How is Sheet Rubber Made?

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Sheet Rubber has for many years represented one of the most reliable and versatile materials for gasketing and sealing applications, as it is both durable under physical or chemical stress, and resilient, able to retain its shape and flexibility under extreme pressures. Rubber seals and gaskets are fabricated in a multitude of ways and in innumerable shapes and sizes. Sealing applications requiring a flat gasket are typically cut from rolls of sheet rubber.

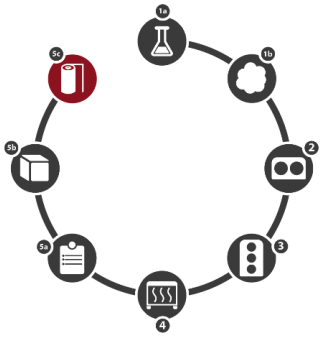
While sheet rubber is produced in a multitude of ways, calendering's greatest advantage is in its flexibility. A single machine can produce a host of variations depending on requirements including, thickness, length, width and with different surface finishes or inserts.

To see the various types of sheet rubber products visit warco.com/sheet. Calendered sheet rubber products can exhibit a wide range of dimensions including:

- Thicknesses: 1/64" to 1/2"
- Lengths: 12.5' to 360'
- Widths: Up to 55"

Note that, while outside the scope of this article, molded rubber slabs can also service many of the same gasket fabrication needs with increased widths and thickness. Additionally, the calender can enhance the roll with different surface finishes or cloth inserts.

This article breaks down the sheet rubber production process into five steps:



1. Material Design
2. Mill Preparation
3. Calendering
4. Autoclave Vulcanization
5. Roll Inspection

Material Design - Mixing & Compounding

The first step in making sheet rubber is developing the formulation, aka recipe, to meet the application's requirements. Whether it needs to be extra soft, resistant to a specific chemical or colored a specific shade, chemists design a formula that meets both the end product requirements and possesses the necessary processing characteristics.

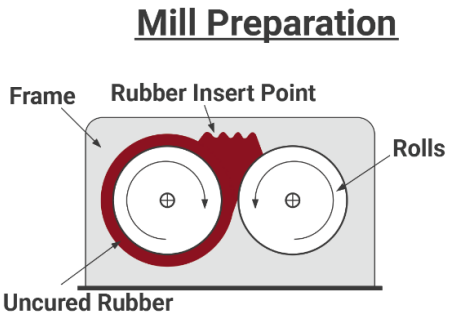
Rubber products are categorized by their base polymer, which go a long way in determining the material's final properties. Learn more about each rubber polymer's characteristics, strengths, resistances, and weaknesses at warco.com/polymers.

The most common types of polymers used in sheet rubber manufacturing include Neoprene rubber, Nitrile rubber, EPDM rubber, Natural Rubber, SBR rubber, Silicone (INFINISIL™) rubber, and Fluoroelastomer (Fluorozone™/FKM/Viton™) rubber.

Assimilation of the ingredients called for in the formulation, known as compounding, is the first step. These materials, including the base elastomer, application specific chemicals, oils, and other processing ingredients and mixed together under a number of carefully defined parameters such as time, temperature and speed. Mixing is typically accomplished by using a mill or internal mixer.

Mill Preparation

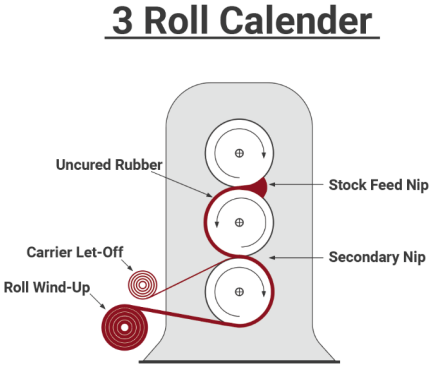
After mixing, the uncured and unformed rubber compound is put onto a mill. The mill, along with the heat generated, is critical in preparing the rubber for calendering.



