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METHOD OF PURIFYING WASTE ENGINE OIL AND STUDIES ON BLACK LOADED NATURAL RUBBER MIXES CONTAINING THIS INGREDIENT

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SUMMARY

This paper deals with the investigation of the suitability of pretreated waste engine oil for use as a processing oil in rubber compounding.

Technological properties and cure characteristics of mixes containing purified waste oil were found to be comparable to those containing similar dosages of well known commercial processing oils.

INTRODUCTION

Considerable cost saving can be effected by replacing part of the natural rubber in a "Rubber Compound" by cheap fillers such as whiting, clay and oils. The oils (known as rubber processing oils) act not only as a filler but also as a plasticizer. They cause a reduction in viscosity and thereby aid the incorporation of the filler during processing.

Rubber processing oils are broadly classified as aromatic, paraffinic or naphthenic depending on the value of their viscosity gravity constant (VGC).

$$VGC = \frac{G - 0.24 - 0.022 \log_{10} (V_2 - 35.5)}{0.755}$$

G = specific gravity at 15.5°C, and V_2 = saybalt viscosity at 99°C. Oils with VGC in between 0.791 – 0.820 are classified as paraffinic, and those with VGC between 0.85 – 0.9 are naphthenic and above 0.90 are classified as aromatic.

Aromatic oils which are the most viscous generally give the best processibility. They are, however, likely to have detrimental effects on staining, colour stability and ageing resistance. Paraffinic oils, on the other hand, are the least viscous and are usually less effective as processing oils. They, however, have no adverse effect on ageing performance, contact staining and colour stability. Naphthenic oils fall between aromatic and paraffinic types in their effects on the performance of rubber. The most popular processing aids in the rubber industry are factice, fatty acids and salts, pine waxes, bitumen and oils.

The object of this study was to investigate the practical and economic feasibility of incorporating waste engine oil as a processing aid in rubber compounding.

EXPERIMENTAL

Mixing of the natural rubber, carbon black and oil was done in a Banbury type internal mixer and subsequent compounding of ingredients was done on a 2 roll mill. The recipe used in the experiments is as follows:

Natural rubber	..	..	100
HAF black	..	..	40
Processing oil	..	..	10
Zinc oxide	..	..	5
Stearic acid	..	..	3
M O R	..	..	1.3
Sulphur	..	..	2.5

The types of oils used in this work were Waste engine oil, Dutrex R, Dutrex 130, Ravelon X P 532, Castrol BS 148, Castrol OM 13, Rubber Processing Oil (A product of Sri Lanka Petroleum Corporation).

The waste engine oil was maintained at 110°C to evaporate the volatile impurities such as water, low molecular weight hydrocarbon etc. It was then allowed to cool when impurities such as metal dust and carbon precipated. The oil was then decanted.

Gum compounds containing different oils were cured in the Monsanto oscillating disc rheometer using the formulations described above (Fig. 1) and the plots of $\log_{,10}$ ($R_{max} - R_t$) against time are given in Fig. 2. (R_{max} – the maximum torque developed and R^t – the torque developed at time t).

Results and Discussion

Various physical properties were studied to evaluate the effect of waste engine oil on a rubber vulcanisate (Table 1).

Tensile strength :

Hounsfield tensometer was used to measure tensile strength. Tensile strengths, of standard dumb bell shape samples were determined before and after ageing for 24 hours at 100°C. The tensile strengths of the vulcanisates prepared with waste engine oil were found to be as good, sometimes even better, then those prepared with popular types of processing oils.

Elongation at break : There was no significant difference in this property compared to other rubber processing oils.

Modulus :

Modulus at 100% and 300% elongation was highest with waste engine oil.

Abrasion resistance :

The abrasion resistance was better with waste engine oil than with Dutrex R or Dutrex 130.

Resilience :

Resilience was comparable with that obtained with Dutrex R and was higher than that with the other oils.

Effect on Vulcanization:

The effect of various types of processing oils on the vulcanisation process are summarised in Figures 1, 2 and Table 2. It is seen that purified waste engine oil has no adverse effects on the vulcanisation of the rubbers.

It was also found that the saybalt viscosity of waste engine oil is 1400 at 80°F and 700 at 100°F. The viscosity gravity constant is 0.8079.

The results presented show that waste engine oil could be used in any carbon black loaded rubber compound provided the antioxidant dosage is increased slightly.

