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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

ON THE RATE OF BURNING OF CRIBS OF WOOD

by

P. H. Thomas

Summary

Some published results for the rates of burning of cribs of wood sticks are used to obtain maximum rates of burning per unit area of wood surface. The seven available results are listed with geometrical properties of the cribs and pursuing a suggestion of Emmons, the peak burning rates are shown to be related to a geometrical parameter of the cribs. This however is consistent with more than one explanation and in view of the limited number of results it cannot be regarded as established.

September, 1958.

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Introduction

There are a number of results available for the rate of burning of cribs of wood. These results are derived from two sources [1], [2] and there are experimental differences. In particular the way in which ignition is effected may influence the rate of burning; if the spread of fire is restricted in a crib in which the spaces between the sticks are small the sticks in the lower layers may be partially exhausted of volatiles before the upper sticks are burning. In two cases quoted data is available whereby this effect can be studied.

This note lists geometrical details of several cribs and gives the maximum measured rate of burning. No detailed attempt has been made here to interpret these results, only to present them together with what may be a significant relation between the rate of burning and a certain crib parameter.

Experimental results

The data comprise Folk's [1] and Bryan's [2] results. A description of the cribs, some of their geometrical properties and the rates of burning are listed in Table 1. The cross section A_v of the vertical air passages in the cribs has been calculated and the area through which air can enter the sides of the cribs A_s is also given. Folk's cribs were all rectilinear and Bryan's triangular. For these cribs the value of A_v has been assessed as that shaded in Fig. 1.

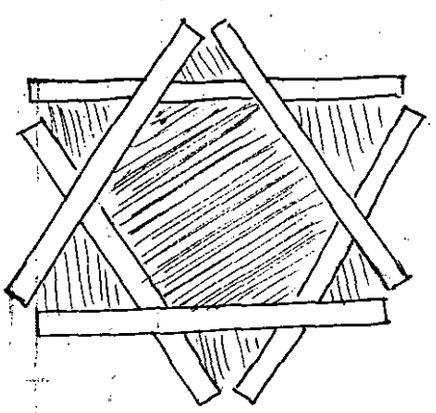

FIG. 1. CROSS SECTION OF BRYAN'S CRIBS EACH LAYER BEING 3 STICKS IN AN EQUILATERAL TRIANGLE.

The value of A_s is easily obtained for a rectilinear crib but it can have little more than a nominal value for Bryan's crib because of the construction of the crib. It was actually taken for the purposes of this report as the inlet area of the crib sides assuming alternate layers to be absent except for the small pieces actually in contact with other layers. Thus for 20 layers of 24 in. x 2 in. x 2 in., A_s equals 3 x 19 x 2 x 24 x 6.45 cm, i.e. 17,700 cm^2.

The area determining the inlet air flow is the lesser of A_v and A_s and in each of these cribs it is A_v. The peak rates of burning and the exposed area of wood - A_w were evaluated from the published records. For the three cribs for which Folk gives details for each separate layer the rate of burning for each layer was evaluated and the average of all the maximum values taken except for the top and bottom layers which are not typical.

Discussion

Emmons (3) suggested a means of correlating Folk's data, but he only considered the three 10 layer cribs.

The data have in fact been plotted in Fig. 2 as a function of A_v/A_w and it is seen that a single curve is obtained. The inclusion of A_v - though not of A_w - is in line with Emmon's suggestion of a correlation in terms of the air passages, but A_v/A_w would equally well be a measure of the "porosity" of the crib to radiation transfer, the radiation from the flames controlling the heating and decomposition of the wood. After all cribs burn well because they do not lose heat by radiation from the inner surfaces. The growth of the fire will certainly be influenced by the air flow conditions because even if when the maximum rate of burning is reached the flames are above and not within the crib, the flames will be within the crib during the growth. The more restricted the air supply the slower the growth and the lower the average rate of burning compared with the maximum rate. More experimental results are required before pursuing this problem and these, as Emmons has pointed out must be obtained by an experimental proceedure considered in the light of similarity principles.

Although the correlation in Fig. 2 is good, it would be as well not to exclude the possibility of its being fortuitous in view of the few results that there are and the absence of a dimensionless correlation. Any relation that there is might well reflect a thermally controlled system as well as one air controlled.

References

(1) FOLK, "Experiments in fire extinguishment". Nat. Fire Proc. Assoc. Quart. 1937, p. 115.

