LETTERS TO THE EDITORS

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Stabilization of Water Mists

THE stability of a water mist formed in an atmosphere that is not fully saturated is severely affected by droplet evaporation. Thus a water-drop 10μ in radius suspended in air at 20° C. and 80 per cent relative humidity can be shown to have a life of only 2·4 sec. Richardson[1] describes experiments in which no water-drop of radius less than 200μ, dropped from the top of a 40-m. tower, reached the bottom.

The possibility of reducing the coefficient of evaporation of a plane water surface from 4×10^{-2} to 6×10^{-6} by coating it with a monomolecular layer of a long-chain fatty acid has been demonstrated[2], and reductions in the rate of evaporation of the order of 50 per cent have been obtained by means of monolayers of cetyl-stearyl alcohol[3]. Bradley[4] pointed out that, with droplets of Stokesian or smaller size, a corresponding reduction in the evaporation coefficient could be expected to result in a very much greater reduction of the rate of evaporation than with a plane surface. This was shown to follow from a simplified form of Fuchs's[5] equation of droplet evaporation:

$$\frac{dm}{dt} = \frac{-4\pi a w c_0}{1 + (D/a\nu\alpha)}$$

in which dm/dt is the rate of evaporation of the droplet, a its radius, w the mass of a vapour molecule, α the evaporation coefficient, c_0 the saturation concentration of vapour in air, D its diffusion coefficient, and $\nu = \sqrt{(kT/2\pi w)}$, where T is the absolute temperature.

The present communication describes an attempt at producing a water mist each drop of which is coated with a monolayer. This was done by dispersing in the water a mixture of almost equal parts of cetyl and stearyl alcohol in a concentration of 0·2 per cent by weight, using as a dispersing agent 0·1–0·2 per cent of a compound of "fully hardened sperm alcohol and 15 molecules (average) of ethylene oxide". The dispersion is stable and can be atomized. At the low mean droplet radii of the aerosol so generated (mean surface radius 7·5μ) this overall concentration proved sufficient to coat the droplets. This is because the rate of diffusion of water into the air at the droplet surface is about 10^4 times that of the dispersed alcohol into the droplet interior; once evaporation starts, monolayers of high surface pressure may be expected to form on the surfaces.

To test the efficacy of the monolayers the dispersion was atomized by means of a compressed-air nozzle and introduced into the top of a vertical tube, 1 ft. in diameter and 15 ft. high, the aerosol being sampled during its descent at various levels inside the tube. The vertical tube was kept at a temperature of 28·3° C. and the humidity varied over a wide range. Counts made of the various samples gave droplet size distributions which enabled the rate of evaporation to be calculated as a function of relative humidity. The experiments were repeated with water alone. Fig. 1 shows the variation with relative humidity of the initial radius of droplets, both water and dispersion, that just fall through 12 ft. in these conditions before completely evaporating.

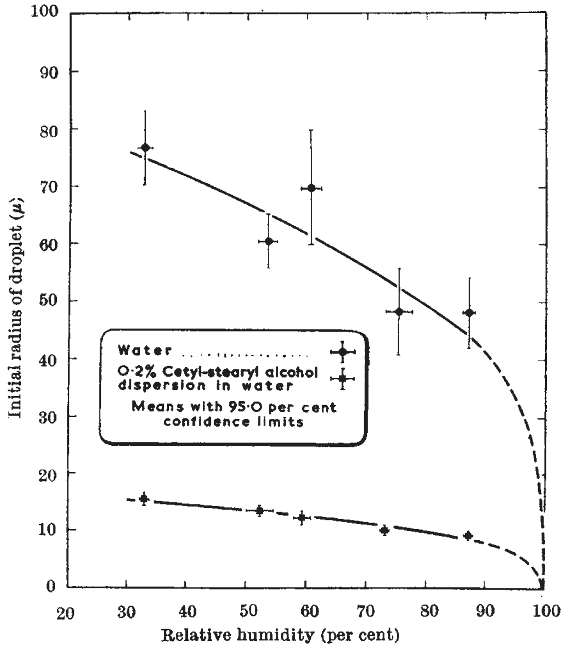

Fig. 1. Effect of humidity on the initial radius of a droplet that falls 357 cm. before completely evaporating. (Crown copyright, S.M.R.E.)

Measurement of the evaporation coefficient of the dispersion gave a minimum value of $1 \cdot 5 \times 10^{-5}$ at high concentrations. Substituting this value in Fuchs's equation, it was found that the latter predicted the rate of evaporation of the dispersion droplets and its variation with relative humidity, within the size-range used, with some accuracy. The equation could thus be used to calculate the total life of the droplets shown in Table 1.

Table 1. LIFE OF DROPLET AT 20° C. AND 80 PER CENT RELATIVE HUMIDITY

Radius of droplet (microns)	Water (sec.)	Dispersion (sec.)
5	0·64	656
10	2·35	1,314

A considerable increase in the life of a droplet and, hence, stability of mist is thus obtained. In more recent experiments it was found that concentrations of 0·1 per cent of alcohols and of dispersing agent gave results that did not differ significantly from those with 0·2 per cent of these agents.

A more detailed paper is to be published in due course. We wish to thank Dr. T. G. Jones, Research Department, Unilever, Ltd., for suggesting and preparing the dispersing agent and the Ministry of Power for permission to publish this communication.

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