TABLE 1

Type of oil	Tensile Strength kg/cm²	Tensile Strength kg/cm² after ageing	% retention of tensile strength	Modulus at 100% elongation kg/cm²	Modulus at 300% elongation kg/cm²	Percentage Elongation at break	Percentage Elongation at break after ageing	Abrasion resistance	Resilience at 27°C
Waste engine oil ..	256	66	26	32	165	400	200	3.223	64
Dutrex R ..	255	79	30	32	161	410	270	2.5513	64
Dutrex 130 ..	255	87	34	28	143	425	250	2.8916	61
Dutrex – 20 P ..	234	90	38	26	136	425	275	3.233	57
Ravelon X P 532 ..	246	76	30	22	125	430	200	4.701	60
Castrol BS 148 ..	193	60	31	26	140	285	200	5.610	57
Castrol OM 13 ..	163	52	31	20	104	400	200	6.851	57
Local rubber processing oil	253	77.2	30	23	128	450	250	3.210	50

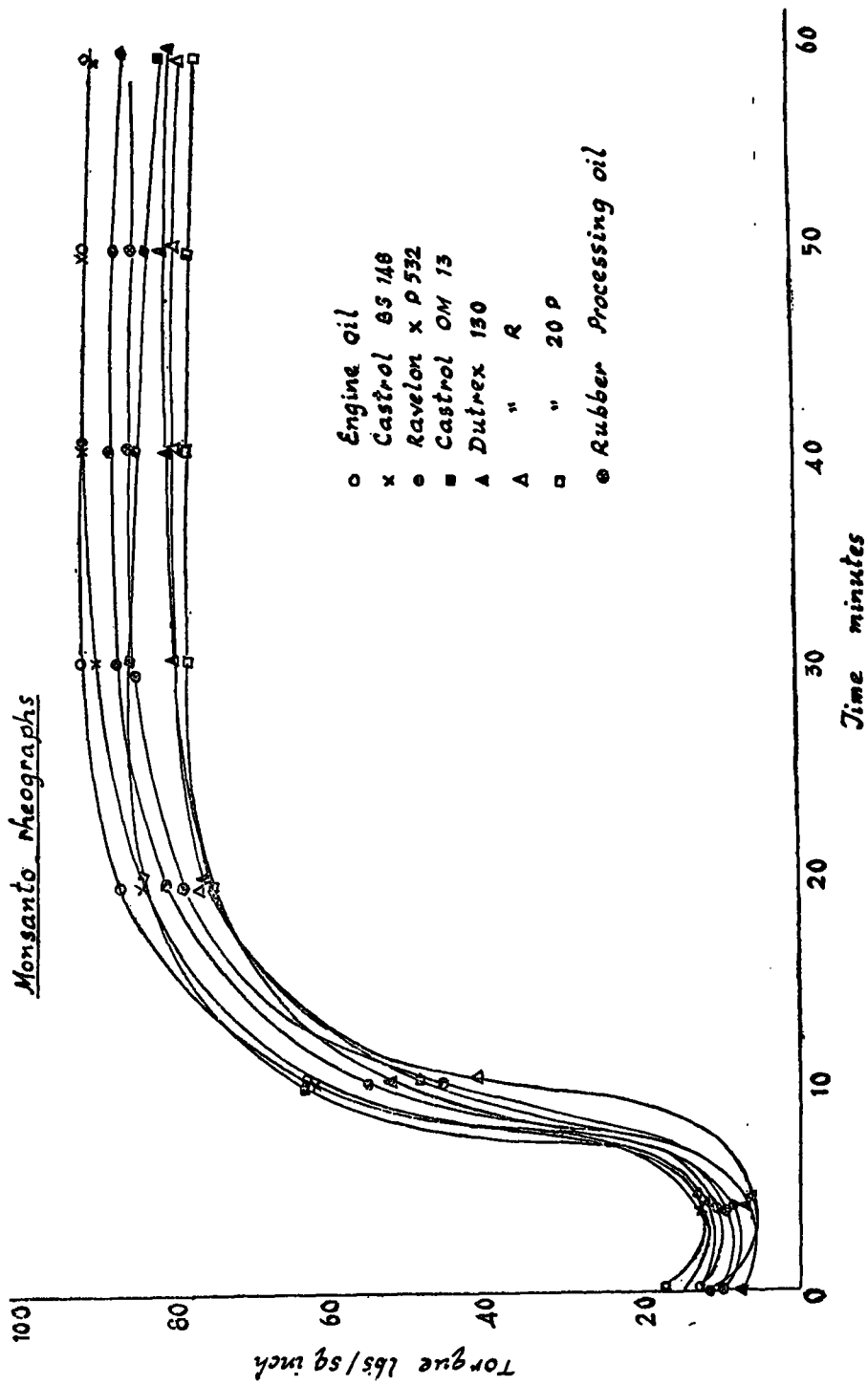

Figure. 1

Monsanto Rheographs

Figure. 2

Analysis of rheographs

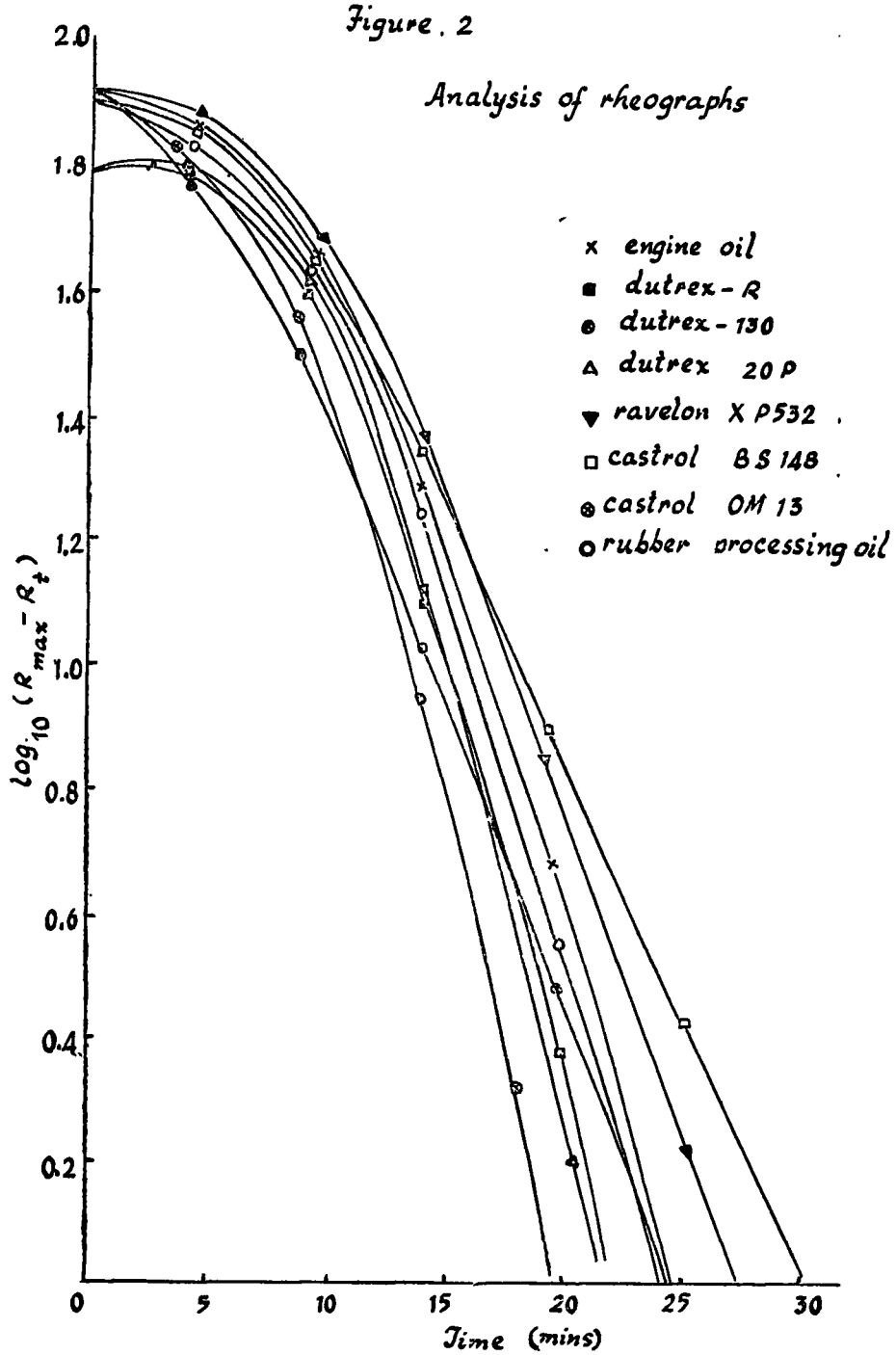

TABLE 2

Sample	R max	$K_{min^{-1}}$	t_1 (min)
Engine oil	90.0	.2303	6.7
Dutrex R	78.0	.2546	6.5
D – 130	79.0	.2100	6.0
D – 20P	76.5	.2756	7.6
Ravelox P 532	86.0	.2272	8.0
Castrol BS 148	90.0	.1807	6.0
Castrol OMB	85.0	.2768	6.5
Rubber Processing Oil	80.0	.2061	6.5

R max – The maximum torque
K – The overall first order rate constant
t – induction period

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