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SMOULDERING IN DUSTS AND FIBROUS MATERIALS PART VII IGNITION WITHIN DUST HEAPS.

by

K.N. Palmer and P.S. Tonkin

Summary

A comparison is made of the times taken for smouldering to penetrate upwards through heaps of sawdust when the position of the igniting source was varied. The sawdust was ignited either at the base of the heap or at a point within the heap. For a given depth of sawdust overlying the igniting source, smouldering was more rapid when initiated at the base of the heap.

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Fire Research Station
Boreham Wood,
Herts.

SMOULDERING IN DUSTS AND FIBROUS MATERIALS
PART XII IGNITIONS WITHIN HEAPS

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K.N. Palmer and P.S. Tonkin

Introduction

In previous work relating to the propagation of smouldering inside dust heaps[1] smouldering was initiated at the base of each heap. It has been suggested that smouldering might not be sustained if initiation were attempted inside the heap, owing to the increased difficulty of supplying air when the source of ignition was completely surrounded by dust. This point was of practical interest since if smouldering were not sustained the possibility of fires arising from the ignition of heaped materials by small buried sources of ignition would be considerably reduced. Consequently, a short experimental investigation was carried out in which both methods of ignition were used.

It was also considered that if smouldering, initiated within the heap, were sustained the relation between the depth of the dust and the time taken for smouldering to emerge might differ from that established in previous work.[1]

Experimental

Materials

The dust used in all the experiments was a mixed hardwood sawdust. It contained 19·2 per cent moisture and the dry weight packing density used was 0·2 g/ml. The distribution of particle sizes was that shown in Figure 1 and the smouldering rate of the sawdust in still air was 416 sec/cm, determined on the dust in trains of base width 5·1 cm and depth 1·65 cm.

Apparatus

The layers of sawdust were contained in a 1ft cube box and the initiating heaps were formed from a flat topped conical mould 5·2 cm in height. Detailed information regarding the box and the mould has already been given[1].

Procedure

In experiments with ignition at the base of the heap, the initiating heap was ignited, placed in the box and further dust added as described before.[1] In the other experiments the initiating heap was placed on a dust layer in the box and then further dust was added until the final depth of dust was three times that of the initial layer.

The time was measured between the depostion of the dust layer upon the initiating heap of sawdust and the emergence of smouldering on the top surface of the dust deposit. The emergence of smouldering was recorded using a thermocouple and automatic temperature recorder as before.[1]

Results

It was found that smouldering was sustained when initiated inside dust heaps.

The logarithmic plot of times for smouldering to emerge against overlying depths of dust is shown in Figure 2.

After smouldering had emerged from the heaps, inspection of the residue revealed that when the source of ignition was placed between two layers of sawdust, smouldering propagated downwards almost to the base of the lower layer of the dust.

Discussion

The experiments have shown that a source of ignition buried within a dust heap can initiate smouldering in the dust and that the smouldering can propagate to the top surface of the overlying dust.

It may be seen from Figure 2 that for both methods of initiation the variation of the time for smouldering to emerge with overlying depth of sawdust can be represented approximately by the expression

$$t = ky^n \qquad \text{- - - - - - (1)}$$

in which t is time in hours and y is depth of layer in cm.
Different values of the constants k and n were obtained with the two methods of initiation of smouldering and are given in Table 1.

Table 1

Values for constants k and n in the expression

$t = ky^n$.

Position of igniting source	n	$k \times 10^2$
At the base of the heap	2·05	4·8
Within the heap	1·85	16·0

The difference in the values for n may not be significant and may be due to the greater scatter of results obtained from the experiments in which smouldering was initiated within heaps of sawdust.

For practical purposes estimations of times for smouldering to emerge from dust heaps may be made as follows;

1. For a given depth of dust overlying the source of ignition, and for both positions of initiation, equation (1) could be used with n = 2·05 and k = 0·048 to obtain estimations of the time required for smouldering to penetrate dust layers deeper than those used in the present experiments. With moderate depths of dust, if ignition is inside a heap the estimations of time may be low although of the correct order.

