

# **The Use of Rubber Blends in Rubber Products Manufacturing Industry**

**EO**

**M. G. S. B. Wijerathne**

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**Dr. Laleen Karunanayake**

**Senior Lecturer**

**Department 'A' Chemistry**

**University of Sri Jayawardenepura**

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## ABSTRACT

Rubber blends are widely used in the product manufacturing industry and very much popular in these days because it has shown very good properties compared to mono polymer products. In day to day life we experience many applications of rubber blend in rubber product, especially in tyres, flooring, water hoses, etc. In most of industries. These products are directly exposed to natural weather condition, when they are used in out door purposes.

In this study we used commercially available three different types of elastomers. Generally, the synergistic effect of the each type of blend compound can be studied by observing several physical properties .These parameters are Tensile strength [ASTM D 412], Tear strength [ASTM D 624], Elongation @ Break [ASTM D 412], Hardness [ASTM D 2240], Abrasion [ DIN 53516], Specific Gravity (SG) [ASTM D 1298], Swelling Resistance(Weight increase %) [ASTM D 471].

Our study shows that the above properties are greatly affected by when change the major polymer composition. When comparing the results obtained for the above physical properties we can clearly conclude that the composition of the rubber compound directly affects some physical properties.

In this study we can select suitable blend ( Polymer composition) compound according to the product application & customer requirement. Hence we can overcome most of the problems which will appear while using the product.

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## ABBREVIATIONS

NR	- Natural Rubber
SBR	- Styrene Butadiene Rubber
NBR	- Acrylo Nitrile Butadiene Rubber
ASTM	- American Standard for Testing and Material
MH	- Maximum torque
Ts2	- Time taken to complete 2% Curing
DRC	-Dry Rubber Content

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# 1. Introduction

## 1.1. IMPLICATION

There has been considerable success in overcoming the problems posed by the blends considered, and in realizing some of the opportunities to provide new alternatives for elastomers in a range of applications. Whilst these developments have been made within the context of essentially four specific blend systems, the solutions may be more widely applicable.

Some care must be exercised in generalizing the particular solutions found to the problem of obtaining even cross-link distribution in NR/NBR blends. It is evident that a cure system which is ideal for blends with NBR at one level of acrylonitrile content may well be quite inappropriate for blend with NBR at a somewhat different acrylonitrile content. Nonetheless, the principle of identifying cure systems which will give near-even crosslink distribution should be applied to all blends of elastomers different in polarity. Furthermore, one general rule has emerged – it appears that every polar thiuram accelerators, TMTM and TMTD, Should be avoided in NR/NBR blends.

The ageing, the approach adopted to developing blends with a combination of high damping, good physical properties and a low dependence of properties on temperature could be applied to other blends of elastomers differing in property<sup>1</sup>. However, the particular combination of NR with ENR has the distinct advantage that both elastomers are inherently high strength due to strain-induced crystallization.

## 1.2. Elastomers used for Blends

Elastomer is a big fancy word, and all it means is “Rubber”. Some polymers which are elastomers include cis 1,4-polyisoprene or natural rubber, polybutadiene, polyisobutylene and acrylonitrile-butadiene. What make elastomers special is the fact that they bounce. But just saying “they bounce” is kind of vague<sup>1</sup>. Let’s be more specific. What makes elastomers special is that they can be stretched to many times their original length, and can bounce back into their original shape without permanent deformation.

### 1.2.1. Natural Rubber

Natural Rubber is the prototype of all elastomers. It is extracted in the form of latex from the bark of the *Hevea sp.* tree. The rubber is collected from the latex in a series of steps involving preservation, concentration, coagulation, dewatering, drying, cleaning and blending. Because of its natural derivation, it is sold in a variety of grades based on purity, viscosity, viscosity stability, oxidation resistance, and rate of the cure.

The pure dry natural rubber contain 100% *cis* – 1, 4 polyisoprene with weight average molecular weight from 1 to  $2.3 \times 10^6$ . The natural rubber has some tendency to spontaneous crystallization due to their high molecular regularity<sup>4</sup>. The natural rubber shows high tensile strength and resistance to cutting, tearing, and abrasion.

