

LXXI.—*The Uniform Movement of Flame in Mixtures of Acetylene and Air.*

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IN continuation of the revision of previous work on the propagation of flame that is being carried out at the Home Office Experimental Station under the direction of Dr. R. V. Wheeler, we have determined the speeds of the "uniform movement" in mixtures of acetylene and air.

It may be recalled that the "uniform movement" occurs when an inflammable mixture of gases is ignited at the open end of a horizontal tube closed at the other end, and is usually regarded as the normal speed of propagation of flame from layer to layer of the mixture by conduction of heat (Mallard and Le Chatelier, *Ann. des Mines*, 1883, [viii], 4, 374).

Previous determinations of the speed of the uniform movement in mixtures of acetylene and air have been made by Le Chatelier (*Compt. rend.*, 1895, 121, 1144), who used a glass tube 4 cm. in diameter. The speeds recorded were:

Acetylene in mixture. Per cent.	Speed of uniform movement. Cm. per second.
2.9	10
8.0	500
9.0 and 10.0	600
22.0	40
64.0	5

In a later publication, namely, "Le Carbone" (Paris, 1908), Le Chatelier gives intermediate values:

Acetylene in mixture. Per cent.	Speed of uniform movement. Cm. per second.
5.0	200
7.0	400
15.0	300
40.0	22
60.0	7

but it is not clear whether these are actual determinations or numbers interpolated on a curve constructed from the six results recorded in the *Comptes rendus*.

Le Chatelier thus describes the curve he obtained (*loc. cit.*, p. 280):

“La courbe . . . présente une forme toute spéciale; elle se compose de trois droites: une droite montante et une descendante se coupant pour la vitesse maxima vers 10 p. 100 d'acétylène, puis ensuite une droite très peu inclinée coupant la seconde à la teneur de 20 p. 100 et se prolongeant jusqu'à la limite d'inflammabilité supérieure. Ce troisième segment de la courbe correspond à la combustion avec flamme fuligineuse et dépôt de charbon. Audessous de 20 p. 100 il ne se forme par la combustion que des produits gazeux, acide carbonique, oxyde de carbone et hydrogène.”

Our own experiments were made in a glass tube 12 mm. in diameter, and are not therefore directly comparable with Le Chatelier's so far as the absolute measurements of speeds are concerned. It is permissible, however, to compare the shapes and characters of the two curves. We can confirm the statement that mixtures containing more than about 20 per cent. of acetylene deposit soot owing to decomposition of excess of acetylene, and that the speed of propagation of flame in such mixtures is slow; but we cannot agree that the curve can be represented by straight lines. As with mixtures of other inflammable gases and air, there is a gradual flattening of the curve towards the limits, and the maximum speed is obtained over a range of mixtures containing between 8 and 10 per cent. of acetylene, so that the crest of the curve also is flattened.

Our results are shown graphically in the diagram. The speed of the flame in mixtures containing more than 20 per cent. of acetylene decreases gradually as the percentage of acetylene is increased. The mixture of acetylene and air for complete combustion contains 7.75 per cent. of acetylene; the fact that the fastest speed of flame is found in mixtures containing rather more than this can be explained on the assumption that the thermal conductivity of acetylene is higher than that of air (compare Haward and Otagawa, T., 1916, 109, 83).

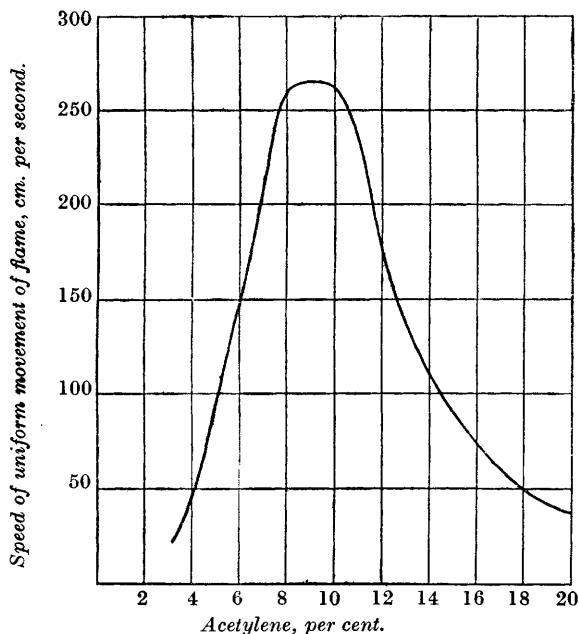
EXPERIMENTAL.

The method of experiment and the electrical means of measuring the speeds of the flames were the same as employed by Wheeler (T., 1914, 105, 2606).

The acetylene was obtained compressed in cylinders, without acetone as solvent, and was of a high degree of purity (98 to 99

per cent. C_2H_2). The mixtures were made over brine in metal gas-holders of 70 litres capacity, and were analysed before use; the explosion tube was filled with the required mixture by displacement of air, six times the volume of the tube being used. The initial temperature of the mixtures was that of the room (15° to 20°), and they were saturated with water-vapour at that temperature.

Ignition was by means of a lighted taper, which was drawn rapidly past the open end of the tube. The speeds were measured



between two points 40 cm. apart, the first point being 10 cm. from the open end of the tube.

In addition to the experiments recorded in the diagram, for which a tube 12 mm. in internal diameter was used, the speeds in tubes of 9 mm. and 25 mm. diameter were also determined. The speeds in the 9 mm. tube were rather slower than those obtained in the 12 mm. tube, but the shape of the curve was the same. With the larger tube, 25 mm., the duration of the uniform movement was too short to admit of accurate measurement by the means employed.

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