DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

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THE FIRE PERFORMANCE OF PRE-MIXED PROTEIN FOAM LIQUIDS STORED FOR LONG PERIODS UNDER PRESSURE

by

R. COASBY and D. W. FITTES

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Fire Research Station.
Boreham Wood.
Herts.
('phone ELStree 1341)

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SUMMARY

This note describes the effect on protein-based foam liquids of storage in aqueous solution under pressure for long periods. The study has shown that even after two years under these conditions, foams made from the liquids can give an adequate performance on petroleum fires.

The same liquids stored in aqueous solution in open reinforced glass-fibre trays for very limited periods have been found to deteriorate rapidly. The results did not correlate satisfactorily with those of the foams stored under pressure, and this method is unlikely to be suitable for an accelerated ageing test.

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Introduction

Although it is known that protein foam liquids can be stored in concentrated form for long periods with no appreciable deterioration in their foam making properties, little information is available on the effect of storing these liquids in pre-mixed aqueous solution for extended periods. Interest has recently been shown in the practical use of pre-mixed liquids for such applications as aircraft crash tenders, fixed foam installations, and small extinguishers. In this investigation an effort has been made to simulate the effects of storage in a pressurized type of extinguisher, and for this, five proprietary liquids were stored in 5 per cent solution in pressurized extinguisher bodies for periods of up to two years.

In addition, the same liquids were stored at the same solution strength in open glass-fibre trays for periods of up to five and a half weeks. This was to show the effects of large surface area contact with the atmosphere and to provide a comparison with the results obtained by pressurising the liquids in containers of relatively small cross sectional area.

Experimental

The five proprietary air foam liquids which were stored in 5 per cent concentration in 2-gallon extinguisher bodies were subjected to a pressure of 150 p.s.i. for periods of 0, 13, 48 and 107 weeks. The 2-year period corresponds to the usual re-filling period for mechanical foam extinguishers.

After storage, each pre-mixed solution was decanted in turn, into a 2-gallon extinguisher fitted with a small plastic branch pipe. This extinguisher was then pressurized to 65 p.s.i., and samples of the foam were taken in order to measure the foam expansion (i.e. the ratio of volume of foam to volume of foaming solution), and critical shear stress (1), two repetitions being made for each property.

For the fire test, special petroleum spirit was used having an initial B.P. of 60°C (Minimum) and a final B.P. of 70°C (maximum), in order to eliminate discrepancies due to variation in the fuel used.

The test apparatus used was that described in F.R. Note 451, (2) the flammable liquid being contained in a circular tank giving a free liquid surface area of 3 sq. ft.

Foam of the same expansion and critical sheer stress obtained in the branch pipe test was produced in a laboratory foam generator (3) and applied to the surface of the fire through a $\frac{1}{2}$ inch B.S.P. tee-piece situated with its outlets just above the fuel surface. In each test the petrol was ignited and allowed to burn for 1 minute before the foam was applied. The "$\frac{2}{3}$rds control time" from the start of foam application to the time when the intensity of the fire was reduced to one third of its initial value was measured using four radiometers mounted symmetrically around the fire test apparatus, and connected in series. The foam was applied at a rate of 0.05 gal. ft^{-2} min^{-1} which is about twice the "critical rate", (i.e. the minimum rate of application which will enable the fire to be controlled) for four minutes.

The stability of the foam blanket on the petrol surface was determined by measuring the total amount of liquid drained from the foam during a 10 minute period from the commencement of foam application.

Results and discussion

The results obtained from the tests on the liquids after storage, are given in Table 1. The table shows that there is a large degree of scatter in the readings, but there is some evidence that the critical shear stress decreases after a considerable storage period, while the $\frac{2}{3}$rds control time and the extinction time tend to increase. The stability of the foam blanket is also adversely affected, as shown by the increase in 10 minute drainage. Neither the two-thirds control time nor the 10 minute drainage show more than a 25 per cent increase on the value obtained from the control test. This is shown in Figures (1) and (2), where "$\frac{2}{3}$rds control time as a fraction of $\frac{2}{3}$rds control time at zero weeks storage" and "Ten minute drainage as a fraction of ten minute drainage at zero weeks storage" are plotted against "Storage time". No curves were drawn through the points owing to the wide variation in test results.

