K.C. SEALS

Rubber Molding Design Guide

Design Tips and Available Materials

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History of Rubber

The story of Charles Goodyear and vulcanization

You can not speak about the history of rubber without mentioning Charles Goodyear. His name graces the tires under millions of automobiles and is credited with inventing the process for the modern form of rubber: Vulcanization. In 1839, Charles Goodyear accidentally dropped some India rubber mixed with sulfur on a hot stove and sodiscovered vulcanization. He was granted his first patent in 1844 but had to fight numerous infringements in court; the decisive victory did not come until 1852. That year he went to England, where articles made under his patents had been displayed at the International Exhibition of 1851; while there he unsuccessfullly attempted to establish factories. He also lost his patent rights there and in France because of technical and legal problems. In France, a company that manufactured vulcanized rubber by his process failed, and in December 1855 Goodyear was imprisoned for debt in Paris Meanwhile, in the United States, his patents continued to be infringed upon. Although his invention made millions for others, at his death he left debts of some $200,000.

Our Products

Packer Elements

Bonded Seals

Seals

Custom Profiles

Centralizer Fins

Liner Wiper

CV Boots

BOP Seals

Factory Tour

Presses

Our facility is home to a multitude of different presses with variable tonnage. KC Seals can manufacture rubber products in diameters ranging all the way from 1/2 an inch to 16 inches, with a maximum height of 10 inches.

CNC Machines

Industry-standard tooling is typically made for the machining of metals. Our CNC lathes are equipped with custom tooling and inserts specifically designed for the manufacturing of rubber. Meaning quality finishes that rival compression molded parts, and tolerances as low as 5 thou.

In-House Mold Manufacturing

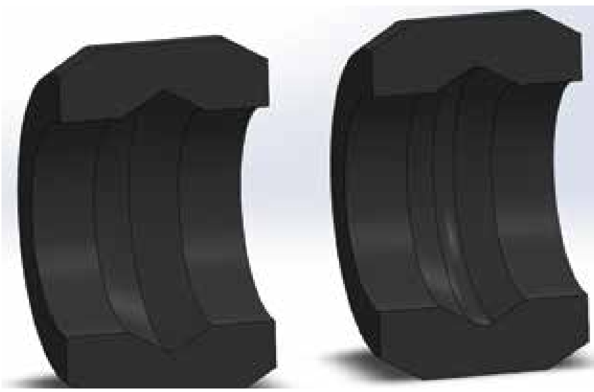
Mold cost is one of the major deterrents when considering moving forward with an engineering project. That's why we moved the mold making process in-house. Our fully equipped machine shop means significant cost savings, consistent quality and guaranteed lead times. You also have the added security that your IP will stay under one roof and not be shipped off to a machine shop you don't know.

Rubber to Metal Bonding

From surface preparation, primer and adhesive application, to molding and testing. KC Seals is fully equipped to handle all your rubber to metal bonding needs.

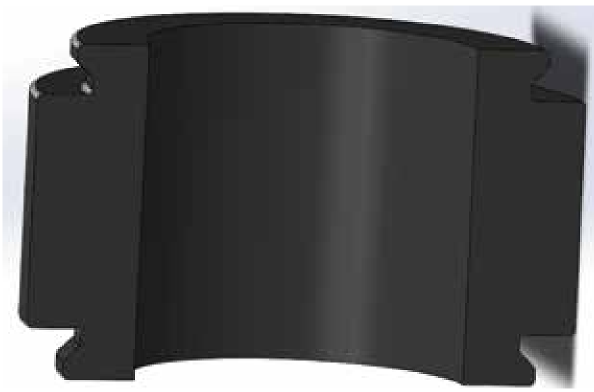
Design Tips for Rubber Molded Products

When faced with the task of designing rubber parts for your mechanical system, it is extremely beneficial to have a basic understanding of the limitations, optimizations related to mold design, as well as the molding process. If certain design guide rules are followed you can expect better product quality, minimized ooling costs, and quicker production speeds. The following two pages are some key considerations for you to make when exploring ways to optimize the production of your rubber part.



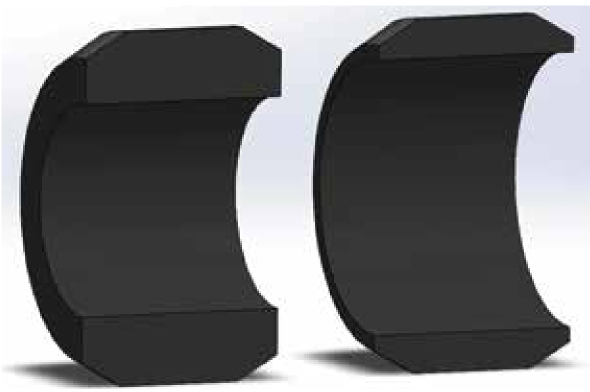
Sharp Vs Rounded Corners

In the image seen above, the rounded edges are the preferred profile for manufacturing purposes. Sharp edges are very susceptible to damage during the molding and de-molding process. An example would be the tearing of the product while uninstalling the molded product out of the assembled tool. Rounded corners will increase consistency, prevent product defects, which in turn will lessen production time and decrease your price per piece.



