Technical Article
Technical Article Content Pulled from the NIBA Belt Line Newsletter

NIBA–The Belting Association
6737 W. Washington St. #1300
Milwaukee, WI 53214
Ph: 414-389-8606
www.niba.org

Vulcanization (Part 3 of a 3-Part Series)

Contributed by Michael Cremeens
Fenner Dunlop Americas
Member, NIBA Member Services & Marketing Committee
Beltline Reprint September 2004

The vulcanization or curing process occurs in three stages and each stage is of importance and affects the service life of the finished product:

(1) Induction or flow time
(2) Crosslinking or rate of cure
(3) Optimum state of cure or overcure

The third stage of the curing or vulcanization process is a point at which all technological properties of the rubber compound are forming and is necessary to cure the rubber compound to its "optimum state of cure" (maximum stress value), but not past that point—"overcure."

Optimum State of Cure

In general, "state of cure" is a term used to indicate the development of a property of the rubber compound as the cure progresses. At this state crosslinks are formed, the vulcanized compound becomes tighter and the forces (stress) necessary to achieve a given deformation increase.

Technically, the most important state of cure is the so-called "optimum state of cure." This is when the predominant properties of cured rubber are formed and thus its elastic behavior after deformation in compression or tension.

It is possible to stretch a rubber compound cured to this "optimum state of cure" ten times its original length, and after removing the tension, it will return to its original shape and length. In addition, these cured rubber compounds are characterized by great toughness under static or dynamic stresses resulting in abrasion resistance higher than that of steel.

Overcure

A cure that is longer than optimum is an "overcure." Overcures may be of two types. In many Synthetic Rubber (SR) types, the rubber compound continues to harden, the modulus rises, and tensile and elongation fall. In other cases, including most Natural Rubber (NR) compounds, reversion occurs with overcure and the modulus and tensile strength decrease.

If overcuring (continued heating) of the rubber occurs, a stiffening (marching modulus), or softening (reversion), of the compound can be the result. These effects will reduce physical and adhesion properties of the rubber compound.

The charts below show how the vulcanization time curve can be divided into several phases—the ratio of pre-vulcanization (flow time) at the beginning of vulcanization, the under-vulcanization (rate of cure), the optimum vulcanization, and the over-vulcanization (overcure) which typically leads to “reversion” or “marching modulus.”

Reversion is often seen in Natural Rubber (NR) based splice materials cured at high temperatures with sulfur while many Synthetic Rubber (SR) types cured at high temperatures will show signs of marching modulus.

It should be noted, the common type of conveyor belting made today uses Synthetic Rubber (SR) as the base polymer with many of the makers of splice materials using Natural Rubber (NR) as a base polymer. If an overcure is made during the splice process, one observes a lowering of the mechanical properties within the splice area.

Since hardness (stiffening) increases with increased cure in the SR belt (marching modulus) and the hardness decreases in the NR splice materials because of “reversion,” as the cure time is increased the so-called “Dixie Cream” effect is the net result within the splice.

So, as the splice moves around the system and through the pulleys, the belt goes through compression, tension, back-bending and front-bending and thus the overcured splice grinds itself apart from the inside out.