NOVA Chemicals®

ARCEL® LD Resin

Tooling and Molded Part Design Guide

INTRODUCTION

NOVA Chemicals' ARCEL® LD moldable foam resin consists of small spherical beads (primarily polystyrene and ethylene vinyl acetate copolymer) typically 0.03 – 0.08 inches (0.7 – 2.0 mm) in unexpanded diameter. ARCEL LD typically contains 6.2 – 8.2% by weight of a volatile, flammable blowing agent, typically isopentane.

NOVA Chemicals Inc. (NOVA Chemicals) manufactures ARCEL LD moldable foam resin at its North American facility located in Beaver Valley (Monaca), Pennsylvania. This site is certified under the International Organization for Standardization (ISO) 9002 quality standard and is supported by an on-site technology center and a pilot demonstration plant. NOVA Chemicals sales offices are located throughout the world.

As a Responsible Care® company, NOVA Chemicals strives to ensure the safest possible management of its chemical products throughout their life cycle from planning of new products through their manufacture, distribution, use and ultimate disposal. In support of our Responsible Care commitment, NOVA Chemicals prepared this Guide to help our customers safely handle, store and process ARCEL. Responsibility for use, transportation, storage, 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 LD. Essential information relating to the safe handling, transporting, storing, and use of ARCEL LD are 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 LD must always be observed. Certain required regulatory information is summarized on the MSDS. Please contact your NOVA Chemicals' Customer Service Representative for an up-to-date MSDS for ARCE LDL. This document is intended as a general guide to processing ARCEL LD resins. Please contact the Technical Service department for further details and assistance.

The information in this Guide is provided in good faith, and is, to the best of our knowledge, true and accurate. 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.

Obtaining quality ARCEL LD 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 LD prepuff, ¾-inch (19 mm) internal diameter fill guns are recommended; 21-22mm guns may offer some benefits at molding densities below 1.1 pcf (17.6 g/l). Fill gun hose size should also be increased when processing densities below 1.1pcf (17.6g/l)

Fill Hoppers- Fill hopper discharge ports may need to be modified, enlarged, to accommodate the larger fill hoses and fill guns required to successfully process low density ARCEL LD.

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 LD 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 <.70-inch (18 mm) flat bottoms and higher, narrower side walls.

Knock-outs – Since ARCEL LD 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, however high de-molding temperatures may require a coating such as Teflon®. Non-Stick mold treatments are highly suggested.

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 LD 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. We suggest that the slots be aligned parallel to the movement of the mold halves. There are no surface lubricants applied to any grade of ARCEL so vent blockage is not an issue. Slotted vents assure adequate steam penetration for fusion and enhance fill characteristics. Proper vent alignment reduces friction during eject, improving part ejection and speeding up cycle time.

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 LD prepuff, a significant stand-off is possible.

Since expanded ARCEL LD 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 0.95 - 2.5 pcf (15.4– 40 g/l) is 0.75 – 1.0% for ARCEL LD resin. Shrinkage may increase at lower densities since the cell walls are thinner and the polymer has been stretched further. Shrinkage may be further influenced by residual pentane content and rate of dissipation.

Part Thickness

- Recommended minimum part thickness for low density < 1.1 pcf (17.6 g/l), fairly simple, average sized parts is 0.71-inch (18-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 LD 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). Use 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 LD mold should be well vented and of uniform metal thickness.

Fabrication - The following techniques can be used to fabricate parts from ARCEL LD 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 LD 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.