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THE IGNITION OF MOTOR TYRE SAMPLES

by

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SUMMARY

Samples of rubber cut from a used motor tyre have been exposed to thermal radiation in order to examine the behaviour of this type of material and in particular to determine the lowest intensity of radiation at which it would ignite. The results show rubber is perhaps somewhat more difficult to ignite than a common species of softwood.

KEY WORDS: Behaviour, Fire Hazard, Ignition, Radiation, Rubber.

MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

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Introduction

Large stocks of motor tyres might be expected to present a fire hazard by igniting due to thermal radiation from a fire already burning nearby. Little or no information could be found on the behaviour of tyres (or indeed any kind of rubber) on exposure to radiant heat. It was decided to carry out some ignition experiments on specimens cut from a used tyre and this note describes these and compares them with similar experimental results for a common species of wood.

Experimental Procedure

The specimens were cut from both the tread and sidewall of a 2-ply, 5-20-14 size, tubeless, used motor tyre which had been made by one of the major tyre manufacturers. They were all approximately 60 mm square and 6 mm thick.

The specimens, either sidewall or tread, were mounted in turn vertically so as to receive radiation from a vertical 0.3 metre square gas-fired radiant panel and the times to ignition recorded. Generally, four specimens were tested at each level of radiation intensity and the mean value of the times to ignition taken.

Specimens were tested for both spontaneous and pilot ignition. The pilot flame was produced by burning town gas at a downward pointing 0.5 mm diameter nozzle situated 13 mm above the top edge of the specimen and slightly in front of it so that the flame was in the rising stream of gaseous decomposition products. The gas flow to the nozzle was adjusted to give a flame length as close to 13 mm as possible.

The experimental results are plotted to show variation of time to ignition with intensity in Fig 1 for spontaneous ignition and in Fig 2 for pilot ignition. Horizontal lines are drawn at the level corresponding to the estimated minimum intensity at which the specimens are likely to ignite.

Results and discussion

The minimum intensities for ignition are given below in Table 1 with corresponding figures for European Whitewood[1]. Some results for the wood are plotted in Figs 1 and 2 and show a tendency for it to ignite sooner than the tyre rubber.

Table 1

Type of ignition	Minimum intensity - W/cm^2	
	Tyre rubber	European Whitewood
Spontaneous	4.0	5.2
Pilot	1.65	1.6

While the specimens were being exposed to radiation no melting of the rubber was observed at any stage prior to either spontaneous or pilot ignition. During the spontaneous ignition experiments the specimens started to crumble well before ignition occurred, the carbon black filling in the tyre rubber glowed in places and fell away from the exposed surface of the specimen.

There is evidence of a difference in behaviour between specimens cut from the sidewall and the tread of the tyre, but not enough material was available to confirm this.

Some relevant physical properties of the tyre rubber are given in Table 2 below, and for comparison corresponding values for some softwood and plain rubber are also given.

Table 2

Material		Density $-\rho-$ g/cm^3	Thermal Conductivity -K- $J\ cm^{-1} s^{-1}\ degC^{-1}$	Specific Heat -c- $J\ g^{-1}\ degC^{-1}$	$-K\rho c-$
Tyre Rubber	Sidewall	1.2	3.1×10^{-3}	1.5	5.6×10^{-3}
	Tread	1.2	3.6×10^{-3}	1.5	6.5×10^{-3}
European Whitewood		0.46	1.2×10^{-3}	1.4	0.8×10^{-3}
Plain Rubber		c.1.5	1.5×10^{-3}	1.1 to 2.0	2.5 to 4.5×10^{-3}

The values for the thermal conductivity and specific heat for the tyre rubber were supplied by the manufacturer who stated that they can only be taken as rough working values, and could probably be reduced by about 10 per cent to allow for the presence of cords in the tyre fabric. The values for the wood are those used in earlier work[1] on ignition by radiation, and those for rubber were taken from tables[2] of physical and chemical constants.

The value of $K\rho c$ for the tyre rubber is much higher than the corresponding value for wood, due to higher values for both thermal conductivity and density. It is also higher than the value for plain rubber although the values of K, ρ and c are here very approximate as there are a number of different kinds of "plain" rubber. Nevertheless the higher value of $K\rho c$ for the tyre rubber would result in longer times to ignition and this was in general found to be so in the experiments.

