. Certain information prescribed by government regulations is summarized on the MSDS. For an up-to-date MSDS, please contact NOVA Chemicals at 1-412-490-4063 or via e-mail at msdsemail@novachem.com . This document is intended as a general guide to processing ARCEL resins.

ARCEL Tooling Guide

Obtaining quality ARCEL resin molded foam parts requires mold design and molding techniques that are essentially similar to expandable polystyrene (EPS) processing. Attention to the following points and minor enhancements of the tooling design should provide optimum results.

Fill Gun Sizing - Due to the size of ARCEL resin prepuff, ¾-inch (19 mm) internal diameter fill guns are recommended; larger guns may offer some benefits at molding densities below 1.4 pcf (22 g/l).

Fill Gun Placement - Fill guns must be positioned to provide proper fill of the mold, and not positioned because it is a convenient location on the tool.

Before metal is cut, consider:
- What press the tool will go into
- Mold mounting configuration
- Orientation of cavities

Fill Air - Multi-cavity ARCEL resin tools can have many fill guns. Consideration must be given to compressed air line sizes to ensure efficient fill gun operation and mold fill velocity. Vacuum assist during fill may be helpful.

Telescoping Tools (Crush Fill) - Telescoping tools enhance fill and molded part surface. They allow the molder to consider <5/8-inch (16 mm) flat bottoms and higher, narrower sidewalls.

Knock-outs – Since ARCEL resin is more flexible than EPS, knock-out pin diameter should be at least 1-¼ inches (32 mm), spaced on 12-inch (310 mm) centers and positioned to provide a balanced ejection for minimum part distortion. Smaller diameter pins may be used in tight areas provided that spacing and positioning are considered.

Mold Finish - Extra care in mold finishing and polishing will provide better ejection properties than the use of non-stick coatings or sprays; however, high de-molding temperatures may require a coating such as Teflon®.

Uniform Metal Thickness - For optimum molding cycles avoid heat sinks. Non-uniform metal thickness can result in under-fused and over-cooled parts. Metal thickness is the same for ARCEL resin and EPS molds.

Steam Vents - Slotted core vents 3/8-inch (10 mm) in diameter and installed on ¾-to-1-inch (19-25 mm) centers on all mold surfaces is recommended. This assures adequate steam penetration for fusion and enhances fill characteristics.

Utility Distribution

- **Steam**: To avoid uneven heating and/or hot spots do not direct the inlet steam supply toward one portion of the molding surface.
- **Water**: To provide uniform, efficient cooling, the cooling water should be spray manifolded; ideal water temperature range is 85-100°F (29-38°C).

Drain Sizing - For efficient air removal, especially during fill, the drain system cross-sectional area must be equal to or greater than total core vent area. There should be no back pressure in the drain lines during fill.

Parting Line – One way to increase venting area is to vent through the parting line using stand-off during the fill cycle. Considering the large size of the ARCEL resin prepuff, a significant stand-off is possible.

ARCEL Part Design Guide

Since expanded ARCEL resin particles are un-lubed and large compared to EPS, successful shape molding begins with careful consideration of the design of the part. The following techniques are guidelines to maximize productivity while still maintaining part functionality.

Shrinkage - Part shrinkage can be affected by mold geometry, tool design, material handling, molding conditions and other factors. Typical shrinkage over the normal part density range of 1.4 – 2.5 pcf (22– 40 g/l) is 0.75 – 1.0% for ARCEL 730 resin. Shrinkage may increase at lower densities since the cell walls are thinner and the polymer has been stretched further. Recommendations for minimizing shrinkage at low densities are in the Shape Molding section of NOVA Chemicals' ARCEL resin *Expansion & Molding Guide*.

Part Thickness

- Recommended minimum part thickness for fairly simple, average sized parts is 1/2-inch (13-mm). To ensure optimum fusion and dimensional control, strive for uniform thickness in all sections of the part; avoid wide disparity of thicknesses within a part.
- Increase wall thickness as part complexity increases. Numerous turns through narrow passages reduce fill velocity and packing, which leads to part distortion.
- Increase wall thickness as sidewall or rib height increases. Sidewalls greater than 4-inches (100-mm) become main walls and may require a change in fill gun placement or additional fill guns.

Part Size - As distance increases from fill gun location, fill velocity and pack decrease. General guidelines to determine minimum number of fill guns for a simple part are:

Direction from Fill Gun	Effective Fill Range
Side to Side	8 inches (200 mm)
Up	5 inches (130 mm)
Down	10 inches (255 mm)

Radius of Corners - Part configuration should enhance the smooth flow of ARCEL resin prepuff particles as well as air. It is recommended that a 0.1-inch (2.5-mm) radius be applied to every edge & corner, where possible.

Transitions - Consider the use of transitional shapes as enhancements to flow. Transitional shapes may add material, but may also avoid excess scrap.

Draft Angles - Recommended draft angles for smooth part ejection are:

- Smooth exterior walls 1.2°
- Ribbed walls 1.7°
- Smooth interior walls 1.2°
- Cut outs 4-5°

Raw Material Savings - If sections of a large wall are thinned or eliminated for raw material savings or other reasons, provide adequate draft angles to prevent the foam from sticking onto the plug (see recommendations above). Exhibit caution when thinning sections of walls parallel to the parting line. Use of stand-off to improve fill can raise the density of these sections non-uniformly, potentially causing poor fusion or post expansion. In either case, plugs added to thin a wall or for material savings should not be solid metal plugs since these will act as heat sinks and adversely impacts fusion and cycle time. All parts of an ARCEL resin mold should be well vented and of uniform metal thickness.

Fabrication - The following techniques can be used to fabricate parts from ARCEL resin board stock:

- Hot wire cutting
- Saw cutting
- Knife cutting and skiving
- Die cutting
- Electric eye contour shaping
- Gluing (hot melt, solvent based)
- Routing
- Heat impressions

Note: ARCEL resin hot wire cutting rate is slower than the rate for EPS, and the odor of the off–gasses is different. As with EPS, proper ventilation and personal protective equipment should be used while performing any foam fabrication.