O-Ring Manufacturing Process

By Savvy Team on June 4, 2024

O-ring is an annular rubber seal, usually made of elastomer material, used to seal two surfaces in relative motion to prevent liquid or gas leakage. It has excellent elasticity and resilience and can maintain good sealing performance under pressure and temperature changes.

There are several o-ring manufacturing processes, the compression molding process being the most typical and commonly used.

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Injection Moulding - for precise o-ring manufacturing process

Injection moulding is suitable for producing high-precision and complex structure o-rings. This method first heats and melts the rubber material and then injects it into the mould through an injection machine for moulding. It has the advantages of fast moulding speed, good product consistency, high precision and surface quality.

Spliced Vulcanized * - for big o-ring manufacturing process

Many large-size o-rings, such as those with an inside diameter greater than at least 450mm, can be produced using the spliced vulcanized manufacturing process. Spliced vulcanized o-rings are made from cut and bonded extruded cord. To form a spliced vulcanized O-ring, the extruded cord is cut to the appropriate length, and then the cut ends are joined using an adhesive. The bonded and joined ends are placed in a high-temperature mold to make the joint bond firm and unbreakable. Savvy uses this method to produce a large number of large-size o-rings. Our production process is advanced, the tolerances are tight, the joint is well processed, and the surface is smooth.

Compression Molding ** - the main o-ring manufacturing process

This is the most common and efficient way to manufacture o-rings. In China, 80% of o-rings are produced using this method. In addition to o-rings, it also includes o-ring seals with special cross-sections, rectangular rings, square rings, x-rings, rubber gaskets, customized rubber seals, etc.

(1) Raw Material Preparation (Rubber Mixing)

The o-ring manufacturing process technology has certain requirements for the plasticity of raw rubber. In order to meet various process performances, raw rubber needs to be plasticized. However, most synthetic rubbers control the initial plasticity of raw rubber during the synthesis process and can be directly mixed without plasticization. In addition, natural rubber, hard nitrile rubber, isoprene rubber, styrene-butadiene rubber, etc., all need to be moderately plasticized.

Plasticization can reduce the viscosity of rubber, making it easy to mix compounding agents; it can improve the rheological properties of rubber, reduce die expansion and calendering shrinkage; it can also improve the solubility and molding adhesion of rubber. Plasticization must be moderate, and excessive plasticization will reduce the strength, elasticity, wear resistance and aging resistance of vulcanized rubber. Plasticity is mainly determined by the process performance of the mixed rubber and the performance requirements of the product. Raw rubber plasticization is generally carried out on an open rubber mixer, but it can also be plasticized on an internal mixer.

The process of pressing various compounding agents with raw rubber on a rubber mixer to make mixed rubber is called mixing. Mixing is not only a simple mechanical mixing process of raw rubber and compounding agents but also a physical-chemical process in which each component is infiltrated, dispersed, adsorbed, and combined to form a colloidal dispersion with a complex network structure. It is actually a rubber modification process.

The quality of the mixed rubber has a decisive influence on the further processing of the rubber and the final performance of the finished product throughout the rubber processing process. Mixing is one of the processes most likely to produce quality fluctuations. If the mixing is not good, the rubber will have uneven dispersion of compounding agents, fluctuations in plasticity, and even scorching and frosting, resulting in a decrease in the performance of the vulcanized rubber and the finished product.

Mixing can be carried out on an open mixer or an internal mixer. For rubbers with small scale, small batches, and a wide variety of varieties, open mixers are often used for mixing. In addition, open mixers are also particularly suitable for the preparation of certain special rubbers, such as sponge rubber, hard rubber, and fluoro rubber. Internal mixing is safer than open mixing, and the dust-flying phenomenon is significantly improved. The mixing process is mechanized, which reduces labour intensity, shortens mixing time, and improves production efficiency. The rubber compound mixed in the internal mixer must be left for 4 to 8 hours before further processing and the addition of accelerators and vulcanizers.

