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USE OF PITCH OIL IN NATURAL RUBBER COMPOUNDING

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SUMMARY

Pitch Oil is the residue from the fatty acid manufacture at the Fats and Oils Corporation, Sri Lanka. It contains about 40 - 50% of free fatty acids. This paper describes investigations carried out on the use of pitch oil in natural rubber compounding. It has been established that pitch oil can replace stearic acid or coconut oil fatty acids in rubber compounding formulations.

INTRODUCTION

Use of one to four parts per hundred parts of rubber (phr) of a high molecular weight monobasic organic acid or a mixture of such acids (fatty acids) in rubber compounding is a well established practice (Morton, 1973). The fatty acid (s) promote the action of zinc oxide, which acts as an accelerator activator, by forming an organic zinc salt having better solubility in rubber than the inorganic zinc oxide. Till recent times a product known commercially as stearic acid was imported into Sri Lanka to be used in rubber compounding as the source of fatty acid. The Sri Lanka Fats and Oils Corporation produces a fatty acid mixture by splitting coconut oil. Gas liquid chromatographic (GLC) analysis of this mixture of fatty acids showed that its composition is as follows :—

ACID	% (w/w)
Caprylic	5
Capric	7
Lauric	56
Myristic	19
Palmitic	7
Stearic	5
Oleic	1

This mixture of fatty acids has replaced the imported stearic acid as a rubber compounding ingredient in recent times. The residue in the fatty acid distillation plant of the Fats and Oils Corporation is a pitch black viscous liquid which is referred to as pitch oil. Chemical analysis has shown that pitch oil contains about 40 - 45% (by weight) of free fatty acids, the rest being charred matter with traces of coconut oil. GLC analysis of a sample of pitch oil indicates that it consists of the following fatty acids :

ACID	% (w/w)
Caprylic	2·5
Capric	3
Lauric	45
Myristic	21
Palmitic	11
Stearic	10·5
Oleic	7

It can be seen from the above analysis that pitch oil is richer in the high molecular weight fatty acids than the fatty acid mixture. This investigation was designed to ascertain the minimum and the maximum quantities of pitch oil that can be used in natural rubber compounding, to obtain the optimum mechanical properties of the vulcanizates.

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EXPERIMENTAL

Rubber compounds were prepared using varying amounts of pitch oil and the mechanical properties of the vulcanized compounds were determined. These properties were compared with those of the rubber vulcanizates prepared using imported stearic acid. To evaluate the optimum amount of pitch oil that can be used in rubber compounding, base mixes with the following formulation were prepared and the tensile properties of the cured mixes were determined using a Hounsfield Rubber Testing Machine.

Formulation of the base mix

RSS	100
ZnO	4
Fatty acid (Pitch Oil or Stearic Acid)	1·5 — 15
Sulphur	2
HAF	50
MBTS	1
TMTD	0·2
Nonox D	1

The mixes were cured at 150°C for 15 minutes.

The results of these experiments are given in Table 1A and Table 1B.

TABLE 1A
TENSILE PROPERTIES OF THE VULCANIZATES USING PITCH OIL

Amount of Pitch Oil phr.	Ultimate Tensile Strength kg/cm²	Modulus at 300% Elongation kg/cm²	Elongation at Break %
1·5	96	24·1	500
3·0	203·5	64·6	600
6·0	218·4	50	600
9·0	203·2	57	550
12·0	185·0	42	600
15·0	172	22·7	650

TABLE 1B
TENSILE PROPERTIES OF THE VULCANIZATES USING STEARIC ACID

Amount of stearic acid phr.	Ultimate Tensile Strength kg/cm²	Modulus at 300% Elongation kg/cm²	Elongation at Break %
1·5	203	55·2	600
3·0	213	40·6	650
5·0	261	39·2	700
9·0	244	59·0	550
15·0	258	58·5	650

Ageing characteristics

Experiments to study the ageing characteristics of the rubber vulcanizates with pitch oil as the source of fatty acid were carried out using a tyre tread compound formulation containing 45 ISAF Black and the following sulphur, accelerator retarder combination. A base mix containing 3 phr of stearic acid was used as the control.

Formulation of the base mix

RSS	100
Zinc Oxide	5
Fatty acid	3, 4·5, 6
Kanifal	1
Antilux (wax)	2
4010 NA	1
Antioxident H.S.	0·5
Vulcalent 'A'	0·7
ISAF Black	45
Dutrex R	8
Santoflex AW	2
Sulphur	1·6
Santocure MOR	1·3

Table 2 gives the codes used to identify the different base mixes used in this investigation.

TABLE 2

CODE DESCRIPTION OF THE BASE MIXES

Code.	A 100 P.H.R.	A 101 P.H.R.	A 102 P.H.R.	A 103 P.H.R.
Zinc oxide	5	5	5	5
Stearic acid	3	—	—	—
Pitch Oil	—	3	4·5	6·0

The Mooney scorch times at 120°C of the base mixes are illustrated in Table 3.

TABLE 3

MOONEY SCORCH TIMES (min)

AT 120°C

A 100	17·5
A 101	15·5
A 102	17·0
A 103	18·5

Table 4 contains the physical and the mechanical properties of the base mixes vulcanized at 143°C for 50 minutes.

TABLE 4

PHYSICAL AND MECHANICAL PROPERTIES OF THE VULCANIZED BASE MIXES

Property	A 100	A 101	A 102	A 103
Tensile strength kg/cm²	262	262	259	250
Modulus at 300% Elongation kg/cm²	111	93	100	86
Elongation at break %	563	621	588	595
Permanent set %	26	28	28	25
Tear Resistance kg	129	131	102	121

The physical and mechanical properties of the vulcanizates after ageing at 100°C for 3 days are given in Table 5.

TABLE 5

AGEING CHARACTERISTICS OF THE VULCANIZATES. (3 DAYS AT 100°C)

Property	A 100	A 101	A 102	A 103
Tensile strength kg/cm²	226	224	228	214
Modulus at 300% Elongation kg/cm²	129·5	118	123	112
Elongation at Break %	475	518	495	495
Permanent set %	26	28	27	28
Tear Resistance kg	92	85	73	80
% of Tensile Strength retained	86·2	85·4	88	85·6
% Increase in Modulus at 300% Elongation	16·6	25·8	23	30·2

DISCUSSION AND CONCLUSION

The results of the experiments outlined above indicate that pitch oil can be used in place of stearic acid in natural rubber compounding. As seen from Table 1A at least 3 phr of pitch oil should be used and this quantity should not exceed 9 phr. At higher doses (> 9 phr) the impurities present in pitch oil (*e.g.* coconut oil) probably have an adverse effect on the vulcanizing mechanism and thereby give rise to low values in the tensile properties.

From the results of our investigations it can be concluded:

(1) Pitch Oil can replace stearic acid in natural rubber compounding

(2) A quantity equivalent to 1½ times the amount of stearic acid in a specific formulation should be used

(3) The quantity of pitch oil should not exceed 9 phr. It is best to use quantities between 3 phr and 6 phr.

The use of this material in place of imported stearic acid or local fatty acids would result in considerable savings to rubber products manufacturers. The price of pitch oil is about 1/5th that of the local fatty acids. Because of the colour of the material (pitch black) its use will be restricted only to dark coloured rubber articles.

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REFERENCES

MORTON, M. (1973). *Rubber Technology*. New York : Van Nostrand Reinhold Company.