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A NOTE ON THE RESISTANCE OF FOAM TO RADIANT HEAT

by

P. H. Thomas

Summary

This note discusses the results of previously reported experiments on the effect of the expansion and shear strength of foam on its resistance to radiant heat. If the probable effect of foam drainage is discounted the ratio of the time to destroy the foam to the time to evaporate its water content is found to vary by no more than 70 per cent for the whole range of properties examined. This ratio, moreover can, except for the results with foam of expansion 13.5, be correlated directly with the specific surface of the water in the foam. The results of experiments with foam of expansion 13.5 appear to be anomalous.

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Introduction

Two series of experiments on the heat resistance of foam were made by French (1). In the first, two foams of known expansion and critical shearing stress were subjected to radiation of various intensities and the times 'H' to destroy a 3.2 cm layer of foam were measured. The results were expressed by a simple formula. With a hydrolysed keratin type of foam (A) of expansion 6.8 and critical shear strength 450 dynes/cm^2 the heat resistance was given by

$$H = \frac{123}{I} + 195 \qquad ....(1)$$

where 'H' is the time in secs to destroy a layer of foam 3.2 cm thick and I is the intensity of radiation in cal cm^{-2}sec^{-1}. With a hydrolysed blood foam 'B' of expansion 7.7 a critical shear strength 850 dynes/cm^2 the heat resistance was found to be

$$H = \frac{73}{I} + 180 \qquad ....(2)$$

Analysis of experimental results

The amount of heat required to evaporate the water content is $\frac{3.2 \times 620}{E}$ cal cm^{-2} of surface, 620 cals/gm being the total heat of steam at 100°C for 20°C ambient. The heat supplied to the foam in H secs is H.I. and this quantity relative to the heat required to evaporate the water is therefore

$$h = \frac{H.I.E.}{1,980} \qquad ....(3)$$

For foam A we have therefore from equations (1) and (3)

$$h_A = 0.42 + 0.67\ I \qquad ....(4)$$

and for foam B from equations (2) and (3)

$$h_B = 0.28 + 0.70\ I \qquad ....(5)$$

The range of I used in the experiments was 0.125 to 0.8 cal cm^{-2}sec^{-1} so that h_A increased linearly from 0.5 to 0.96 and h_B from 0.36 to 0.84

A second series of experiments was made in which foam A was subjected to a constant intensity of I = 0.49 cal cm^{-2}sec^{-1} over a range of values of E and S. Now the mean bubble wall thickness is given (2) by $\frac{2}{ES_s}$ where S_s is the specific surface which is proportional to S(3). It is thus convenient to plot 'h' against ES which is proportional to the inverse of the bubble wall thickness or alternatively proportional to the specific surface of water for all values of E and S. Figure 1 shows that a single correlation is satisfactory for all the results, except those derived from tests with foam of expansion 13.5, which are in excess of the other values.

Discussion

From Fig.(1) it will again be seen that values of 'h' occur which are less than unity and the most likely explanation for this is that the foam has drained and water has flowed past the piston supporting the foam sample. The effective water content of the foam is therefore lowered and values of 'h' are obtained which are too small. Neglecting the values of 'h' below unity it is seen that 'h' varies by about 70 per cent over the whole range of the experiments and this is a much smaller variation than in the absolute heat resistance 'H'. If this explanation of the values of 'h' below unity is valid we should expect the greatest lowering of 'h' to occur in the tests of greatest duration and for foams which drain most rapidly. This in fact is so. In the first series of tests 'h' increases from a low value to a high one as H the destruction time, decreases from about 12 minutes to about 5 minutes. In the second series, the more rapidly draining foams are those of low expansion and it is for these that 'h' is less than unity.

The second series of tests shows that the relative heat resistance 'h' increases as the product ES increases. It is not possible to say why this is so but a crust of dried foam on the surface of the foam may well, by acting as an insulator, be partly responsible. In foams with thin bubble walls one might expect this crust to form sooner than in foams of thick bubble walls.

The results obtained with foam of expansion 13.5 are generally above the others and this was taken as evidence$^{(1)}$ that there is an expansion at which the heat resistance is a maximum.