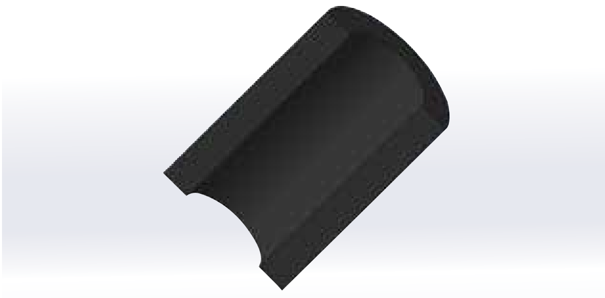
Undercut features

Undercut features will most likely introduce a split-core design to facilitate demolding and not tearing the product while ejecting the part out of the mold. Most of the time, a saw-cut will not be acceptable to split the mold component and therefore we would need to manufacture multiple identical pieces to be able to achieve the split-core design. Consequently, the manufacturing cost of the mold increases significantly. Although undercuts can be done, if they are not necessary for your design they are better left out.



Wall Thickness

When molding rubber, it is important to be able to disturb the raw material (uncured elastomer) as much as possible within the mold cavity. Therefore the inner diameter of the product needs to be reasonably big enough as compared to the cross-sectional thickness. This gives the mold component that makes the product ID the ability to plunge into the uncured rubber within the cavity, actively getting the raw material to flow as best as it can. The results of this mean: less likelihood of ir pockets, consistent quality, and prevents the need for a transfer mold, which significantly reduces the cost of setup fees.



Product Size Limitations

Although there is a wide range of part complexities we can manufacture, with our 150-350 ton vacuum presses, we have the ability to manufacture rubber products with outer diameters up to 16 inches, whereas, on the smaller scale, the parts can be as small as half an inch. Part height-wise, the product could be as long as 10 inches.

Bonding Rubber To Metal

When it comes to bonding rubber to metal, it is important to have the surface finish on the metal roughed in order to increase the mechanical grip between the rubber and the metal. Some of the recommended options are knurling, sandblasting, or during the machining process, you can leave a surface finish of at least RMS 250.

Dimensional Tolerances RMA "A2" Spec

The table below shows the RMA "A2" tolerance standards which is commonly used in the Oil and Gas industry. The main reason why there is a need to use a tolerance range standard for a finished rubber product, is simply the fact that all cured elastomers shrink differently while it is cooling off after the demolding process. Besides, the same material can shrink differently if the following process parameters are altered: Mold design (Transfer vs Compression molding), mold cavity pressure, different raw material batches, wall thickness of the product, etc.

Size (millimeters)			**Fixed**	**Closure**	**Size (inches)**			**Fixed**	**Closure**
Above		Incl.			Above		Incl.		
0	-	10	+/-.16	+/-.16	0	-	.40	+/-.006	+/-.008
10	-	16	0.20	0.25	.40	-	63	0.008	0.010
16	-	25	0.25	0.32	.63	-	1.00	0.010	0.013
25	-	40	0.32	0.40	1.00	-	1.60	0.013	0.016
40	-	63	0.40	0.50	1.60	-	2.50	0.016	0.020
63	-	100	0.50	0.63	2.50	-	4.00	0.020	0.025
100	-	160	0.63	0.80	4.00	-	6.30	0.025	0.032
160	-	& over			6.30		&over		
multiply by			0.004	0.005	multiply by			0.004	0.005

Available Materials

When it comes to pressure, temperature, corrosion, H2S, the impact of chemicals and the like. It is generally agreed that there is no material that will meet all the criteria, hence selection of the right elastomer is key in ensuring the longest life and reliability at optimum cost.

The next following pages will go over the compounds we offer at Kc Seals. There are many other variations of each listed compound, but for sake of space, we have listed our most commonly supplied versions of each compound.

FKM is a copolymer made of highly fluorinated hydrocarbons. FKM displays very good resistance to media, ozone, and aging. The material is also stable in fuels as well as petroleum-based oils and greases, along with aliphatic and aromatic hydrocarbons.

List of available compounds

- Standard grade 70, 80, and 90 durometer
- Low Temp FKM
- Viton Extreme
- Highly Fluorinated FKM

NBR is a synthetic rubber that is fabricated through the co-polymerization of acrylonitrile and 1.3-butadine. It.is a cost-efficient material solution and features good cold flexibility with low acrylonitrile content, elastic properties, and tough wear resistance.

