

**COMPATIBILITY IMPROVEMENT OF
TYRE CRUMB IN NATURAL RUBBER &
POLYBUTADIENE BLENDS**

By

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DECLARATION

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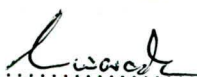


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LIST OF ABBREVIATIONS

6 PPD	-	N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine
AA	-	Atomic Absorbtion
ASTM	-	American Society for Testing and Materials
BR	-	Polybutadien Rubber
BTU	-	British Thermal Unit
CBOT	-	Chicago Board of Trade
Contd	-	Continuation
CV	-	Constant Viscosity
DIN	-	German Industry Standards (Detsche Norm)
EU	-	European Union
HAF	-	High abrasion furnace black
IR	-	Infrared Spectroscopy
IR	-	Isoprene Rubber
IRHD	-	International Rubber Hardness Degrees
ISO	-	International Standard Organizations
LKR	-	Sri Lankan Rupees
LN ₂	-	Liquid Nitrogen
LON	-	Light Optical Microscope
\bar{M}_n	-	Number Average Molecular Weight
MT	-	Metric Ton
MUFA	-	Mono Unsaturated Fatty Acid
\bar{M}_w	-	Weight Average Molecular Weight
MW	-	Molecular Weight
MWD	-	Molecular Weight Distribution
NR	-	Natural Rubber
Phr	-	Parts per Hundred Rubber
PUFA	-	Poly Unsaturated Fatty Acid
RPM	-	Revolutions Per Minute
RSS	-	Ribbed Smoked Sheet

SBR	-	Styrene Butadiene Rubber
SFA	-	Saturated Fatty Acid
SLR	-	Standard Lanka Rubber
TBBS	-	N-tertiary-butyl-benzothiazole sulfenamide
TDF	-	Tyre Derived Fuel
TDQ	-	2,2, 4-trimethyl-1, 2-dihydroquinoline (oligomers)
TSR	-	Technically Specified Rubber
US	-	United States of America
WRHA	-	White Rice Husk Ash

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ABSTRACT

Today, the local value addition to rubber is done at a considerably higher level, converting over 65% of the raw rubber, and over 20% of raw rubber is exported as 'crepe rubber', which is also marketed as a product, called "Lankaprene".

For both environmental and economic reasons, there is a continuing broad based interest in recycling of scrap rubber and development of recycling technologies. The disposal and reuse of scrap tires remains a serious environmental concern and a business opportunity. The major process at the present time is to utilize the scrap rubber as a very finely ground powder known as "crumb". Crumb is produced either by mechanical grinding at ambient temperature or by cryogenic shattering. In general, the crumb rubber is combined with virgin elastomers in compounds to reduce cost.

This process, however, leads to a strong deterioration of the physical properties due to the less compatibility of cured rubber particles with virgin polymers.

The purpose of this study was to develop a method to activate the surface of ground tyre crumb to improve compatibility and performance in tyre tread compounds.

Surface activation of crumb rubber with fatty acids has been suggested as a method of improving compatibility between tyre crumb with Natural Rubber and Poly butadiene.

In this research, 30 mesh tyre crumb was activated with four different fatty acids and incorporated in to standard tyre tread formulae in different mixing sequences. The effects of mixing sequences on mechanical properties of the compounds are studied. Results indicate that the crumb activated with the Stearic Acid and crumb incorporated in to BR/NR blended phase gives improved mechanical properties and better filler dispersion compared with the compound having non activated crumb particles.

CHAPTER ONE

INTRODUCTION TO THE RESEARCH

1.0 INTRODUCTION

1.1 RUBBER INDUSTRY IN SRI LANKA

The Rubber Industry in Sri Lanka basically consists of two major sectors those are interdependent. They are;

- Plantation industry
- Rubber products manufacturing industry.

As in most of the rubber growing countries, rubber plantation industry is one of the remaining and beneficial colonial legacies in Sri Lanka. Ceylon, as it was known then, embarked on rubber industry in 1876 with planting of 1919 "Hevea" rubber seedling in Henarathgoda Botanical gardens. Rubber products manufacturing industry however, began in the beginning of 1950's and expanded rapidly after the introduction of free trade policies in the late 1970's [1].

Sri Lankan rubber industry stakeholders are concerned about their future competitiveness compared to the other natural rubber producing countries such as Thailand, India, Indonesia and Malaysia. In the year 2008, Sri Lanka produced 129,000 MT of natural rubber which was 1.27% of the global NR - production and exported 48,600 MT earning LKR 7.2 billion. However, the rubber products sector consumed 80,000 MT of natural rubber and earned over LKR 72 billion [2].

Rubber products manufacturing industry in Sri Lanka has a tremendous task to perform in the future, as it has to contribute to the national economy by leading the industrialization efforts in Sri Lanka and finally reaching the goal of "using every single drop of latex produced in this land to be converted into a value- added product before it leaves our shores". The rubber products manufacturing sector has recently emerged as a key contributor to Sri Lanka's export earning being around 5%, but with a potential of growing up to 10%. It is important to note that Sri Lankan rubber industry caters to over 35% of the world solid tyre market.

The main features of the global rubber industry could be summarized as follows;

- Global rubber industry shows steady growth and at present records an annual turnover exceeding LKR 15 trillion [2].
- Global total rubber consumption is growing at an annual rate of 4.1 % [2].

- Sri Lanka rubber products industry currently enjoys a tiny share of this huge global market, less than 0.25%.
- Few Sri Lankan product manufacturers have achieved global competitiveness through business strategies, innovation, sound management coupled with the information technology and perseverance.

Table 1.1**Present Status of the Rubber Products Industry in Sri Lanka**

Investment	-	exceeds LKR. 16 billion
Capacity utilization	-	around 85%
Turnover	-	LKR 72.3 billion in 2008
Exports	-	LKR 46 billion in 2008
Direct employment	-	Over 40,000 persons

Global rubber based industry value is estimated to exceed LKR 12 trillion and it is growing steadily as humankind increases living standards. More than 40,000 generic rubber products are being made worldwide. The average world rubber consumption per capita is still around 3 kg but in developed countries such as the United States it is around 12 kg. The highest rates are recorded in countries in the Asia Pacific region such as Malaysia - 19 kg, Taiwan - 14 kg, Japan - 15 kg and the Republic of Korea 15 kg [3].

It is clear that, with the development of the social levels of many developing countries per capita consumption of natural rubber in the form of rubber products will be on the increase. Therefore, the rubber products industry is a potential industry for Sri Lanka to improve its competitiveness in view of the huge and increasing rubber products market.

1.2 PROBLEMS ASSOCIATED WITH UNCONTROLLED OR ILLEGAL SCRAP TYRE DISPOSAL

As a rule of thumb, the scrap tyre generation in industrialized countries is approximately one passenger car tyre equivalent (PTE, 20 lbs., 9 kg) per population and year. It is estimated that 2 to 3 billion scrap tyres are stockpiled in illegal