The greatest deterioration in performance occurred with compound C which, although satisfactory after 48 weeks was rather marginal at 107 weeks, with control times of 89 and 92 seconds and extinction times of 4 minutes for each of the two samples. The 10 minute drainage was also high for this compound.

The results of the fire tests on foams produced from premixed foam liquids stored in open trays were found to be very variable. The control times varied greatly with different storage periods and for different liquids, but in general most of the foam liquids could not control the test fire after 2-3 weeks storage, and heavy sludging was found to have occurred. It was not found possible to obtain a general correlation between these results and those of the tests on foam liquids stored under pressure.

These results suggest that a large surface area of contact between foam liquid and air is a more potent factor in liquid deterioration than is the use of a relatively high air pressure over a limited surface area of contact.

Conclusions

1. The four protein foam liquids tested after two years storage under pressure, gave a satisfactory performance on fires.

2. The stability of the foam blanket, after the 2 year period was still within 25 per cent of the control value as measured by the 10 minute drainage figure. No appreciable sludging of the solutions occurred during the storage period.

3. The tests in which the premixed solutions were stored in open trays showed that the foam liquids depreciated rapidly, and after two to three weeks could not produce foams capable of controlling the test fires. No correlation could be made between the results of the two series of tests, and it is concluded that the open-tray test cannot be used as an accelerated ageing test for storage of foam liquids under pressure.

4. The foam liquids tested, depreciated far more rapidly when exposed to air over a large surface area, than when exposed to air at a relatively high pressure over a limited surface area.

Acknowledgment

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Table 1 - Results on Branch pipe and fire tests on the premixed compounds

Compounds	Storage Time at 150 p.s.i.	Critical Shear Stress Dynes/sq. sm.	Expansion	$\frac{2}{3}$ Control Time Seconds	Extinction Time Minutes	10 Min. Drainage cc's
Compound A	Control	180	7.4	88 83	$3\frac{1}{2}$ $3\frac{1}{2}$	1620 1620
	13 Weeks	136	6.9	58 66	$3\frac{1}{2}$ 3	1645 1670
	48 Weeks	124	5.4	70 78	3 $3\frac{1}{2}$	1570 1620
	107 Weeks	144	8.0	67 70	3 $3\frac{1}{4}$	1710 1710
Compound B	Control	149	7.9	59 53	$2\frac{1}{2}$ $2\frac{1}{4}$	1855 1935
	13 Weeks	108	5.4	67 68	$3\frac{1}{4}$ 4	1985 2015
	48 Weeks	130	6.5	49 53	$2\frac{1}{2}$ $2\frac{1}{2}$	1805 1840
	107 Weeks	98	8.2	61 69	$2\frac{3}{4}$ $3\frac{1}{4}$	2035 2045
Compound C	Control	155	7.1	75 70	3 $3\frac{1}{4}$	1775 1775
	13 Weeks	174	7.3	70 66	4 3	1710 1765
	48 Weeks	149	6.7	55 51	$2\frac{1}{2}$ $2\frac{1}{2}$	1850 1890
	107 Weeks	107	6.8	89 92	4 4	2150 2175
Compound D	Control	118	7.1	60 57	$2\frac{1}{4}$ $2\frac{1}{4}$	1685 1775
	13 Weeks	143	7.7	60 61	$2\frac{1}{2}$ 2	2045 2070
	48 Weeks	93	6.3	57 54	3 3	1990 2030
	107 Weeks	102	6.8	68 65	3 3	2005 2125
	Control	118	7.0	58 52	$2\frac{1}{2}$ $2\frac{1}{2}$	1835 1835
	30 Weeks	107	8.5	62	3	1985