2. For a given depth of heap, within the range of depths tested, the times required for smouldering to penetrate the heap would be approximately equal for ignition at any point between the base of the heap and one third of the depth above the base, as may be seen from the broken line in Figure 2. The broken line represents the results for ignition within the heap, but plotted against the total depth of the heap and not the depth overlying the igniting source. With depths much greater than those within the experimental range the approximation becomes less accurate since smouldering from ignition within the heap would reach the top surface more quickly than that from ignition at the base of the heap.

Reference

1. Palmer K.N. and Perry M.D. Smouldering in dusts and fibrous materials Part XI. Propagation of smouldering inside dust heaps. F.R. Note No. 149/1953.

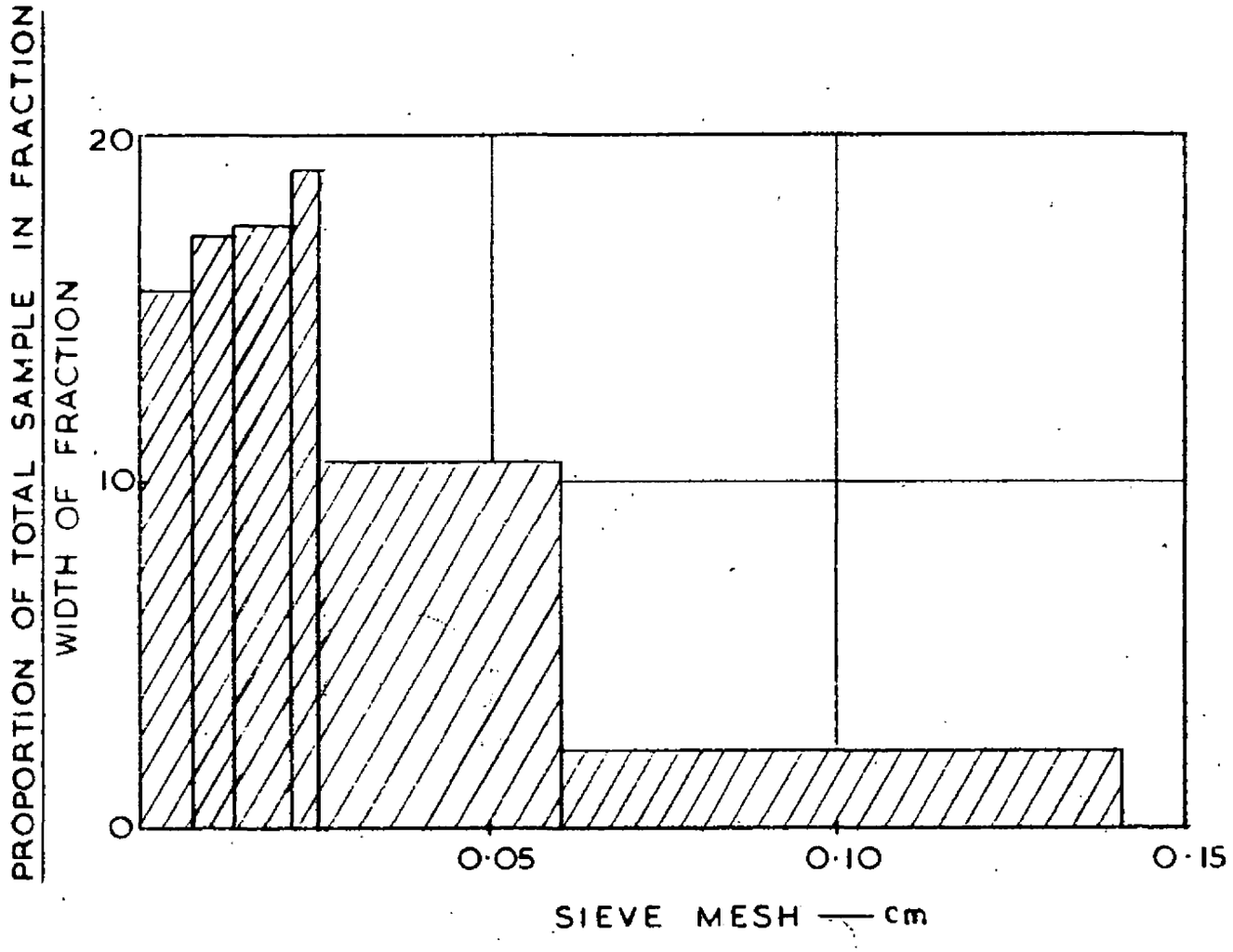

FIG. 1. DISTRIBUTION OF PARTICLE SIZES. MIXED HARDWOOD SAWDUST

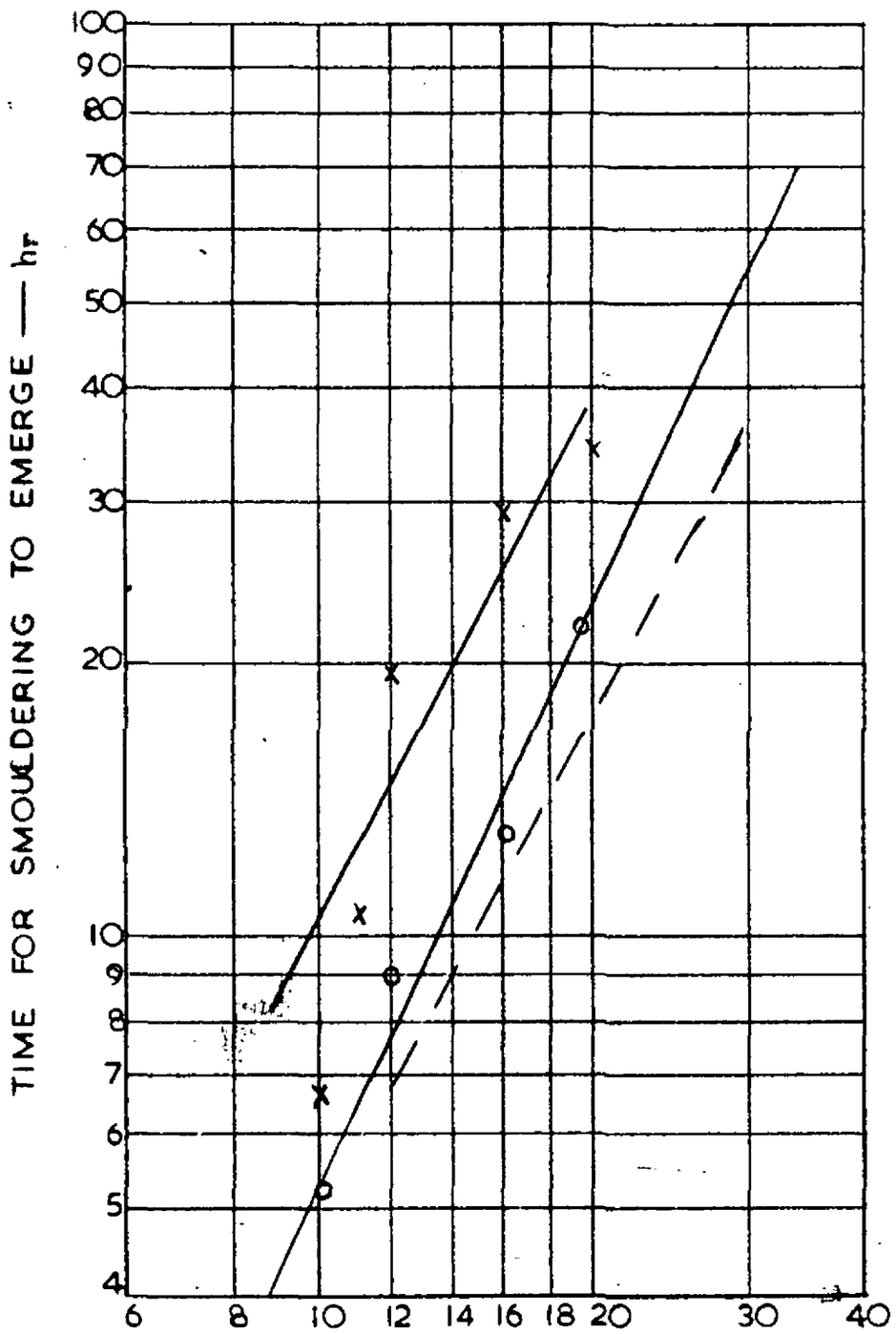

FIG. 2. SMOULDERING WITHIN HEAPS OF MIXED HARDWOOD SAWDUST