Cryogenic deflashing for molded rubber parts

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Flash is excess rubber that protrudes from the surface of a molded part. This defect is common to injection, transfer and compression molding, and can be caused by worn tooling, improper venting, low clamping pressure, low viscosity or uneven flow. Even a small amount of mold flash reduces part quality; but excessive flashing can interfere with part performance or product assembly. Rubber molders have a choice of deflashing methods, but cryogenic deflashing provides cost saving advantages and improves quality and consistency across elastomers and applications.

How cryogenic deflashing works

Cryogenic deflashing cools molded rubber parts below the elastomer's glass transition temperature (T_g) so that the flash becomes hard, brittle and easy to remove. The parts are then impacted with a cryogenic grade polycarbonate medium that comes in different lengths and diameters, including sizes that are small enough to clean internal part features. This process is especially efficient at removing flash from cross holes, blind holes and other hard to reach part geometries. Most importantly, cryogenic deflashing will not affect a part's critical tolerances or change the elastomer's physical or mechanical properties. In other words, only the flash is removed.

Unlike manual trimming with knives or other hand tools, cryogenic deflashing is a computer controlled, machine based process. An operator loads and unloads a parts basket, but the deflashing itself is automated. This eliminates variability across workers and shifts, ensuring the consistent removal of flash from all of the batch's parts. Cryogenic deflashing also makes it possible to define and save the optimal recipe for removing flash from a future batch of the same part. Customers can request initial sampling before work begins, and then review part inspection reports before and after deflashing to ensure the highest level of quality is achieved.

The polycarbonate media that are used in cryogenic deflashing are specially formulated for cryogenic temperatures and can reach small cavities. Below 0.015" (0.381 mm), however, these plastic media lose their aggression. They can also become trapped in complex part geometries. Yet, cryogenic technology can still address these challenges. Dry ice blasting, an effectively medialess process, uses frozen carbon dioxide particles that sublimate upon impact. Although this sublimation occurs too quickly for reliable measurements at smaller sizes, dry ice blasting can clean cavities as small as 0.003" (0.0762 mm).

Dry ice blasting, or dry ice cleaning as it is also known, is not always required after cryogenic deflashing; however, this safe, clean process is sometimes used with batches of small, but precise parts that need to meet strict cleanliness requirements. Still, it is important to note that the polycarbonate media for cryogenic deflashing are both non-toxic and dust-free. Dry ice blasting is FDA and USDA approved, and it can be used as a standalone process for parts that are too large to fit inside a cryogenic deflashing machine. Examples include large rubber sleeve-like seals for power generation equipment.

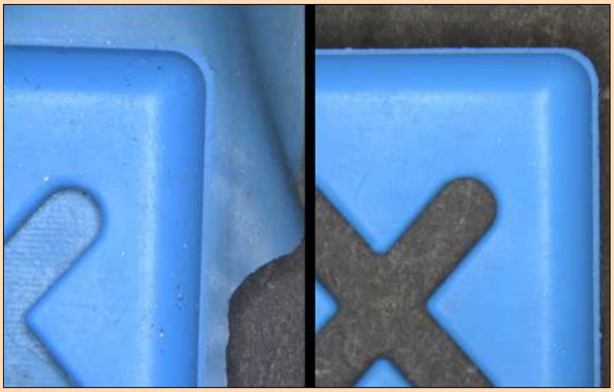
Elastomers and applications

Today, cryogenic deflashing is used with parts that are molded from a variety of elastomers, including silicone, EPDM, nitrile and butyl rubber. Applications include the medical, automotive, aerospace and electronics industries. Table 1 provides an over-

Table 1 - molded rubber materials and examples of parts that can be deflashed cryogenically

Molded rubber material	*Examples of molded parts*
Butyl	Gas resistant seals and gaskets, medical products, sporting goods and electrical components
EPDM	Automotive parts, weather resistant seals and gaskets, electrical insulation, marine applications
Polychloroprene	Protective gear, waterproof gaskets and seals, laptop sleeves and cases, industrial hoses, orthopedic supports
Nitrile (NBR, Buna-N)	Grommets, gaskets, seals, hoses, tubes and other molded rubber parts that resist contact with fuels
Polyurethane	Impact resistant bumpers, bushings, rollers, casters, wheels, cams and furniture components
Silicone	Blocks, bumper stops, distal handles, o-rings, gaskets, housings, overmolded springs
Liquid silicone rubber (LSR)	Medical devices, infant care products, automotive components, appliance parts, consumer goods and textiles
Urethane	Abrasion resistant seals and gaskets, wheels and rollers, bumpers and shock absorbers, electrical components, medical devices
Fluoroelastomer	Oil seals, gaskets, hoses and o-rings

Figure 1 - silicone medical gasket before and after cryogenic deflashing



view of molded rubber materials, and examples of parts that can be deflashed cryogenically.

