F. R. Note No.482

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

THE EXTINCTION OF FIRES IN MIXTURES OF PETROL AND METHYLATED SPIRIT USING PROTEIN FOAMS

by

D. W. Fittes and D. D. Richardson

Summary

This note describes an investigation of the performance of protein-based foams in the extinction of fires in mixtures of petrol and methylated spirits in different proportions. The study shows that while 1 per cent by volume addition of methylated spirit will barely accelerate the breakdown of the foam, an addition of 20 per cent causes severe breakdown.

October 1961

Fire Research Station,
Boreham Wood,
HERTS

THE EXTINCTION OF FIRES IN MIXTURES OF PETROL AND METHYLATED SPIRIT USING PROTEIN FOAMS

by

D. W. Fittes and D. D. Richardson

Introduction

The extinction of fires in petrol and other hydrocarbons with fire points below 100°C may be achieved effectively with normal protein-based air foams. Such foams are not, however, suitable for use on fires in water-miscible solvents such as methylated spirits, as rapid drainage of the water from the foam occurs - indeed, alcohols are used industrially as foam breakers.

In certain applications, hydrocarbon fuels are treated with admixtures of alcohols, for example, in the addition of up to 20 per cent ethyl alcohol to petrol. It is of importance to know how this will affect the performance of normal protein foams in the extinction of any fires that may occur. There are, of course, protein-based foams specially treated[1] for use on water-miscible solvents, but these might not be available where the storage is predominantly of hydrocarbons.

In this investigation, the performance of normal protein-based airfoams on petrol containing up to 20 per cent of methylated spirits has been examined, in terms of the increase in the critical rate of application of foaming liquid to the fire, and in the quantities required to control the fire at higher rates of application.

Experimental

A special petroleum spirit having an initial B.P. of 60°C (minimum) and a final B.P. of 70°C (maximum) was used in the experiments. Methylated spirits, containing 95 per cent ethyl alcohol, was mixed with the petrol in proportions of 1, 5 and 20 per cent by volume. In all the experiments the fuel was contained in a tray 5 in deep and 2 ft in diameter. The intensity of the fire was measured by three radiometers connected in series and arranged symmetrically around the fire. Foam from a laboratory foam generator [2] was applied to the surface of the fuel through a $\frac{1}{4}$ inch B.S.P. teepiece situated with its outlets just above the fuel surface.

In some experiments, the foam was projected into the centre of the burning fuel from a horizontally-mounted jet, placed 2 ft from the centre of the tray and 1 ft above the fuel surface. A $\frac{1}{8}$ inch diameter jet was used to apply foam at a rate of 0.02 gl/ft^2/min. At other rates the diameter of the jet was chosen to ensure a constant efflux velocity of the foam. The airfoam was of 4 per cent concentration having an expansion of 8 and a critical shear stress [3] of 250 dynes/cm^2. In one experiment, the critical shear stress was increased to 600 dynes/cm^2. A protein foam compound to current M.O.W. Specification was used.

In each test the petrol was ignited and allowed to burn for 30 seconds before foam was applied. The "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, the mean intensity of radiation during the 5 second period immediately prior to the application of foam being taken as the initial intensity. The critical rate of application was determined by estimating the asymptote to the control time - rate of application curve.

