

MANUFACTURING PROCESS

Each radial shaft seal is made for an application, which uses a particular fluid, runs at a pre-determined speed, has certain temperatures and pressures, and is in a specific environment. Because of this the manufacturing process of each type of seal may have some additional steps or modifications.

In general the seal consists of three main components, a rubber portion, a metal can and a spring. Of which, the rubber and can are bonded together and the spring is assembled to the rubber portion.

The elastomer that is used in the seal is called a compound and consists of a variety of different materials (base polymer, fillers, plasticizers, vulcanizing agents, accelerators, cure activator, inhibitors, anti-degradant, pigments). The ingredients for the compound is placed in a mixing machine, where the rotating rotors mix the ingredients creating a homogeneous substance. Because the movement of the rotor creates high temperatures the rotors need to have an internal refrigerant system to avoid the vulcanization of the rubber during this step.

After the compound is homogeneous, it is sent to an open mill, where two cylinders rotate in opposite directions. The speed of the cylinders are different, that way the rubber builds onto one of the cylinders, creating a rubber sheet. The cylinder temperature is also controlled so that it does not exceed the vulcanization temperature of the compound.



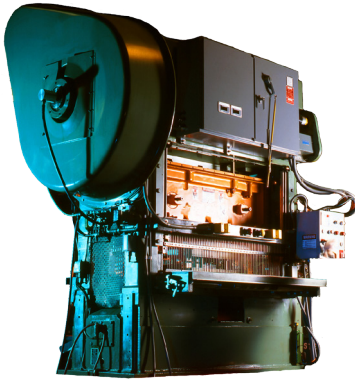
Mixing Machine.

The rotating rotors mix the ingredients creating a homogeneous substance.



Open Mill.

After the compound is homogeneous, it is sent to the open mill, where two cylinders rotate in opposite direction.



Stamping Machine.

The metal sheet is placed on the top of the bottom plate, and the upper die comes down and presses the die into the metal sheet.

Before the rubber moves to the molding department, it is inspected to make sure that it meets the minimum requirements for the material. Various tests are performed to evaluate, hardness, tensile strength, elongation, compression set. The compound may also be tested to those criteria after it has been immersed in a fluid or heated in air. After the batch has been qualified it moves to the molding department and is ready for use.

The metal case is typically manufactured from low carbon steel or stainless steel. Typically metal strip is purchased and the case is formed from a stamping process.

To avoid oxidation in the metal, the parts are coated shortly after stamping. After the stamping process the case is cleaned to remove any metal shavings, grease and dirt. When the case is clean they are coated with zinc phosphate. This coating protects against corrosion and helps improve the surface for later bonding to the elastomer.

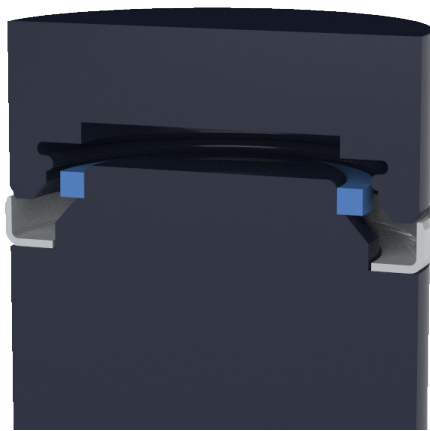
After the plated parts have dried, a primer and bonding agent are applied to the case. The bonding agent is required in order for the rubber to bond to the metal during molding. The primer and bonding agent can be applied with a spray gun, a brush or by dipping.

**MANUFACTURING
PROCESS**

The bonding of the case and rubber is occurs during vulcanization. There are three methods that can be used to mold radial shaft seals:

- Compression molding: The metal case is placed into the lower part of the mold and the pre cut shape of the compound (or preform) is set on top of the case. The upper and lower molds, which contains the shape of the seal, is heated to the vulcanization temperature of the compound. The upper mold is pressed down, forcing the compound to flow into the areas of the mold. After a specific period of time the compound is fully cured, the mold is then opened and the parts are removed.

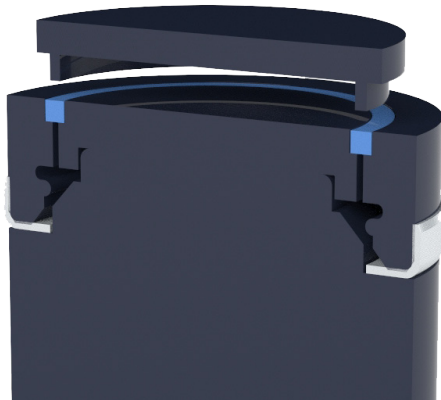
MANUFACTURING PROCESS



Compression Molding

The upper mold is pressed down, forcing the compound into the areas of the mold

- Transfer molding: Again the metal case is placed into the lower part of the mold and the upper and lower molds are heated to the vulcanization temperature. The preform in transfer molding is placed into a transfer pot and not in the mold itself. The mold is then closed and the elastomer is transferred into the mold via the later compression of the transfer pot. This type of molding presents less flash in the part than compression molding.

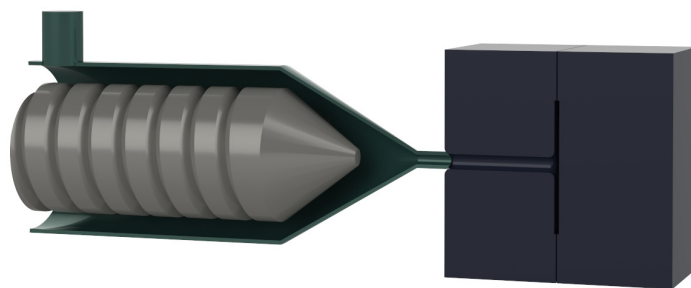


Transfer Molding

The preform is placed into the transfer pot and not into the mold itself

MANUFACTURING PROCESS

- Injection molding: In this type of molding the compound is poured into a barrel, where it is heated at higher temperatures than the compression or transfer molding. This is done because the distance to the mold is generally longer. The barrel contains a screw that moves the compound forward while it is being heated. The compound is then forced into the mold through a nozzle. Once the mold is full the screw stops moving, ceasing the flow into the mold. After the elastomer has cured the mold opens and the parts are removed.



