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H AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

THE INFLUENCE OF EXTERNAL AIR MOVEMENTS ON THE IGNITION OF MATERIALS BY RADIATION

by

D. L. Simms

Summary

The minimum intensity of radiation at which materials ignite is affected by the draught conditions. Experiments are described which show that these effects explain certain discrepancies between the results obtained with different apparatus. It is also shown that if ignition occurs in the absence of external draught, the imposition of one does not, in the range of these experiments, affect the ignition time.

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1. Introduction

Experiments described elsewhere [1, 2] have shown that the minimum intensity of radiation at which spontaneous ignition of a material occurs may vary for the types of sources described in Table 1. The discrepancy is noticed even if the specimens have been blackened to remove effects due to variations in absorptivity [3] of the surfaces for radiations characteristic of different temperatures.

Table 1

Characteristics of radiation sources in use

Source	Approximate temperature °K	Uniform irradiated area - cm^{-2}	External draught	Approximate minimum intensity of ignition of fibre insulation board cal cm^{-2} s^{-1} (w/cm^{-2})	
Gas-fired radiant panel [4]	1,000	60	Spent gases from panel	1.6	(6.7)
Tungsten filament lamp [5] - ellipsoidal mirror	2,800	0.5	None	2.5	(10)
Carbon arc [6] - ellipsoidal mirror	4,000	2	Draught induced by arc flame	1.7	(7.1)

The two sources with low minimum intensities for spontaneous ignition both have external draughts.

The experiments described were designed to impose the draught from the gas-fired panel on the specimens when these were subjected to radiation from the tungsten lamp alone.

2. Experimental arrangement and procedure

The apparatus used is shown in Fig. 1 and Plate 1. The specimen was placed on the central axis of the panel where specimens are normally placed for exposure except that the specimen was perpendicular, not parallel, to the panel. The specimen was then subjected to the draught from the panel while exposed to radiation from the tungsten lamp. The draught from the panel was practically the same as for exposure at the minimum intensity for ignition on the panel alone.*

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* The velocity of the draught was measured by a radiation compensated anemometer [8] and was found to be about 24 cm/s.

The experiments of exposing specimens to radiation from the lamp were in two sets; in the first, the panel was not operating so there was no draught, while in the second, the radiant panel was operating and imposing its draught on the specimens. These were exposed to radiation of different intensities and the times taken to ignite were noted. The results of the experiments are shown in Fig. 2; each point being the mean of six readings. The minimum intensities for ignition in each set of experiments are given in Table 2.

Table 2

Minimum intensities for ignition cal cm^{-2} s^{-1} (w/cm^2)

System	Oak	Cedar	Fibre insulation board
Lamp without draught	2.8 (11.6)	2.8 (11.6)	2.2 (9.3)
Lamp and draught from panel.	1.8 (7.6)	2.3 (9.5)	1.6 (6.7)

3. Discussion and conclusions

The absence or presence of external air movements of velocity order 24 cm/s does not affect the time taken to ignite at those intensities at which ignition normally occurs. The minimum intensity at which ignition occurs is, however, reduced by such a draught.

In particular, the present experiments appear to show that the minimum intensity at which ignition occurs on the lamp system is lowered by the air movement from the radiant panel to a level which is characteristic of the panel alone[2].

This effect of an external draught must be considered when assessing the danger of ignition by radiation.

In view of the present results and those reported earlier on the origin of ignition in the stream of volatiles[6], further consideration is being given to the role of mixing in ignition [7].

4. References

1. Simms, D. L., Law, Margaret., Hinkley, P. L. and Pickard R.W. The effect of size of irradiated area on the spontaneous ignition of materials. Part I: The effect on ignition time. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization F.R. Note 307/1957.

2. Simms, D. L. The ignitability of materials. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization F.R. Note (in preparation).

3. Simms, D.L., Law, Margaret and Hinkley, P. L. The effect of absorptivity on the ignition of materials by radiation. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization. F.R. Note 308/1957.

4. Simms, D. L. and Miller, Joan. Radiation characteristics of a gas-fired panel. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization, F.R. Note No. 217/1956.