(2) Mold Design and Making

The sealing performance of the o-ring is closely related to the mould structure, mould processing accuracy and roughness. Strictly process according to dimensional accuracy, the surface roughness of the cavity must be below 0.4um, and all are ground to mirror surface after machining. O-ring moulds are divided into single-cavity moulds and multi-cavity moulds according to the size of the o-ring; according to the process and working conditions, there are 45° parting moulds and 180° parting moulds. The appearance of the o-ring mould can be divided into two types: cylindrical and rectangular. In order to facilitate processing, the 180° parting single-cavity mould and 45° parting single-cavity mould of the o-ring usually adopt a cylindrical shape structure. In contrast, the 180° parting multi-cavity mould adopts a rectangular plate mould shape structure.

(3) Semi-Finished Product Preparation (Cutting Strips)

The manufacturing of o-rings is still mainly based on the molding method. In order to improve production efficiency and product quality and reduce waste, it is necessary to prepare semi-finished products in advance. The traditional manufacturing process of flat vulcanized semi-finished products is that qualified mixed rubber is fully re-refined and pressed into rubber sheets and then cut into rubber strips and rubber blocks. In recent years, many Chinese manufacturers have adopted precision-performing machines to produce semi-finished products of O-rings and other products. This not only improves production efficiency but also ensures the accuracy of the volume and weight of semi-finished products and improves the level of rubber product production technology.

(4) Mold Pressing

During the mold pressing curing process, it is necessary to strictly control the temperature, time, and pressure of curing, pay attention to changes in parameters such as temperature at any time, and take corresponding measures. Otherwise, the product will be under- or over-cured. If an automatic control system is used, the entire curing process will be automatically controlled to ensure that the product reaches the correct curing degree.

The curing temperature is one of the basic conditions for the curing reaction of rubber, which directly affects the curing speed and product quality. The higher the curing temperature, the faster the curing speed, and the higher the production efficiency; the lower the curing temperature, the slower the curing speed. The curing temperature depends on the formula, and the most important thing is to rely on the type of rubber and the curing system used. The most suitable curing temperature for natural rubber is generally 145-150°C, and that for synthetic rubber is typically 150-180°C. The curing time is usually determined by experiment according to the determined curing temperature. Usually, the temperature should be selected appropriately so that the product can be cured quickly and efficiently, and the scorch of the rubber during the mold-on process should be avoided. The temperature and time are usually adjusted according to the size of the product. The larger the product, the lower the temperature and the longer the time to ensure that the product can be fully cured to an appropriate degree.

The purpose of pressurizing rubber products during the curing process is to make the rubber easy to flow, fill the mold cavity, prevent bubbles from being generated, and improve the density of the product. The size of the curing pressure depends on the hardness of the rubber and the size of the mold. When the hardness of the rubber is high, and the mold

size is large, the pressure can be higher. Otherwise, the pressure should be appropriately reduced.

(5) Flash Trimming (Deburring)

When rubber moulded o-rings are vulcanized, excess rubber will flow out along the parting surface, forming rubber edges of different thicknesses. In order to make the product meet the specified size and ensure the appearance quality, the finished product after vulcanization needs to be trimmed. Even if the product is pressed with a borderless mould, it will have a small number of rubber edges. In the O-ring product, these rubber edges are redundant. The process of removing these redundant rubber edges is called trimming in technology.

The trimming methods of moulded rubber O-rings can be divided into two categories according to the operation method: manual trimming and mechanical trimming.

Manual trimming is the most traditional trimming method. Its basic operation is to remove the rubber edges with a scraper or other tool. Manual trimming requires a small investment, has low trimming quality, and is inefficient. It is only suitable for processing small batches of products.

There are two methods of mechanical trimming. One is to put the vulcanized O-ring on a sand rod or nylon rod with a matching inner diameter size, drive it to rotate by a motor and use sandpaper or a grinding wheel on the outer circle to grind off the rubber edge of the inner hole or outer circle with the help of the relative movement between the two. This method is relatively simple, easy to use, and more efficient than manual trimming. It is particularly suitable for small-size and large-volume products. However, this trimming relies on grinding wheels, the trimming accuracy is not high, and the grinding surface is relatively rough.

Another method is low-temperature freezing trimming. At present, there are five methods of freezing trimming: drum freezing trimming, vibration freezing trimming, swinging or shaking freezing trimming, brushing freezing trimming, and shot blasting freezing trimming.