The rubber polymer network allows elasticity and flexibility to be combined with crystallization- induced strength and toughness when stretched. The elastic nature of the rubber molecules also account for the exceptional resilience of rubber products. The natural rubber is one of the preferred sidewall elastomers in radial tyres.

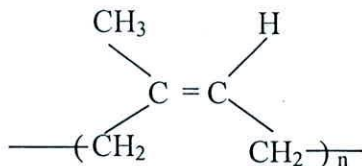
#### 1.2.1.1. Composition and chemical structure of natural rubber

Natural rubber (*Hevea*) latex varies in its composition but the following may be considered the typical<sup>2</sup>.

**Table 1.1 :** Typical composition of natural rubber latex

Materials	%
1 DRC	33
2.Total solid content	36
3. Proteinous substances	1-1.5
4. Resinous substance	1-1.5
5. Ash	<1
6. Sugars	1
7. Water	60

The rubber molecules consist virtually entirely of *cis*- 1,4-polyisoprene:



**Figure 1.1.** The chemical structure of Natural Rubber (NR)

There is no evidence for any *trans* materials or for any 1,2- or 3,4-isoprene polymer in the natural product, in contrast to the synthetic polyisoprenes. There is some evidence for a few carbonyl groups attached to the chain and which may be a site for cross linking and lead to the formation of gel. There is some dispute as to the nature of these groups, both aldehyde and lactone groups have been suggested. The presence of the occasional epoxy group in the chain has also been postulated.

#### 1.2.1.2. Molar Mass Distribution

The molecular weight of the natural polymer is very high but varies between lattices from different clones. In one study the number average molecular weight ( $\bar{M}_n$ ) was found to range from  $0.25 \times 10^6$  to  $2.71 \times 10^6$  and the weight – average molecular weight ( $\bar{M}_w$ ) from  $3.4 \times 10^6$  to  $10.17 \times 10^6$ . The average values from  $\bar{M}_w/\bar{M}_n$  for 12 different clones is 6.72 with values for individual clones ranging from 3.63 to 10.94.

#### 1.2.1.3. Properties

The natural rubber molecule is an unsaturated aliphatic hydrocarbon polymer of very regular structure. Whilst the molecular weight of the raw polymer is so high that entanglements make solution difficult, masticated rubber will dissolve in aliphatic hydrocarbons and other liquid of similar solubility parameter<sup>9</sup>. It will also react with chemicals known to be reactive to carbon – carbon double bonds, will be a good electrical insulator when pure and will burn in air as may be predicted from the structure.

The very flexible chain backbone leads to a very low  $T_g$  of about  $-73\text{ }^{\circ}\text{C}$ . Because of the stiffening effect of the methyl group on the chain backbone this value is somewhat higher than that for *cis* – polybutadiene. The natural rubber molecule is capable of crystallization and the unsaturated raw polymer has a crystalline melting point ( $T_m$ ) of about  $+25\text{ }^{\circ}\text{C}$ . Crystallization may also be induced by stretching samples such as in a tensile test. As a result of this stress-induced crystallization, the tiny crystal structures formed act rather like reinforcing particles and, unlike SBR which does not crystallize, enable gum and lightly loaded stocks to exhibit high vulcanizate strengths.

#### 1.2.1.4. NR Grades available in Sri Lanka

Classification of natural rubber by visual grading in accordance with guidelines laid down in the Green Book – International Standards of Quality and Packing in Natural Rubber is given below<sup>9</sup>.

