CONFIDENTIAL

F.R. Note No. 1.

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

THE EFFECTS OF CERTAIN HALOGENATED HYDROCARBONS ON THE INFLAMMABILITY LIMITS OF n - HEXANE AND AIR

by

E. H. Coleman and P. S. Tonkin

Summary

A series of tests has been carried out to determine the effects of certain fluorinated hydrocarbons containing bromine and chlorine on the inflammability limits of n - hexane and air.

The compounds tested were, in order of efficiency by volume, tetrafluorodibromoethane, difluorodibromomethane, trifluorobromomethane and trifluoretrichloroethane. The chlorine compound was much less efficent than the compounds containing bromine.

Introduction

Extensive experiments in the U.S.A.[1] have indicated that certain fluorine substituted paraffins containing bromine or chlorine showed promise as extinguishers of fires involving inflammable liquids. The American workers, however, used n-heptane as the combustible, whereas similar experiments on other hydrocarbons in this laboratory[2] and elsewhere[3] had been made with n-hexane. A short series of experiments has been made therefore to assess the efficiency of the more promising compounds by comparing them with compounds already tested against n-hexane.

Experimental

A supply of four compounds, (Table 1), was obtained through the courtesy of Imperial Chemical Industries, Research Laboratories, Widnes, and measurements were made of the inflammability limits of n-hexane and air to which the compounds had been added.

The inflammability limits were measured by the method of H. F. Coward and G. W. Jones,[4] but the flow apparatus described previously[5] could not be used since only small quantities of the compounds were available. Accordingly a static method was used. The tube was evacuated and the vapours and air admitted, the propertions being measured by the increase in pressure. The vapours were mixed by a sliding vane in the ignition tube, the vane being operated by rotating the tube, a device similar to that used by Burgoyne and his co-workers at Imperial College of Science and Technology.

The inflammability limits of n-hexane with the compounds are given in Fig. 1. and the peak values and limiting safe mixtures in Table 1. Figures obtained in U.S.A.[6] using n-heptane are included for comparison.

TABLE I

Peak values and limiting safe mixtures of n-hexane and n-heptane with some fluorinated hydrocarbons

Compound	Density (liq)	B.Pt. °C	Limiting safe mixtures				Peak values			
			With air		With Hexane		With hexane		With heptane	
			% Vol.	% Wt	% Vol	% Wt	Hexane % Vol	Diluent % Vol	Heptane % Vol	Diluent % Vol
Tetrafluorodibromoethane CF_2Br, CF_2Br	20° 2.18	44-45	3.32	23.4	49.3	74.5	3.35	3.22	3.3	4.9
Difluorodibromomethane CF_2Br_2	20° 2.29	23.5	3.6	21.3	54.0	74.0	3.2	3.55	4.4	4.2
Trifluorobromomethane CF_3Br	21° 1.58	-59	5.1	21.7	63.1	74.5	2.9	4.9	3.0	6.1
Trifluorotrichloroethane $CF_2Cl.\ CFCl_2$	20° 1.576	47.6	15.0	53.3	78.6	88.9	4.1	14.4	4.0	9.0
Methyl Bromide CH_3Br.	0° 1.732	4.6	7.2	20.3	80.0	82.0	2.1	7.05	1.4	9.7

Discussion

When compared on a volume basis the best of these compounds was tetrafluorodibromoethane but the difference between it and difluorodibromomethane was small. The trifluorotrichloroethane was markedly less efficient than any of the three bromine compounds.

The peak values for the brominated compounds were lower, but the peak value for trifluorotrichloroethane was higher, when using n-hexane instead of n-heptane. The results agreed with those determined in the U.S.A. insofar as the brominated compounds were so much superior, but the order of superiority among them was slightly different; all, however, were superior to methyl bromide, figures for which are included for comparison in Table I.

By comparison of the weights of inhibitors required in air the trifluorobromomethane and difluorodibromomethane were better than tetrafluorodibromoethane but none was quite so effective as methyl bromide. Comparison of the proportion of the inhibitor required in the combustible (hexane), however, showed that the "fluorobromo" compounds were all very similar and better than methyl bromide. It was noteworthy that, although the proportion of trifluorotrichloroethane in the limiting safe mixtures with air was much higher than that of any of the other compounds, the differences between the hexane/inhibitor mixtures were much less.

From the results it appears that the differences between the inhibitors lie in their effects on the upper limit.

All the flames from mixtures near the lower limit were well-defined domes and were various shades of green in colour. With mixtures near the upper limits, propagation of flame was much slower and the flames varied from blue or green domes trailing long yellow tails, to small red flakes. Only the trifluorotrichloroethane gave smoky flames and deposited carbon on the tube. With the bromine compounds there was a brown, oily deposit on the tube, especially with difluorodibromomethane.