Rubber gradually changes from a highly elastic state to a glassy state under certain low-temperature conditions. The rubber that changes to a glassy state becomes hard and brittle. The speed of hardening and brittleness is related to the thickness of the rubber product. When the O-shaped rubber sealing ring is placed in the freezing trimming machine, the thin rubber edge of the product is frozen at a certain low temperature, hardened and brittle, and the product itself still has a certain elasticity. With the operation of the drum, only collision occurs between them. Impact abrasion occurs between the product and the shot blasting and abrasive, and the rubber edge is broken and falls off, thereby achieving the purpose of trimming. The trimmed product gradually heats up at room temperature to restore its elasticity.

Low-temperature trimming has high production efficiency and good economic benefits. According to relevant information, the drum trimming device's investment is small, and the cost is low. Still, the trimming effect of the inner ring of the product is poor, while the trimming quality of the shot blasting trimming device is the most ideal.

To ensure the trimming quality, the freezing trimming process requires: the rubber edge of the product should be thin, not more than 0.2 mm, the O-ring section should not be misaligned, and the rubber flow groove should be 1~2mm away from the product, that is, the rubber edge width is preferably 1~2mm; if the products vulcanized with a multi-cavity mould are connected into one piece, they should be cut and torn off one by one, and the rubber edge of the inner hole should be opened, so that the freezing trimming effect is good and the trimming time is shortened; the chilly temperature and refrigeration method should be selected appropriately.

In fact, rubber materials are often not brittle when they reach the glass transition temperature. To ensure smooth trimming, the freezing temperature is usually selected to be about 10℃ lower than the brittle temperature of the rubber. The selection of the refrigeration method is mainly based on the refrigeration effect and cost. Most rubbers become brittle at -20~-150℃. Commonly used refrigeration methods include refrigeration with Freon as refrigerant, refrigeration temperature 0 ~ -120℃; solid or liquid carbon dioxide refrigeration, refrigeration temperature 0 ~ -79℃; liquid nitrogen refrigeration, refrigeration temperature 0 ~ 196℃. In contrast, refrigeration by refrigeration machine

consumes a large amount of energy and investment, and the cost is relatively high. Carbon dioxide refrigeration equipment is simple and inexpensive, but when in use, liquid carbon dioxide sometimes “frosts”, and the refrigeration temperature of solid carbon dioxide is difficult to adjust. Liquid nitrogen refrigeration is pollution-free, has a large freezing capacity, fast refrigeration speed, and has high trimming quality, especially for rubber with a very low brittle temperature. At present, liquid nitrogen refrigeration is mostly used abroad.

(6) Post Curing / After Curing / Secondary Curing

Some O-rings need to be cured after production, which is also called two-stage curing. Post curing puts the molded product into an oven or other heating and baking equipment for high-temperature heating and baking.

Not all rubber products need post curing. Some can be directly molded once, depending on the raw material formula. However, some special materials, such as FKM / Viton rubber products and some EPDM rubber products, need secondary vulcanization.

1. Secondary curing can improve the physical properties of rubber products. After secondary curing, the hardness, wear resistance, pressure resistance, aging resistance and other properties of rubber products will be improved, making the products more durable.
2. Improve the processing performance of rubber products. Since post-curing can make the rubber molecules cross-link again during the vulcanization process, the viscosity and strength of the products are improved, so the phenomena of stretching, compression, and shearing during the processing process can be better controlled, thereby improving production efficiency and quality.
3. Repair defects in rubber products. In the production process of rubber products, defects such as bubbles, cracks, holes, etc., may appear due to process problems or material quality. After-curing allows the surface of rubber products to be cured again to fill these defects and strengthen them.

In short, post-curing plays an important role in improving the quality and performance of rubber products, improving processing performance, and repairing defects.

In summary, there are three o-ring manufacturing Processes, and compression molding is the most important one. It includes raw material preparation, mold making, strip cutting, mold pressing, deburring, and post-curing. Each procedure needs to be precisely controlled to ensure the quality and performance of the final product. Only through scientific production processes can o-rings with good sealing performance be produced to meet the needs of various industrial applications.

The o-rings produced by Savvy Rubber are of excellent quality and at a favorable price. You are welcome to inquire and purchase.

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For injection molding, please refer to https://en.wikipedia.org/wiki/Injection_moulding.