Conclusions

On exposure to radiation samples of tyre rubber tended to take longer than wood to ignite owing to their greater conductivity. The minimum radiation intensity likely to cause ignition is similar for both wood and tyre rubber particularly for pilot ignition. The absence of any tendency for the rubber to melt, at least before ignition occurs, is a decided advantage should fire develop close to a stack of tyres. It would appear that the behaviour of the rubber in tyres on exposure to heat is considerably influenced by the quantity of carbon black filling incorporated in the tyre during manufacture. The carbon might well be expected to retard or prevent melting of the rubber.

References

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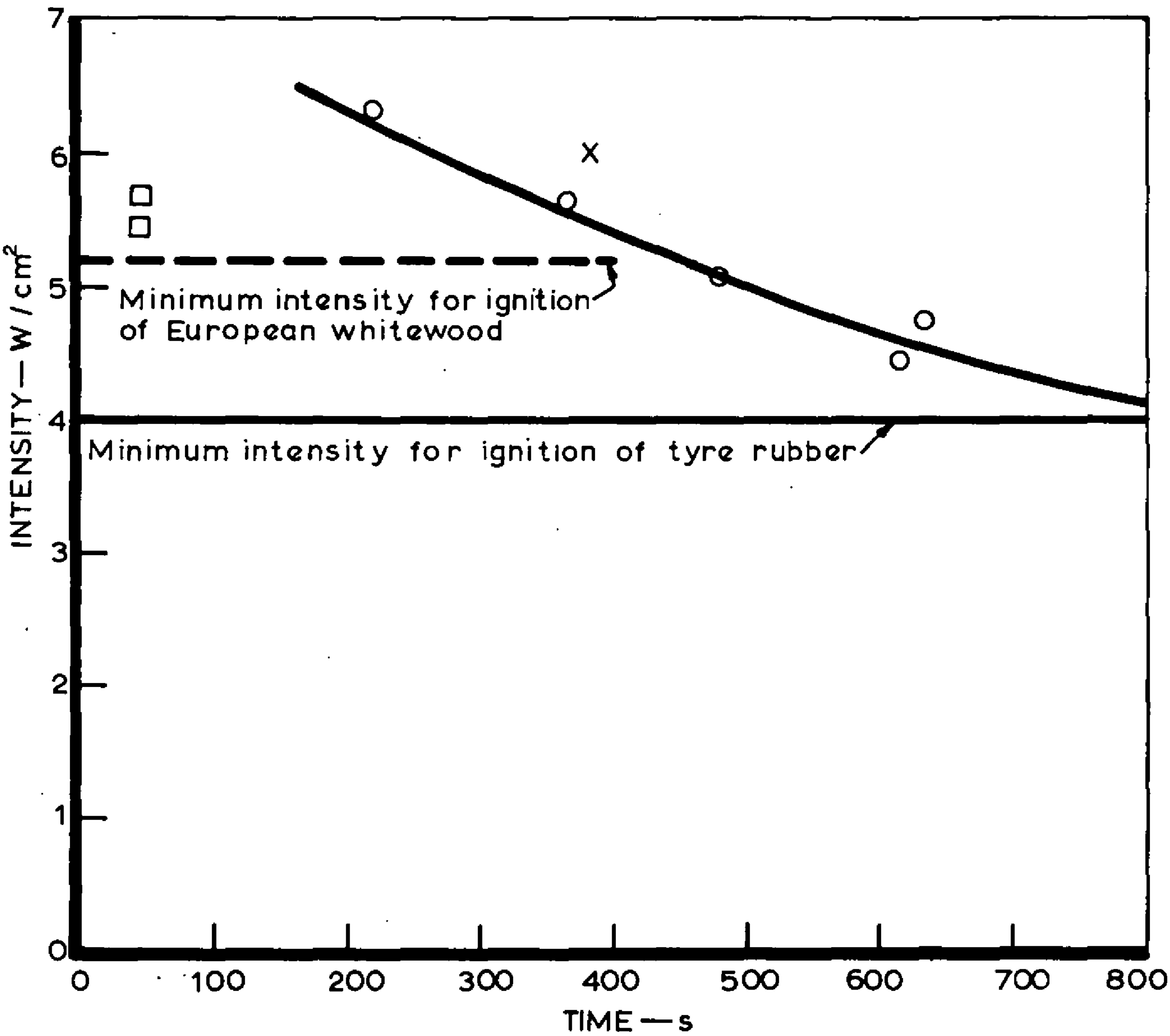
2. KAYE AND LABY. Tables of physical and chemical constants, 11th edition, Longmans, Green and Co., London, 1956.