It was noticed also that with difluorodibromomethane there was a region of partial burns around the peak values where the flame travelled for short distances up the tube. With the other compounds the distinction between the inflammable and the non inflammable mixtures was defined clearly, and the mixtures either burned to the top of the tube or did not burn at all.

References

(1) Final Report on Fire Extinguishing Agents, Purdue University, July 1950.

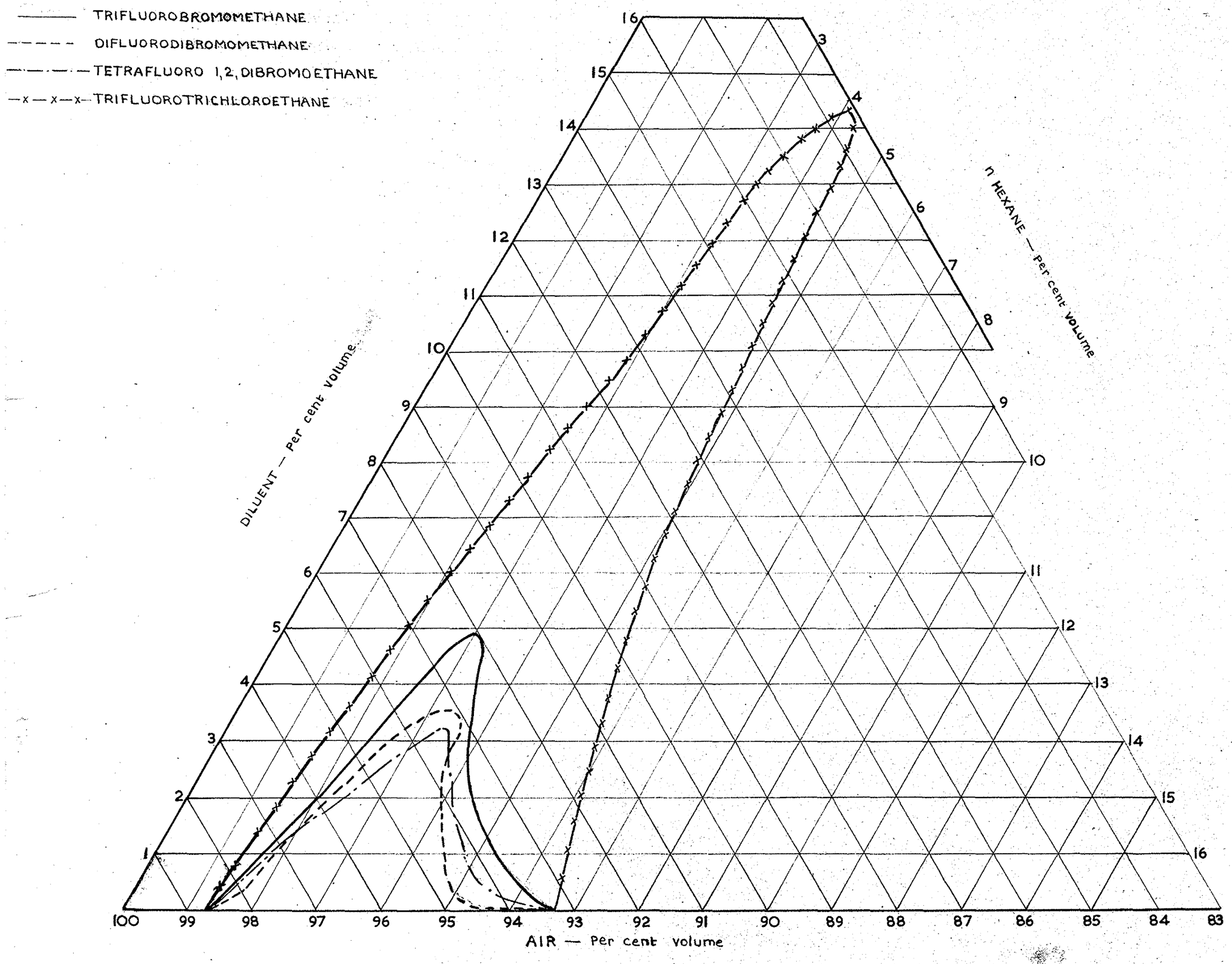
(2) E. H. Coleman Fuel (1951) 30. 114.

(3) J. H. Burgoyne and G. Williams-Leir Fuel (1948) 27. 118.

(4) H. F. Coward and G. W. Jones U.S. Bur. Min. Bull No. 279 (Revised) 1938

(5) F. C. Note No. 35. October 1950.

(6) Vapourising Fire Extinguishing Agents Interim Report 1177. Engineer Research and Development Laboratories Fort Belvoir Va. Aug. 1950.



THE EFFECTS OF FLUORO HALO CARBONS ON THE INFLAMMABILITY LIMITS OF n HEXANE AND AIR