List of available compounds

- Standard grade 70, 80, and 90 durometer
- Low ACN content NBR
- High ACN content NBR

HNBR is produced through the selective hydrogenation[1,2] of NBR. The reactive double bonds are removed from NBR. As a result, the molecule chain does not react as easily to oxygen and is thus significantly more heat resistant than NBR. In addition, HNBR offers better wear behavior in dynamic applications.

List of available compounds

- Standard grade 60, 70, 80, and 90 durometer
- Upgraded HNBR

TFE/P commonly referred to as Aflas®; it is a unique fluoroelastomer that has superior amine resistance, suitable for glycol-based brake fluids, Ammonia gas, superheated steam, and has excellent electrical insulation compared to conventional fluoroelastomers.

List of available compounds

- 75 durometer
- 95 durometer

EPDM Thanks to its excellent stability in water and aqueous solutions, EPDM is one of the most widespread materials in the food and pharmaceutical industry with its share of approx. 70 percent.

List of available compounds

- Standard grade 70, 80, and 90 durometer
- Low ACN content NBR
- High ACN content NBR

XNBR Carboxylated Nitrile is similar to Nitrile rubber, but the polymer backbone has been chemically modified with Carboxylic Acid containing group. This result is XNBR with more excellent abrasion and tear resistance than traditional NBR.

List of available compounds

- Standard grade 80 and 90 durometer

VMQ Silicone elastomers are ideal for high and low-temperature applications. They have high heat and oxidative stability, outstanding low-temperature flexibility, and are resistant to many chemicals, weathering, ozone and sunlight (UV).

List of available compounds

- 60 durometer
- 70 durometer
- 80 durometer
- 90 durometer

SBR derived from styrene and butadiene. These materials have good abrasion resistance and good aging stability when protected by additives. About 50% of car tires are made from various types of SBR.

List of available compounds

- 70 durometer
- 80 durometer
- 90 durometer

FFKM With the ability to withstand temperatures as high as 300 C, while matching chemical resistance typically seen with PTFE. FFKM materials are suited for the most aggressive environments and are second to no elastomer.

List of available compounds

- SZ481
- SZ485
- SZ498
- SZ134

Polymer Report

Major Compounding Ingredients And Their Function

Although there can be many differentiating characteristics with compounded materials. One thing the majority of them share in common is the compounding ingredients. Below is a list of what those pounding ingredients are and their function.

Elastomers: a polymer with viscoelasticity and has very weak intermolecular forces , generally low oung's modulus and high failure strain compared with other materials. This is the most important ingredient in rubber formulation. Specific elastomers are selected for desired compound properties. Examples of common elastomers include, but are not limited to Nitrile, Hydrogenated Nitrile Butadiene Rubber, Fluoroelastomers , Ethylene Propylene Diene Monomer Rubber, and Styrene-Butadiene Rubber.

Fillers: These are used to reinforce or enhance the properties of elastomers while reducing the cost of the compound. In black compounds, carbon blacks are used and most all rubber compounds use carbon black (CB) as a filler. Carbon black filler functions to strengthen, increase the volume, improve the physical properties of rubber, and strengthen vulcanization. The results of the rubber compound can be useful in making shoe soles, gloves, boots, elements, and motorized vehicle tires. For white compounds, silica, clay, calcium carbonate, etc. can be used.

Processing Aids: a generic term given to a class of material which, when added to a rubber compound at relatively low loading, will improve process-ability without adversely affecting physical properties. These materials are used to help in mixing, calendering, extrusion and molding by lowering the viscosity of a compound. Examples would be various oils and plasticizers.

Antidegradants: These chemicals are used to protect rubber both in uncured and cured states, from oxidation, ozonization, and aging and, therefore, aid in extending product life. Anti-degradants include antioxidants and antiozonants. Since the aging of rubber is caused largely by oxygen, materials that quickly react with oxygen can be used as anti-degradant depending on the type of rubber, although organic compounds that easily react with oxygen are recommended for use as anti-degradant (chemical antioxidant).

Vulcanizing Agents: These chemicals, upon heating, crosslink elastomer molecules to provide harder, more thermally stable elastic products. Sulfur is the primary vulcanizing agent. However, in some cases, peroxides are also used. Peroxides are rather hazardous chemicals and require more attention to the safe storage and handling procedures than many other compounding ingredients. Curing, vulcanization, and crosslinking are synonymous and are used interchangeably.

Accelerators: These materials accelerate vulcanization by increasing the rate of crosslinking reactions. Accelerators also decrease the quantity of sulfur necessary for vulcanization and thus improving 'aged' properties of the rubber vulcanizates.

Activators: These chemicals form complexes with accelerators and further activate the curing process. Zinc oxide and stearic acid are commonly used activators. The accelerator complex plays an important role in both the insertion of sulfur atoms into the complex and in the formation of initial polysulfidic crosslinks. As it is the case with other catalysts, remarkable small quantities of solubilized zinc are needed to initiate and speed up the vulcanization process.