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8. Bigmore, R. H. A radiation compensated anemometer. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization. F.R. Note No. 297/1957.

4. Acknowledgements

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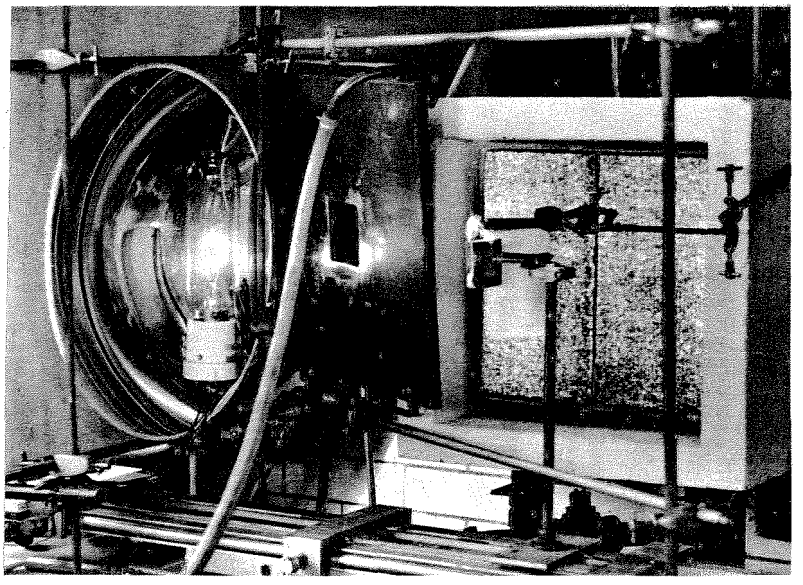

PLATE. I. GENERAL ARRANGEMENT OF APPARATUS

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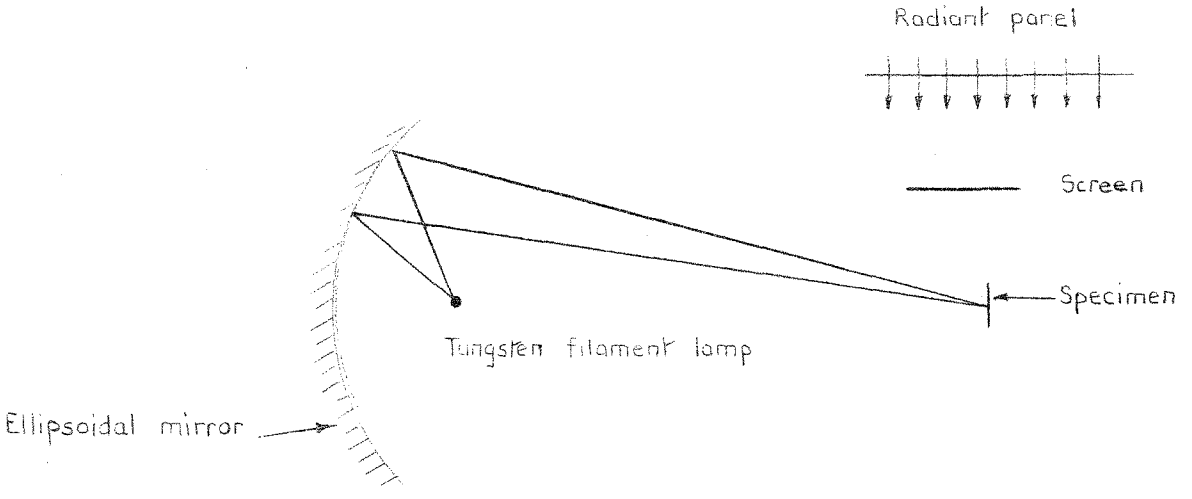