Cryogenic deflashing for silicone is used with parts that are compression, transfer or injection molded, or that are molded from liquid silicone rubber (LSR) (figure 1). Examples include block shaped silicone implants for surgical applications, and silicone bumper stops for shock absorption. Cryogenic deflashing is an especially good choice for removing flash from the silicone distal handles that are used with handheld surgical instruments. When a medical molder wanted to replace hand trimming, Nitrofreeze Cryogenic Solutions saved the molder over six hours of deflashing labor for every 1,000 distal handles.

In addition to silicone o-rings, gaskets and housings, cryogenic deflashing is used with silicone overmolded springs, a type of rubber-to-metal bonded assembly. For a 60 durometer silicone part that measured just 1 cubic inch, Nitrofreeze Cryogenic Solutions removed parting line flash that was 0.005" thick and extended 0.200". The batch sizes were thousands of parts per week, an amount that would have required a significant amount of hand labor. Cryogenic deflashing can also remove mold flash from fluorosilicone seals and gaskets that provide increased resistance to fuels, oils, chemicals and high temperatures. Often, molded fluorosilicone parts are used in military and aerospace applications.

EPDM rubber costs less than silicones or fluorosilicones, but molders still need to deflash molded EPDM cost effectively. In the automotive industry, cryogenic deflashing can support the fast and accurate removal of flash from high volumes of EPDM hoses, seals and gaskets. Because of its resistance to high temperatures, EPDM rubber is also used in electrical insulation and industrial gaskets. With the increasing popularity of alternative energy technologies, additional applications are being developed, including deflashing molded EPDM parts for solar panels and battery energy storage systems.

In various industries, cryogenic deflashing applications for molded EPDM include grommets for wires and cables. When a rubber molder asked Nitrofreeze to remove flash from 50 durometer EPDM grommets, it was especially critical to remove material from inner diameter (ID) holes to support smoother feeding. Cryogenic deflashing also removed the outer diameter (OD) flash that could distort the part's cone shaped features. Manual parts trimming could remove this OD flash, too, but it could not match cryogenic deflashing for important ID dimensions.

Nitrile, a synthetic rubber that resists oil and abrasion, is also a strong candidate for cryogenic parts deflashing. Molded nitrile parts are used in a wide range of industrial and automotive applications, but especially seals, gaskets, o-rings and hoses. Buna-N, as nitrile is also known, is sometimes used in the aerospace industry with fuel system components, and in the medical industry with catheter kits. As with other elastomers, the design of the part and the thickness of the flash are factors that a cryogenic deflashing service will consider in defining the right recipe for a molded nitrile part.

Like other elastomers, butyl rubber is also a suitable material for cryogenic deflashing because it can withstand low temperatures without becoming overly brittle and cracking. Butyl supports compression, transfer and injection molding, but is prone to flashing if there are issues with tooling or processing. Because of its airtight and water resistant properties, butyl is used in seals and gaskets for building and construction applications. Butyl's inertness and low extractable levels also make it a good choice for the molded vials and syringe plungers used in medical applications. To ensure sealing and insulation, all of these parts require a flash-free surface.

Cryogenic deflashing versus other deflashing methods

Compared to hand trimming, cryogenic deflashing can remove mold flash from batches of parts with greater speed, accuracy and consistency. Yet this deflashing method also provides advantages over vibratory tumbling, which typically uses polyester based plastic pellets as the media. These plastic media are softer than the ceramic or steel media that can be used, but polyester is generally combined with abrasives that produce significant dust. In addition, vibratory tumbling may require water and chemical cleaners.

For rubber molders, cryogenic deflashing supports greater productivity, along with improved part quality and consistency. At a time when many manufacturers are struggling to fill open positions, this machine based, automated process also supports the more efficient use of labor resources, since hand trimming is time consuming, and vibratory tumbling requires cleanups. Whether a rubber molder outsources deflashing or brings cryogenic deflashing equipment in-house, it is worth investigating the advantages that this process can provide.