**Table 1.2.** Available Grades of natural rubber

Section	Available Grades
1. Ribbed smoked sheets: Made entirely from coagulated rubber sheets properly dried and smoked.	1XRSS Superior quality
	1RSS Standard quality
	2RSS Good fair average quality
	3RSS Fair average quality
	4RSS Low fair average quality
	5RSS Inferior fair average quality
2. White and pale crepes: Prepared from fresh coagula of NR latex under controlled conditions(classified as either thin or thick)	1X Superior quality pale crepe
	1 Standard quality pale crepe
	2 Good fair average quality palish crepe
	3 fair average off-colour palish crepe
3.Estate brown crepe: from cup lump, other high – grade scraps and pre-cleaned tree bark scrape ((classified as either thin or thick)	1 X Clean light brown crepe
	2 X Inferior grade
	3 X Inferior grade
4. Compo crepes	Grades 1,2,3
5. Remills – thin brown crepes	Grades 1, 2, 3, 4
6. Thick blanket crepe –amber	Grades 2, 3, 4
7. Flat bark crepes: earth scraps	Grades standard, hard

### 1.2.2. Acrylonitrile Butadiene Rubber (NBR)

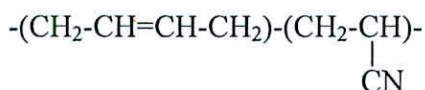
A somewhat simplistic way of describing acrylonitrile – butadiene rubbers, commonly known as nitrile rubbers, is to say that they are the special purpose rubbers with the conventional technology. Commercially available for over 50 years, they are known primarily for their resistance to liquid fuels such as petrol and other hydrocarbons.

Acrylonitrile Butadiene copolymers were first prepared in 1930 with pilot-plant production commencing in 1934 and full-scale production in 1937, the product being marketed as Buna N<sup>7</sup>.

In recent years materials related to nitrile rubbers have been developed. These include carboxylated NBR, epoxy-modified NBR, hydrogenated NBR, copolymers containing isoprene and alternating copolymers.

#### 1.2.2.1. Chemical structure of NBR

Nitrile rubber is represented by the basic chemical structure given below



*Figure 1.2.* The chemical structure of NBR<sup>2</sup>

There are two obvious features of this structure:

1. The double bond which facilitates sulphur vulcanisation but which is also susceptible to oxidation and ozone attack;
2. The polar acrylo nitrile group which confers resistance to hydrocarbon oils but tends to raise the  $T_g$  of the rubber with several other directly consequent effects.

There are a number of variables which lead to important differences between commercial grades. The following are important:

1. Acrylonitrile content – the dominate variable;
2. Additional monomers or substitutes for acrylonitrile and butadiene;
3. Average molecular weight;
4. Molecular weight distribution;
5. Branching;
6. Microstructure;
7. Stabilizer incorporated on manufacture.

#### **1.2.2.1.1. Effect of Acrylonitrile Content**

Increasing the acrylonitrile content will clearly raise the minimum service temperature down to which the rubber may be used<sup>2</sup>. This in ability of nitrile rubber to remain rubbery at low temperature is obviously an advantage. Higher acrylonitrile contents also lead to lower resilience, greater hardness and higher compression set, are generally considered as there is increase in a slight increase in hardness, abrasion resistance and tensile strength at normal ambient temperatures<sup>4</sup>.

On the other hand, increasing the acrylonitrile content increases the petrol resistance and swelling in hydrocarbon oils. Since there is a very close relationship between Tg and swelling, compromises have to be arrived. As a result most grades have nominal acrylonitrile contents between 28 and 45%<sup>4</sup>.

#### **1.2.2.1.2. Use additional or alternative Monomers.**

Substituted acrylonitrile such as methacrylonitrile have also been used to produce polymer with somewhat different flow and solubility characteristics<sup>4</sup>. No commercial grades are known to be available at the time of writ.

#### **1.2.2.1.3. Effect of molecular weight, molecular weight mistribution.**

The molecular weight can influence properties in three ways<sup>4</sup>

1. By influencing flow properties. Lowering the molecular weight lowers the viscosity and generally results in easier calendering and extrusion. Compounding is also generally easier with lower compounding heat build-up.
2. The higher molecular weight rubbers have better stability during open cure, can accept higher loadings of filler and plasticizer, and are less susceptible to air entrapment. These improvements are presumably the result of the higher green strength of the higher molecular- weight polymer compound.
3. Vulcanizate properties such as tensile strength and resilience are slightly higher with higher-molecular weight polymers. This can be attributed to the fact that with low-molecular – weight polymers the proportion of non –load-bearing chain ends in the network is higher.