Now, although the difference in heat resistance relative to water content between these foams and those of all other expansion appears to be about 15 per cent, the values obtained with foams of expansion 19 are consistent with those obtained for all other values of expansion of 9 below. If the heat resistance of foam of expansion 13.5 has in fact a maximum value it would be expected that heat resistance of foams of some expansion between 9 and 13.5 and between 13.5 and 19 should lie intermediate between the two curves. In the absence of such data it is considered that further work should be done before any definite conclusions are drawn on the validity of this maximum.

References

(1) "The resistance of fire-fighting foams to destruction by radiant heat". FRENCH, R. J. K. App. Chem. 2 1952, 60.

(2) "A note on the application of foam to vertical surfaces". THOMAS, P. H. F.R. Note 143/54.

(3) "A study of mechanically produced foams for combating petrol fires." CLARK, N.O. H.M.S.O. 1947.

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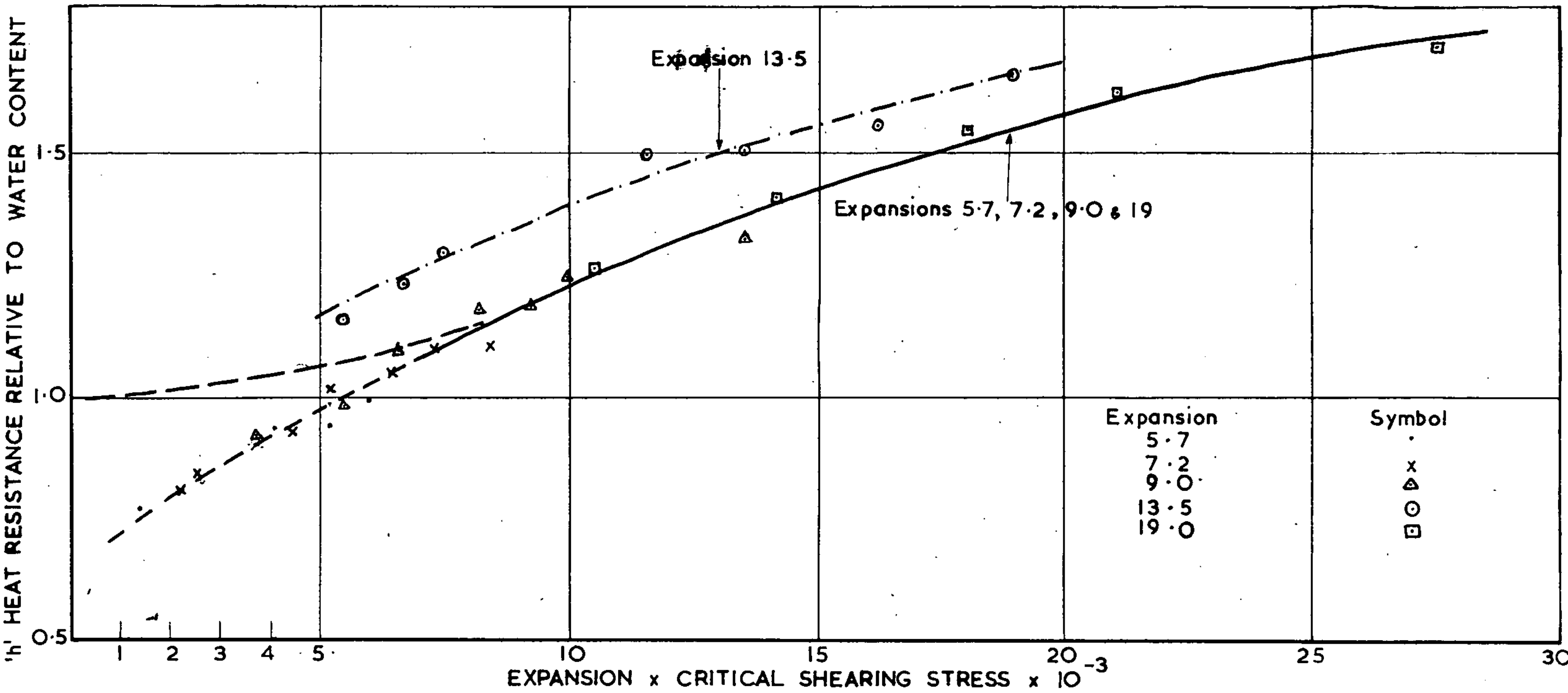

FIG. I. THE VARIATION OF HEAT RESISTANCE RELATIVE TO WATER CONTENT WITH THE SPECIFIC SURFACE OF WATER