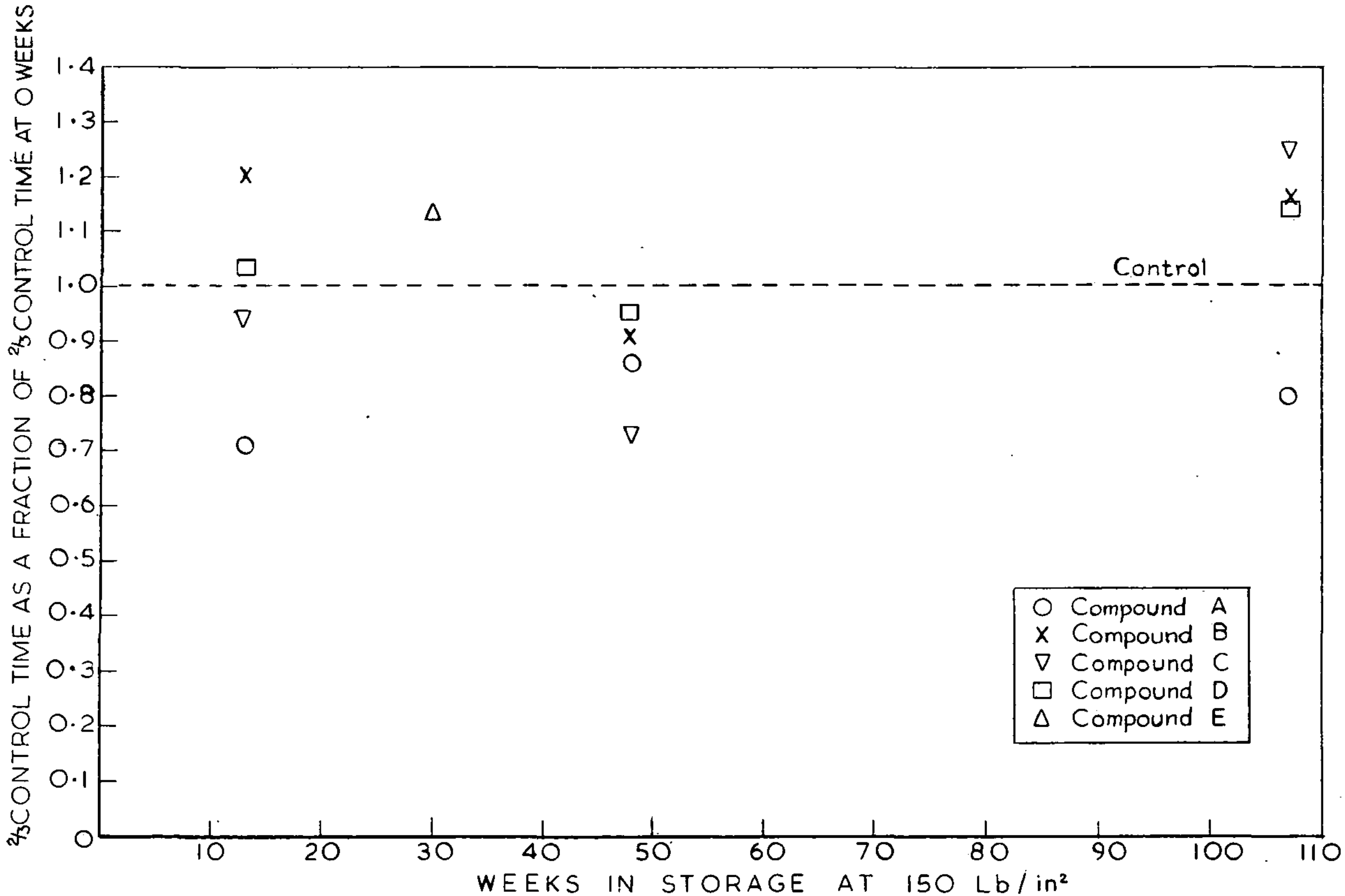

FIG. 1. EFFECT OF TIME OF STORAGE UNDER PRESSURE ON 2/3 CONTROL TIME