Results and discussion

In investigations to determine the effectiveness of foam in the control of flammable liquid fires, the foam is usually applied gently to the fuel surface by a tee-piece applicator. In the present investigation the effect of more forceful foam application was also examined, and for this purpose a jet applicator was used. Figure 1 shows the relationship between control time and rate of application of foam to the fire for both gentle (tee-piece applicator) and forceful (jet applicator) foam application to fires involving petrol containing 0, 1, 5 or 20 per cent (vol/vol) of methylated spirit. Examination of Figure 1 shows that in tests involving petrol only, the critical rate of foam application is about 0.016 gl/ft^2/min for either method of foam application. No increase in the critical rate is discernible when the foam is applied, either gently or forcefully, to burning petrol containing 1 per cent of methylated spirit. More rapid foam drainage occurs when 5 per cent of methylated spirit is contained in the petrol and when the fuel includes 20 per cent of the alcohol, the severity of breakdown is considerably greater, the breakdown being greatest when the foam is applied forcefully to the fire. The relationship between the quantity of alcohol in petrol and the critical rate of application of foam is shown for both methods of foam application in Figure 2. It may be seen that amounts of alcohol in petrol greater than about 1 per cent cause a discernible increase in the critical rate. With 20 per cent of alcohol the critical rate is about 0.05 gl/ft^2/min for gentle foam application and about 0.13 gl/ft^2/min for forceful foam application. These values are respectively about 3 and 8 times the critical rate on petrol containing no alcohol.

The quantity of foaming liquid necessary to control a 100 sq. ft area of fire at different rates of application is shown in Figure 3. Curves are shown for forceful and gentle foam application to fires in petrol containing 20 per cent methylated spirit and petrol containing no alcohol.

It is of interest to note that an increase in the critical shear stress value of the foam renders it slightly more resistant to breakdown by the alcohol (Fig.1). When a foam of critical shear stress 600 dynes/cm^2 is applied by jet to a fire involving 20 per cent of methylated spirit the critical rate is about 0.11 gl/ft^2/min compared with about 0.13 gl/ft^2/min when more fluid foam (critical shear stress 250 dyne/cm^2) is used.

Conclusions

1. The presence of a little over 1 per cent of methylated spirit in petrol is sufficient to cause accelerated breakdown of normal protein foam.

2. The breakdown is less severe when the foam is applied gently to the fire than when it is forcibly applied.

3. The critical rates for gentle and forceful foam application to fires involving 20 per cent of methylated spirit in petrol, are approximately 3 and 8 times as great as the critical rate on petrol containing no alcohol.

4. At higher rates of gentle application (by tee-piece) of 0.06 - 0.12 gl/sq.ft/min the quantity of foaming liquid required to control the fire is between five and two times as great with the admixture of 20 per cent methylated spirit as it is without addition of spirit to the petrol.

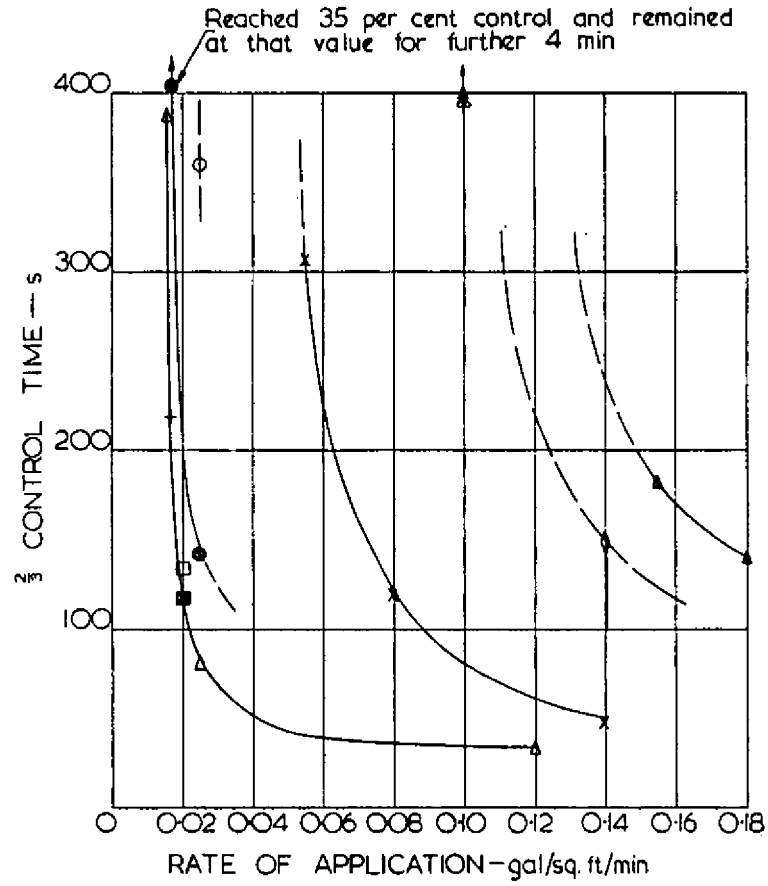
5. Increasing the critical shear stress of the foam slightly increases its resistance to breakdown by the methylated spirit.