Tyre Rubber	Sidewall	O
	Tread	X
European whitewood		□

FIG. 1. SPONTANEOUS IGNITION OF RUBBER TYRES

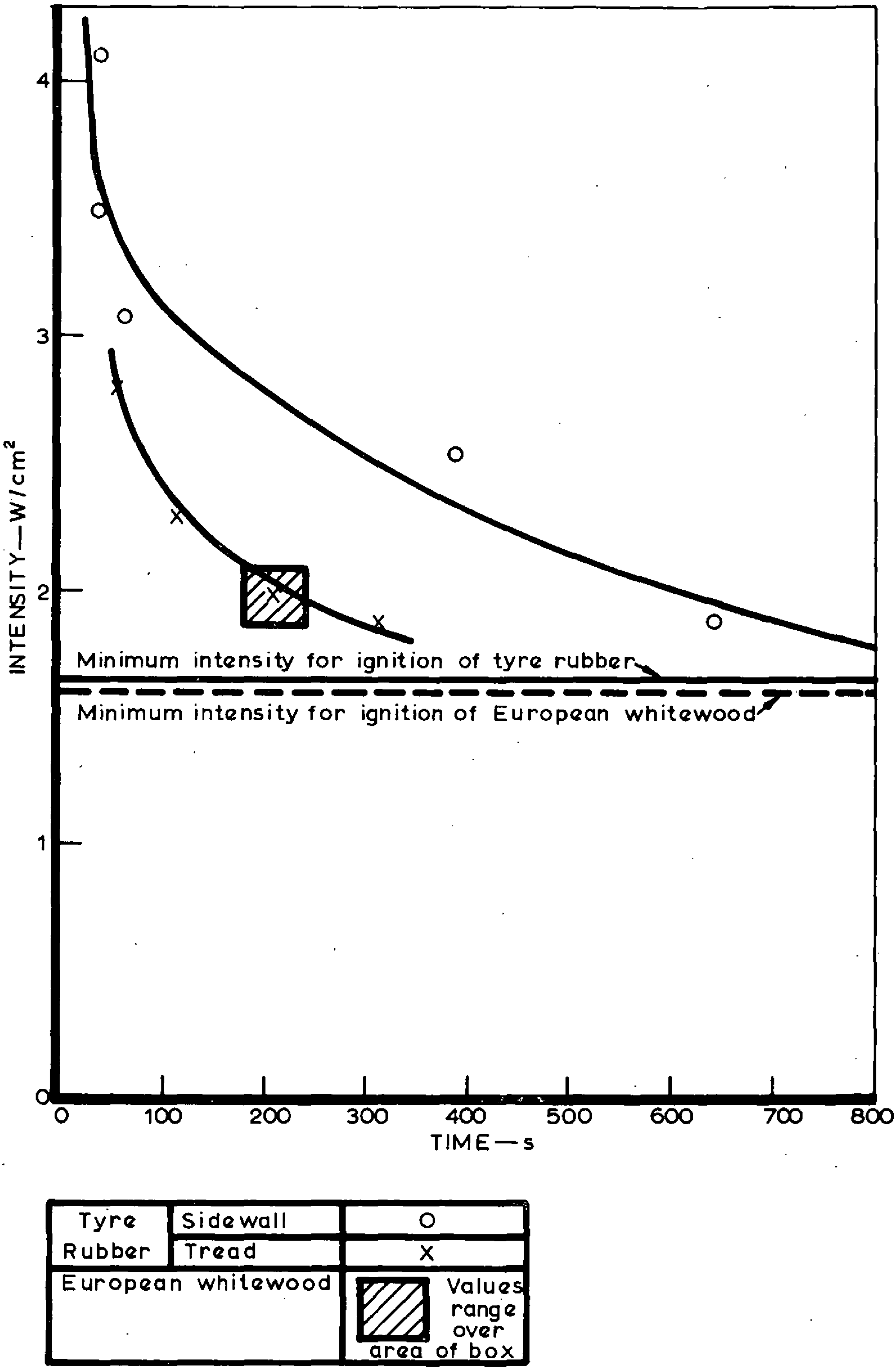


FIG.2. PILOT IGNITION OF RUBBER TYRES