Equations (9–12) are four first-order differential equations but highly nonlinear ones. These equations together with appropriate boundary conditions constitute the complete formulation of the problem. The obvious boundary conditions are the regularity conditions for w_u and w_b at $r = 0$ and that the total amount of fluid is prescribed. One is free also to position the origin of the vertical axis anywhere one wishes. This means that the elevation of a certain point in the film may be taken to be zero. The boundary condition at the support of the film is more involved because it depends very much upon the nature of the support, such as the detailed geometry and the material of the support.

From the basic Eqs. (9–12), various approximate formulations may be derived, and interesting results have been found in some cases. However, the limitation of space of this brief note does not permit their inclusion.

Finally, a further remark will be made on Eqs. (1) and (2). As stated before, in the case of small deflections Eq. (1) may be ignored, and Eq. (2) becomes the well-known Poisson equation. However, there is no information available about the thickness of the film, which is certainly variable in the general case, particularly near the support. In this sense, the formulation resulting in a single Poisson equation is incomplete even for soap films with small deflections.

Effects of Water on Hydrogen Flames

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In his note,[1] Kuehl shows that the increase in burning velocity in H_2-O_2 flames is proportional to the concentration of added water vapor. He further suggests that, since the amount of radiant energy absorbed by the unburned gases (by water) is approximately proportional to the concentration of water, the increase in burning velocity is a direct function of the amount of radiant energy transfer. Although these suggestions are *not* to be disregarded and can help explain some of the anomalous character of H_2-O_2-H_2O flames, the writer would like to bring to the readers' attention other (chemical kinetic) aspects that have been observed in the H_2-O_2-H_2O system and that help to explain Kuehl's anomalous burning velocity data.

In accord with Kuehl's results,[1] David and Mann[2] also have observed that moist H_2-O_2 flame temperatures were 40° to 50°C higher than those of dry mixtures. They suggested that, inasmuch as dry mixtures should, by calculation, have flame temperatures about 15°C higher than moist mixtures, the water vapor probably aids in radical recombination reactions. In studies on chemical inhibition reactions in flame systems, it has been demonstrated further that the addition of water vapor *accelerates* the combination of H_2-O_2 mixtures.[3, 4] These results have been corroborated further by Chirkov,[5] using water to increase the rate of oxidation of ethane, and by Voevodskii,[6] in explaining the S-shaped, water-accelerated, rate curves in the oxidation of hydrogen. The results of these slow reaction studies suggest that the accelerating influence of water vapor is due to an increase in OH radical concentration by such steps as

$$H_2O + HO_2 = OH + H_2O_2$$

or

$$H_2O + H + O_2 = OH + H_2O_2$$

Transposing these kinetic results to flame conditions, it then follows that the increased burning velocity of H_2-O_2-H_2O systems, as compared with dry systems, is due in large part to the increase in reaction rate. However, whether one applies Semenov[7] or Tanford-Pease[8] equations of the burning velocity, one might expect an increase in burning velocity related to the square root of the reaction rate. In either instance, the anomalously high flame temperature would still have to be taken into account. So, as pointed out in Kuehl's note,[1] a completely satisfactory explanation of the effect of water vapor on the H_2-O_2 system (or on any hydrocarbon-O_2 system, for that matter) still is lacking.

Received January 14, 1963.

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