(2) BRYAN, "Scale effects in the burning of timber". Ministry of Home Security. July, 1943. RC(F).64.

(3) EMMONS, "First Fire Research Correlation Conference". National Research Council U.S. National Academy of Science. 1956.

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TABLE 1

Details of cribs and rates of burning

	Number of layers	No. of sticks in each layer	Size of stick cm	Height of crib cm	Total exposed wood surface cm^2 A_w	Area of vertical air passages A_v cm^2	Area of side inlets A_s cm^2	A_v/A_w	Rate of burning mg cm^{-2} sec^{-1}	
									Maximum value of total rate averaged over whole exposed surface	Average of maximum rates for each single layer in crib
Folk	10	4	10 x 1 x 1	10	1,350	36	108	0.026	0.62	1.0
	10	5	10 x 1 x 1	10	1,600	25	90	0.0156	0.50	1.4
	10	7	10 x 1 x 1	10	1,990	9	54	0.0045	0.21	-
	6	3	15 x 2.5 x 2.5	15	2,240	42	176	0.019	0.49	0.49
Bryan	20	3	61 x 5.1 x 5.1	102	73,470	2,500	18,000	0.036	0.94	-
	20	3	53 x 4.4 x 4.4	89	55,420	1,940	13,800	0.036	0.85	-
	20	3	38 x 3.1 x 3.1	63	27,860	1,070	7,000	0.036	0.82	-

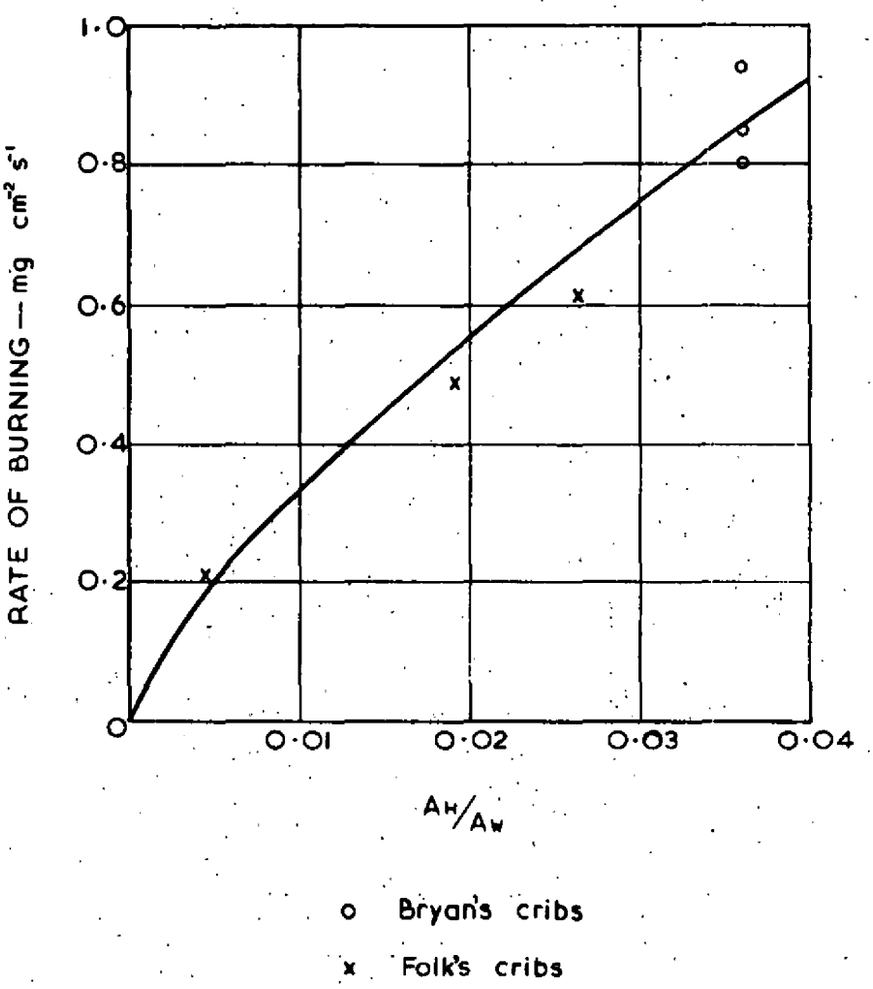

FIG. 2. MAXIMUM RATE OF BURNING OF CRIBS — AVERAGE FOR ALL LAYERS