CONFIDENTIAL

F.R. Note No. 88/1953
Research Programme
Objective C3·1

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

THE FIRE HAZARD OF ACETONE AND METHYLENE CHLORIDE

by

E. H. Coleman and P. S. Tonkin

Summary

The effect of methylene chloride on the flash point and the flammability limits of acetone in air has been determined. A mixture of ten parts by volume of methylene chloride and one part of acetone was non-flammable, according to the flash point test, but the flammable limit measurements showed that if the liquid evaporated completely a flammable mixture could be produced.

November, 1953.

File No. F.1040/19/2

Fire Research Station
Station Road,
Boreham Wood,
Herts.

THE FIRE HAZARD OF MIXTURES OF ACETONE AND METHYLENE CHLORIDE

by

E. H. Coleman and P. S. Tonkin

Introduction

Information was required about the fire hazard of a liquid mixture of ten parts by volume of methylene chloride and one part of acetone. It was proposed to produce the mixture for use as a paint stripper.

Methylene chloride is often added to paint solvents to reduce the flammability. It is however flammable in atmospheres containing more than 25 per cent of oxygen (1) and the flash point in oxygen has been quoted as 5°C (2).

Burgoyne and Richardson (3) found that liquid mixtures of 1 part of acetone with either 4 parts of carbon tetrachloride or 1/9 part of methyl bromide (proportions by volume) could not be ignited. Weinberger and Kunert (4) examined the effect of methylene chloride additions on the flash points of several combustible solvents and noted that, the flash point of the mixture was raised if the flash point of the original solvent was below 10°C and lowered if it was above that temperature. The flash point of acetone is -17·8°C (0°F) and it thus appeared that the flash point would be raised by methylene chloride additions until the extinction limit was reached.

Experimental

The flammability limits of mixtures of methylene chloride and acetone vapours were measured in the standard Coward and Jones (5) apparatus, and the proposed 10:1 mixture was also examined in the Abel flash point apparatus. The measurements were made with pure and a technical grade of acetone. The flammability limit curves have been plotted in Fig.1 and the data are given in Table 1.

Table 1

Limits of flammability, limiting safe values and peak values of acetone with methylene chloride

Data refer to concentrations of vapour

Compound				Limiting safe concentration of methylene chloride (per cent by volume)		Peak value (per cent by volume)	
	Boiling Point °C	Flammable limits in air (per cent)		With Acetone	With Air	Acetone	Methylene chloride
		lower	upper				
Acetone Pure	56.5	2.9	10.9	94.6	19.1	18.5	2.6
Acetone Technical	55.5 to 60.0	3.7	12.2	90.2	19.1	18.6	2.3
		In oxygen (1)					
Methylene chloride	40.1	15.5	66.4				

Both the lower and upper flammability limits of the technical grade were higher than the limits of pure acetone, but the ranges of flammability were similar.

Additions of methylene chloride lowered both lower and upper limits, but the upper limit was the more affected, so that the flammable range was narrowed. The difference between the peak values of methylene chloride with the two grades of acetone would have no practical significance.

The partial pressures of acetone and methylene chloride in the proposed mixture were calculated, using standard data [6] for a range of temperatures, and from them the compositions of the vapour above the liquid were calculated. Straight lines representing the composition of vapours at 10°C and 30°C have been drawn (A & B) in Fig.1 and show that at least below 30°C the vapour would be outside the flammable range. This was confirmed by no flame being observed when the mixtures were tested between - 5° and + 30°C in the Abel flash point apparatus. Although there was no ignition the pilot light of the apparatus was surrounded by a green "halo" and pungent acrid vapours could be smelt.

If the mixture evaporated completely (as could happen when spilled) it would produce a vapour containing 92 per cent methylene chloride and 8 per cent acetone. The straight line representing mixtures of this composition is shown (C) on Fig.1. It approaches very close to the flammability curve for the technical grade of acetone, and intersects the flammable range of mixtures with pure acetone Thus, with pure acetone in the mixture, a flammable atmosphere would be produced with between 80 and 82 per cent of air, which means, that if 1 pint of the mixture were spilled and completely evaporated it would make the atmosphere flammable in a compartment of 30 cu ft capacity.

Conclusions

Methylene chloride can be described as "almost flammable" in air, so that mixtures of the vapour with acetone vapour behave very similarly to mixtures of two flammable gases, and the lower flammability limit of acetone is decreased by methylene chloride additions. The same effect was noted with n. hexane [7].

The composition of the proposed mixture is so close to the flammable limits that slight variations in the quality of the acetone in the composition of the mixture would exert a great influence on the fire hazard.

The flash point experiments show that in the presence of a flame the mixture is decomposed with the production of acid vapours, which would presumably contain high proportions of hydrochloric acid from the methylene chloride.

The investigation has also shown that while a flash point determination is useful for liquids or mixtures of combustible liquids it cannot be made the sole criterion of the fire hazard of mixtures containing a non-flammable constituent.