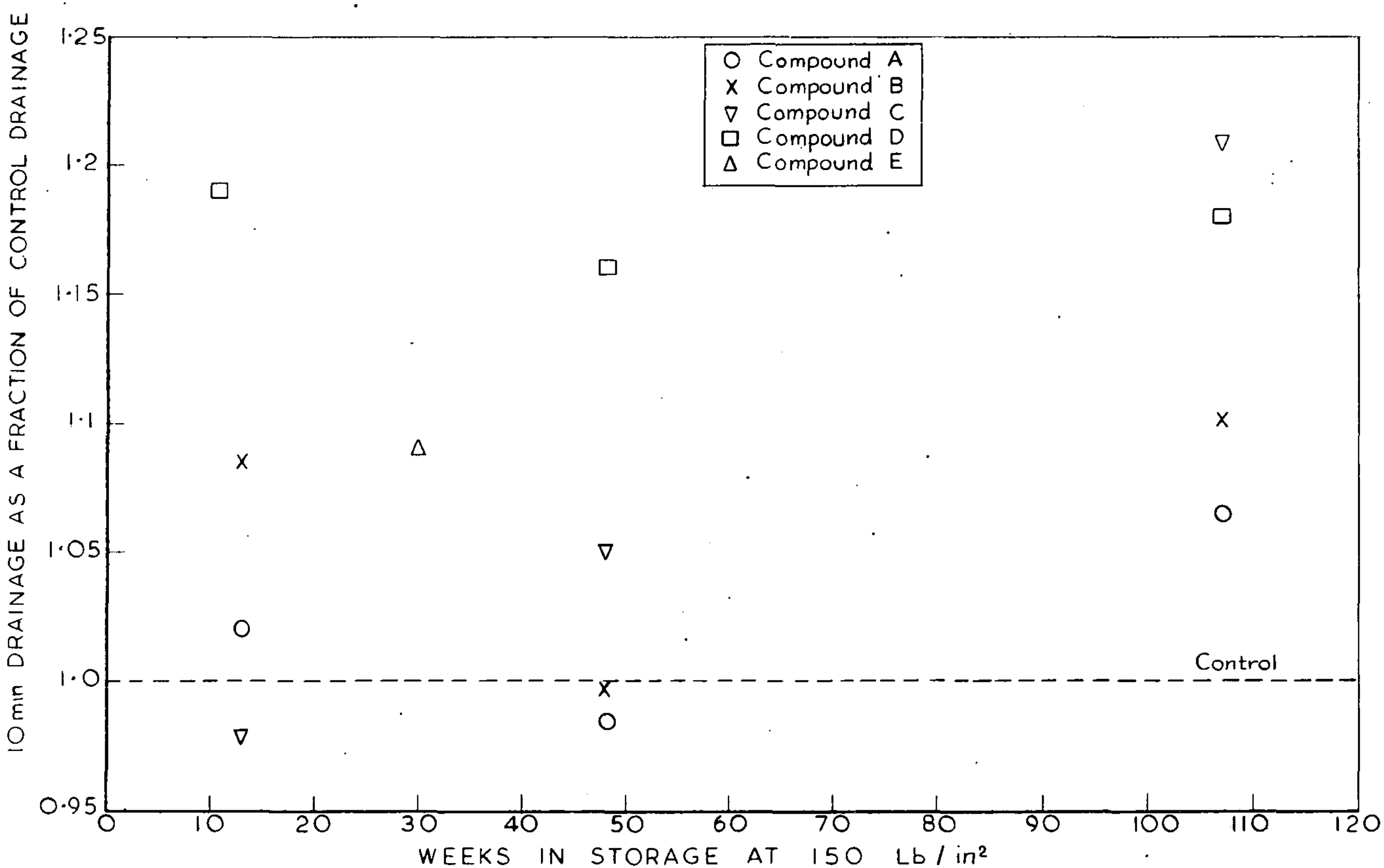

FIG 2. EFFECT OF TIME OF STORAGE UNDER PRESSURE ON DRAINAGE