Injection Molding

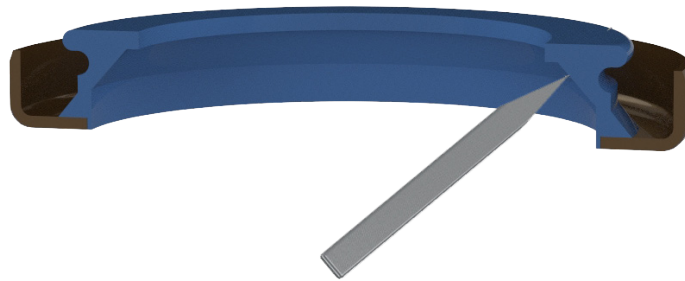
The compound is forced into the mold through a nozzle

After the rubber and can are bonded together they are transferred to the trimming machine; there are different kinds of machines for trimming a seal, the main difference is the way the seal is held down while is being trimmed, some use a vacuum and others use a tight fit to a collet. During trimming the seal rotates at a high RPM while knives trim the part.

The spring in a radial shaft seal is manufactured from high carbon steel wire that is placed in a spring coiling machine.

The seals and springs are inserted into the seal either in an insertion machine or by hand. The seals may go through a machine to help orient them properly for assembly of the spring.

After the spring has been loaded the seals may be checked in the same insertion machine or in a checking machine, where a camera will measure the inner diameter of the seal to make sure that the spring was correctly installed.



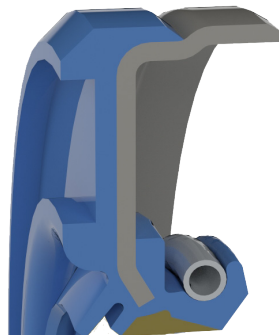
Knife Trimming

During trimming the seal rotates at a high RPM while the knives trim the part.

Some seals require added manufacturing steps. A few of the more common steps are listed below:

- The outside diameter can be ground. Grinding the OD helps to control a tighter tolerance on the OD of the metal portion of the seal.
- OD sealant may be added to the outside diameter. This helps to prevent leaks due to bore imperfections. OD sealant is typically applied to all seals that have metal only OD's, such as a TB2 or VB2 cross section.
- The edge of some seal cases can be rolled to make the installation of the seal easier and prevent seal-cocking during installation
- Seals can also be pre-greased before packaging. The added grease acts as a pre-lubrication for the seal lip and helps to provide initial lubrication to the lip for installation and initial run-in of the lip.

MANUFACTURING PROCESS



Greased Seal.

Grease can be added to some seals to keep the lip lubricated during the break in period.

Manufacturing Process

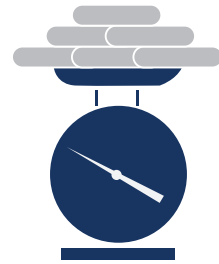
START

1



ESP engineers work with the customer to design a seal for their application.

2



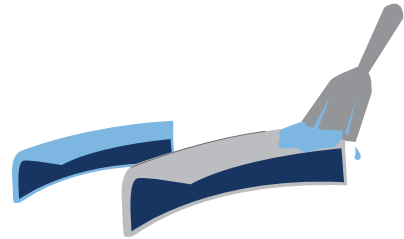
Select and weigh compound ingredients

5



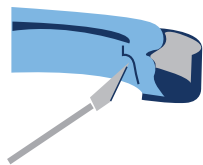
Material is inspected and tested

6



Metal cans are stamped, zinc phosphate coated and a bonding agent is applied

8



The seals are trimmed as needed

9



Springs are inserted into the seals

12

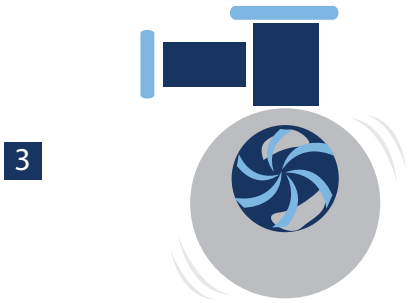


Sample parts are tested and inspected

13

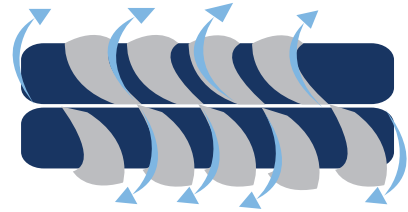
Parts are packaged and shipped from one of the ESP worldwide locations





3

Compound is combined in a mixing device



4

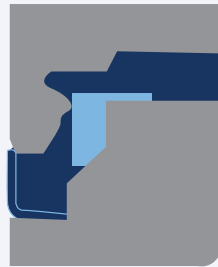
The compound is transferred to an open mill

The parts are molded using one of this methods

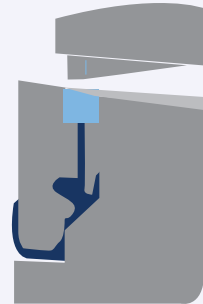
7



Injection Molding



Compression Molding



Transfer Molding

10



The OD can be ground, OD sealant applied and the edge of the case can be rolled as needed

11



Seals are greased as needed