References

1) G.W.Jones, R.E.Kennedy and F.E.Scott. Inflammability of methylene chloride - oxygen - nitrogen mixtures. Bureau of Mines Report 3727 1943.

2) K.B.Meyer and H.Baum. Lack u. Farbenzeitschrift (1943) 92.

3) J.H.Burgoyne and J.F.Richardson. Extinguishing burning liquids by the application of non-inflammable gases and liquids. Fuel. 28 (7) (1949) 150

4) Weinberger and G.Kunert. Über die Beinflussung des Flammpunktes durch Zusatz von Methylenchlorid zu brennbaren Lösungsmitteln. Fette u. Seifen 51 (1944) 192.

5) H.F.Coward and G.W.Jones. Limits of Flammability of gases or vapours. Bull 503. Bur. Mines. Washington (1952).

6) Int Crit. Tables. 3 215, 218. Nat. Res. Council. (1933) McGraw Hill Publishing Co. New York.

7) Fire Research 1951, p 11.

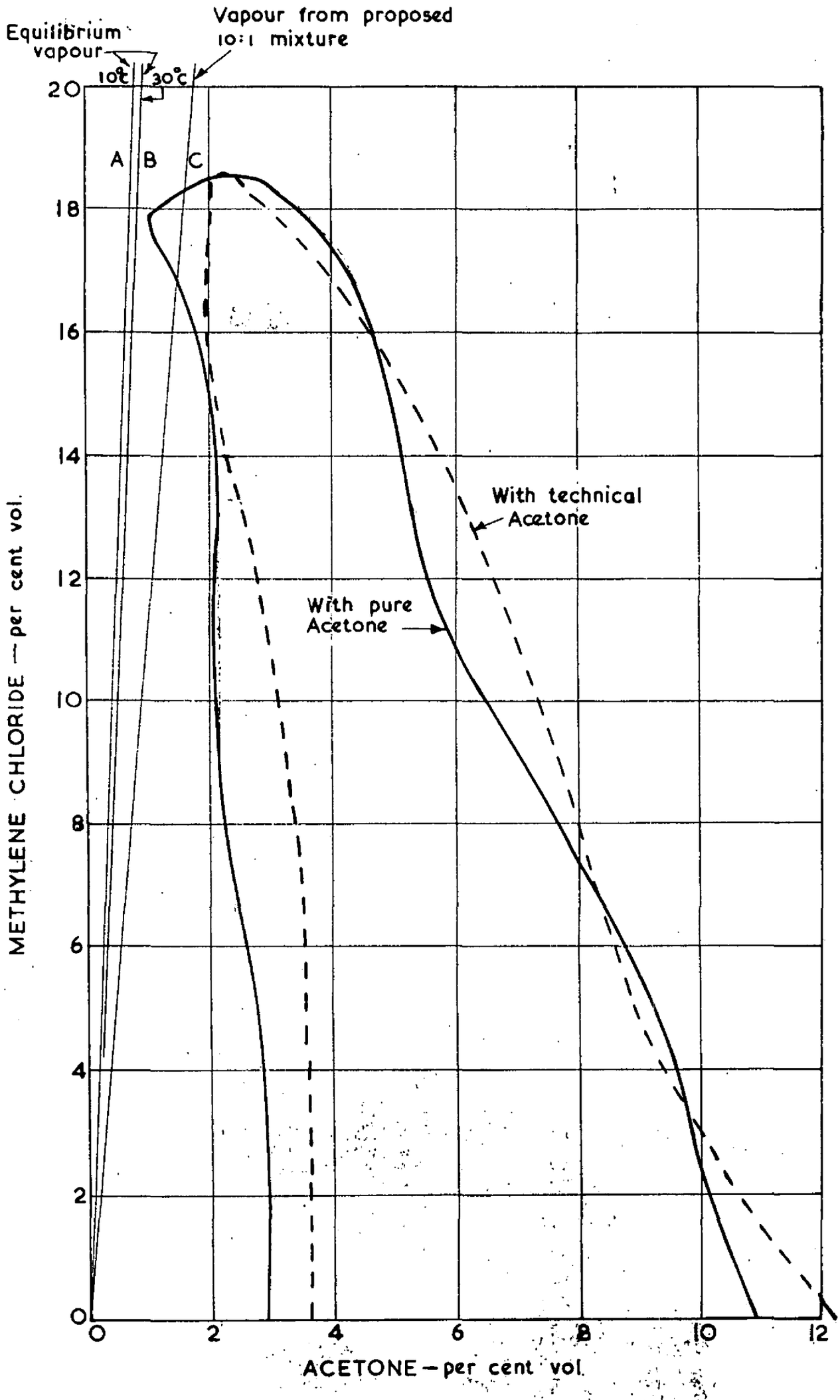

FIG.1. FLAMMABILITY LIMITS OF ACETONE AND METHYLENE CHLORIDE IN AIR

F.R. Note 87

Not Issued