References

1. NASH, P. and FRENCH, R.J. Foam compounds for use against fires in water miscible solvents. J. Inst. Petrol. Volume 47, No. 450, June 1961. pp. 219 - 222.

2. FRY, J. F. and FRENCH, R. J. A mechanical foam-generator for use in laboratories. J. appl. Chem., I. October 1951, pp.425 - 429.

3. FRENCH, R. J. Foam viscometer. J. Sci. Instrum., Vol. 37, August 1960, pp. 307 - 308.



Symbol	Tee-piece applicator	Symbol	Jet applicator
△	No alcohol	□	No alcohol
+	1 per cent methylated spirit	■	1 per cent methylated spirit
●	5 per cent methylated spirit	○	5 per cent methylated spirit
x	20 per cent methylated spirit	▲	20 per cent methylated spirit
		◊	20 per cent methylated spirit Critical shear stress of foam 600 dyn/sq.cm

FIG. 1. THE CONTROL BY FOAM OF FIRES INVOLVING MIXTURES OF PETROL AND METHYLATED SPIRIT

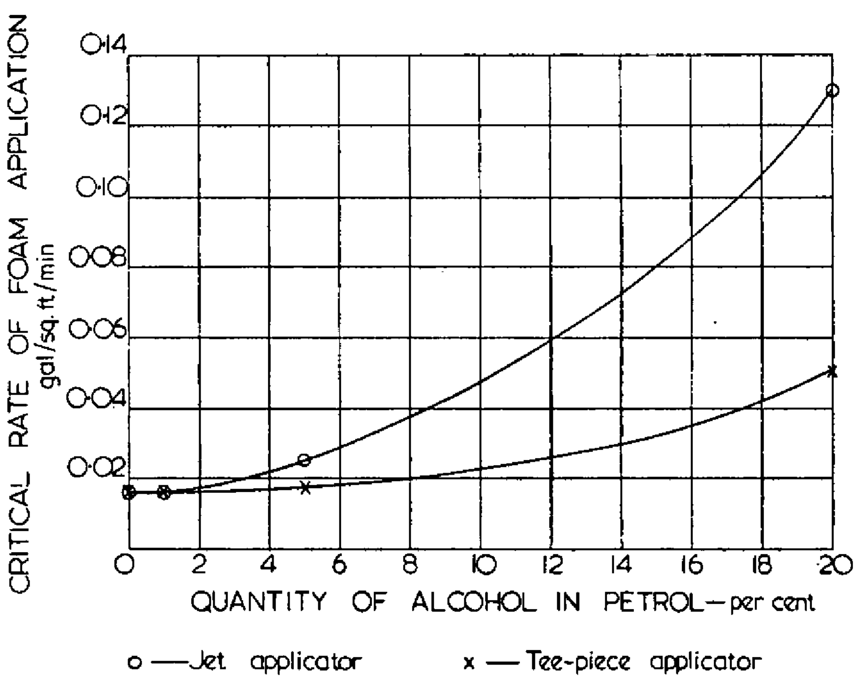
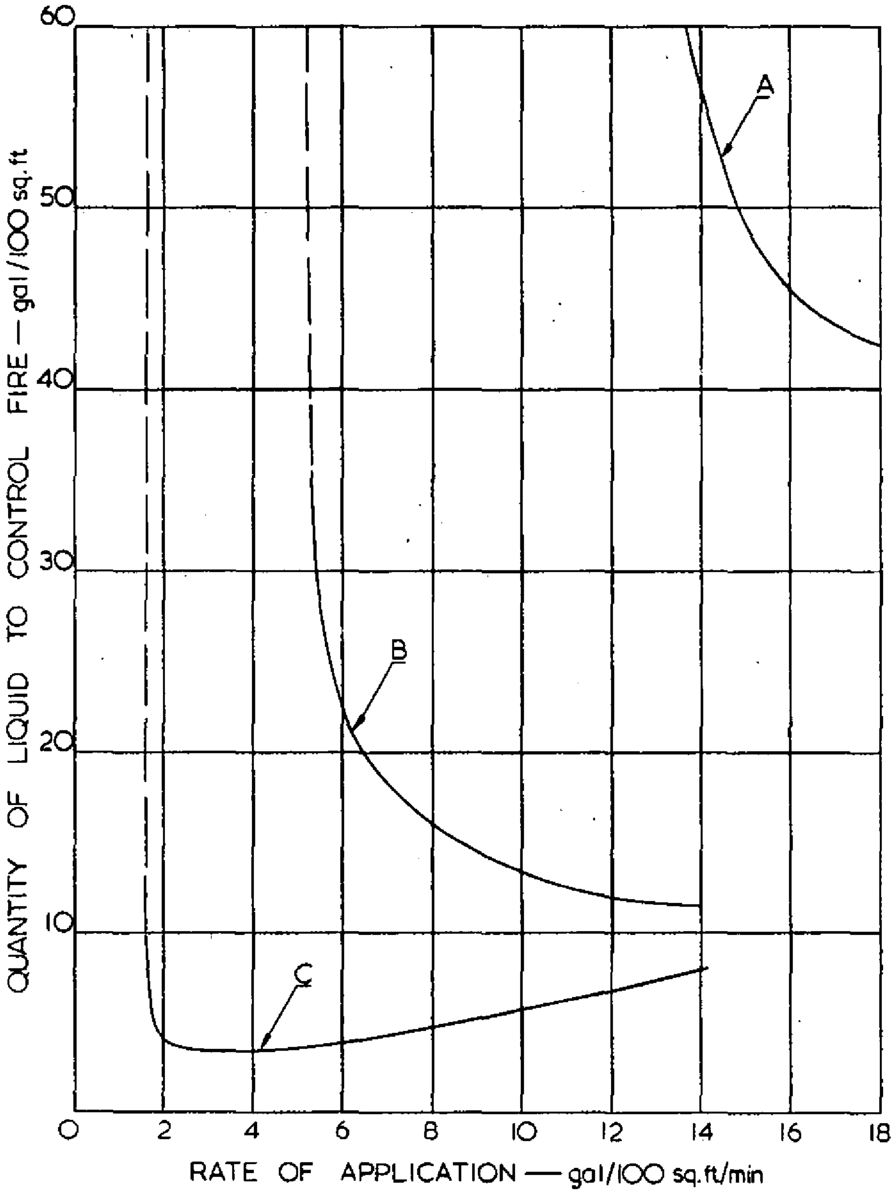


FIG. 2. RELATIONSHIP BETWEEN CRITICAL RATE AND QUANTITY OF METHYLATED SPIRIT IN PETROL FOR TWO METHODS OF FOAM APPLICATION

1/4344 F.R. 482



A — Petrol with 20 per cent methylated spirit (Jet applicator)

B — Petrol with 20 per cent methylated spirit (Tee-piece applicator)

C — Petrol

1/4345 F.R. 482

FIG. 3. QUANTITY OF LIQUID TO CONTROL FIRE AT DIFFERENT RATES OF APPLICATION