THE SPECIMEN IS SUBJECTED TO RADIATION ONLY FROM THE LAMP. THE DRAUGHT FROM THE PANEL CAN BE SUPERIMPOSED

FIG.1 PLAN OF EXPERIMENTAL ARRANGEMENT

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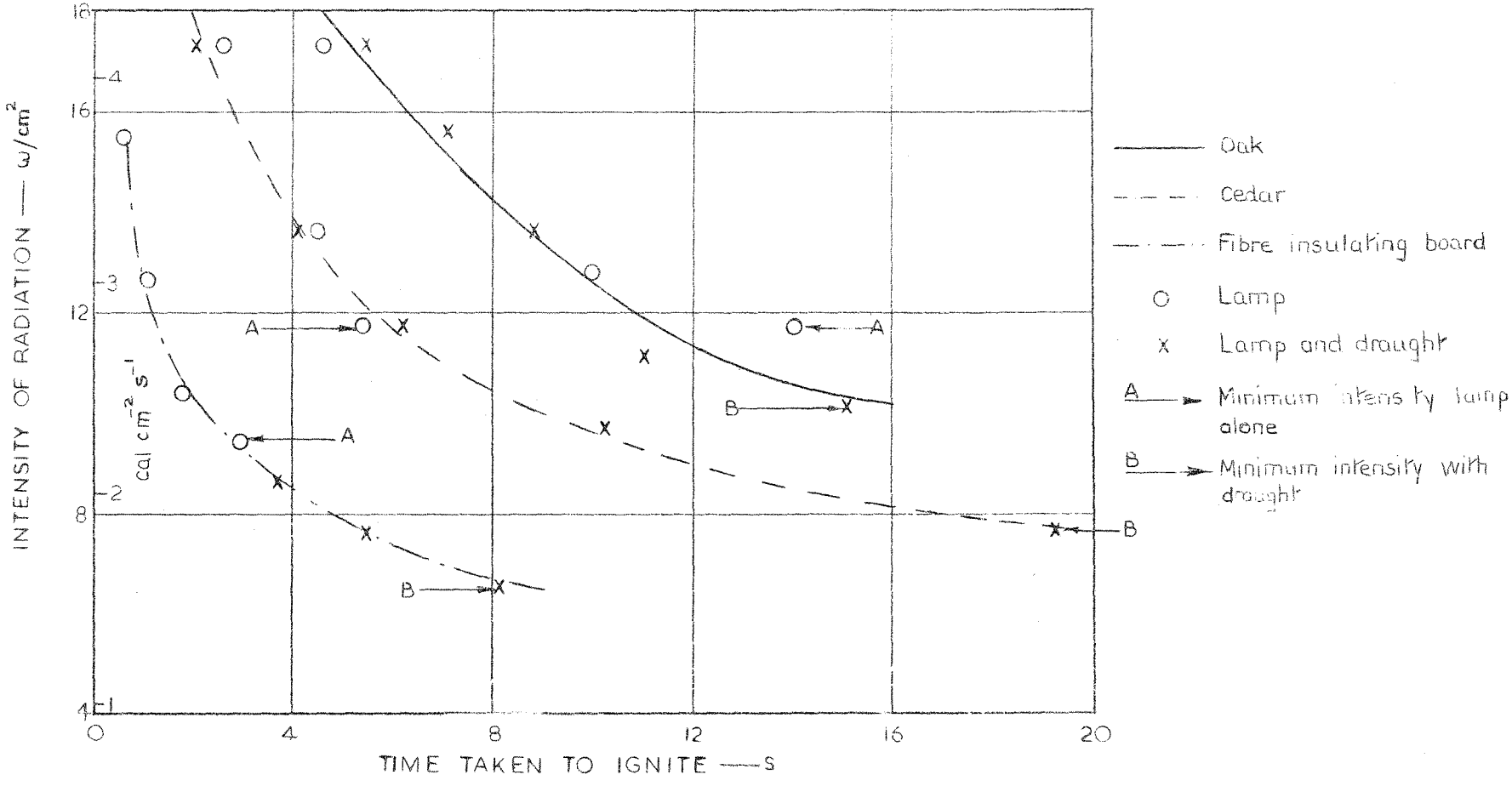

FIG. 2 THE EFFECT OF AN EXTERNAL DRAUGHT ON THE MINIMUM INTENSITY FOR IGNITION