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The role of processing parameters in an industrial thermo-mechanical devulcanization process

12th Fall Rubber
Colloquium

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Introduction

The recycling of rubbers in the rubber industry has become increasingly important due to environmental and financial reasons. An approach to recycle is to devulcanize the rubber in order to reintroduce it as a raw material. This is a notably challenging process since one aims to rupture the rubber network by breaking sulfur bridges without damaging the carbon-carbon bonds.

This work aims to study a devulcanization process known as “High Shear Mixing” (HSM) that does not involve the addition of any chemicals.

High shear mixing process

A special HSM machine, heavily instrumented, has been designed and built with the main purpose of studying the different phenomena that occur during the HSM devulcanization process. The figure 1 shows a schematic representation of this machine.

In the HSM process, the treated rubber is sheared between two metallic cones with special geometries. One cone is static and the other cone simultaneously turns and applies pressure to the material. During this shearing the treated rubber is self-heated, a cooling system prevents the rubber degradation due to excessive heat.

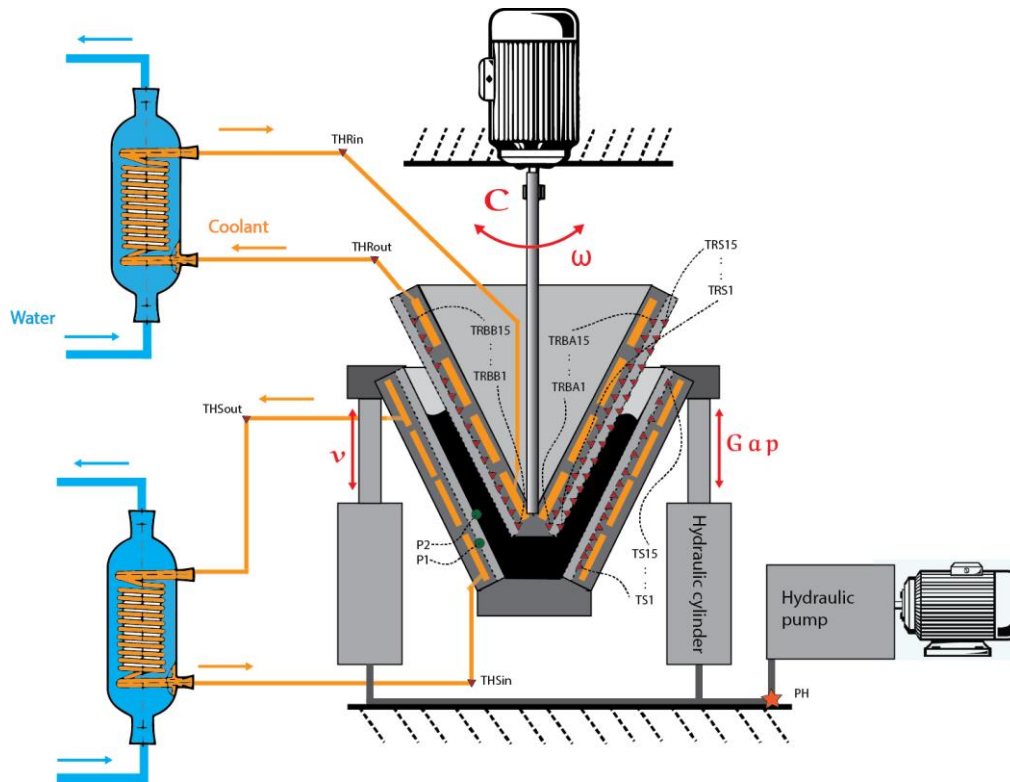


Figure 1 - schema of the machine HSM.

The rubber material used in this study, an 80 phr carbon black filled extended EPDM, is analyzed before and after vulcanization, and then again after the HSM treatment using solvent swelling and Soxhlet extraction. The goal is to determine the structure changes caused by the process. The Horikx analysis is used to determine the quality of the devulcanization [1], [2].

Sets of experiments were conducted where processing parameters such as the rotation speed, the duration of rotation, and the gap between the cones were systematically varied. A model that allows the estimation of the energy store in the rubber during the procedure will be presented. The correlation between data recorded during the process and the physical state of the material will be discussed.

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