The speed and temperature of the mill are carefully monitored in order to ensure that the rubber will process smoothly along the calendar when applied; this ensures uniform consistency and affords the first point of inspection where trained operators perform a visual inspection of the material.

3-Roll Calendering - Uncured Sheet Rubber

This is a process of forming sheets through compression and shear to achieve uniform thickness of the rubber by passing it through a series of three heated rolls. Warmed uncured rubber compound is cut from the mill and fed between the top and center rolls of the calender - the Stock Feed Nip. The rubber then passes through the Secondary Nip between the center and bottom rolls where it is applied to a carrier that embosses the surface of the rubber while also serving as a barrier to prevent the sheet



from sticking to itself prior to vulcanizing. Carriers include cellophane for Smooth Finish, Paper for Matte Finish and Fabric for a deeply embossed Fabric Finish. Finally, the material is rolled up onto a core via the calender's Roll Wind-Up.

The distance between the rolls determines the thickness of the calendered sheet. Modern three-roll calenders are equipped with advanced capabilities, allowing for precise control over speed, temperature and tension of the roll through the process. The rolls' surface speed and temperature are tightly controlled to achieve the correct flow of material across the calender and avoiding scoring or sticking. As each compound will interact with the calender differently, effective communication between the material design experts (chemists) and experienced operators is key to a material's calendering success.

Autoclave Vulcanization - Curing Sheet Rubber
After the rubber sheet is successfully calendered, it is placed into an autoclave for curing. An autoclave is an industrial steam vessel which exposes the rubber sheet to heat and pressure, allowing the rubber to vulcanize. This is the process that cross-links its molecular structure, giving rubber its stretchy nature and memory to retain its shape under extreme manipulation.

This process is absolutely necessary to achieve the physical properties designed by chemists, such as durometer hardness, compression set, tensile strength, and resistance to environmental factors.

Once the autoclave vulcanization is completed, the embossing carrier is stripped from the roll. A liner or powder is required for most rolls to reduce adhesion between the roll layers. The cured roll of sheet rubber will go through final inspection.

Final Inspection of the Roll
Before the sheet rubber is ready for shipment, it undergoes various levels of final inspection. While some jobs have specifications that require extensive laboratory testing, other rolls are tested simply for physicals and form. The final inspection can include:

- **Durometer**: this measures the hardness of the rubber, checking the rubber sheet has the correct level of hardness for its intended application.
- **Thickness**: this is conducted to ensure that the rubber sheet meets the specified thickness requirements. The proper thickness must be consistently within tolerance across the entire sheet.
- **Surface Consistency**: the surface consistency of the rubber sheet is examined to ensure that it is free from any defects or irregularities.
- **Visual Inspection**: a visual inspection is carried out to check for any visual defects, such as air bubbles, discoloration, or surface imperfections.

If the specification of the rubber material requires additional testing, the sample is sent to our in-house laboratory and testing facility where application-specific tests such as oil swell or heat aging is conducted.

Finished Goods – Rolls of Sheet Rubber
Calenders have the capacity to produce a wide range of industrial sheet rubber products applied in thousands of industries. Rubber's inherent flexibility, durability, and chemical resistance make it an excellent choice for many applications. Some common applications of sheet rubber products include:

- Gaskets and seals
- Vibration damping or grip enhanced linings
- Automotive components
- Roofing materials & insulation
- Food/FDA safe & medical grade healthcare equipment
- Water & weather resistant marine barriers
- Non-conductive electrical insulation

Additionally, sheet rubber is provided in accordance to a wide variety of specifications such as:

- Mil spec sheet rubber
- SAE AMS sheet rubber
- AASHTO sheet rubber
- ASTM D2000 sheet rubber
- FDA grade sheet rubber

Takeaways
From R&D and compounding to calendering, vulcanization, and final inspection, each step plays a crucial role in determining the economics, quality and characteristics of the final product.