tegration of the solid curve drawn through these points can be made to estimate the actual contact time of the surface elements of the film. At *Re* 647 the additional contact time is equivalent to the time in which the film surface could travel an additional distance of 6 δ at the steady state velocity u_s. As is mentioned below, however, the authors have shown that the effect on gas absorption is even less than would be estimated on the basis of the additional contact time alone.

The flow situation treated by the authors is shown schematically in Figure 3. They assumed that since the liquid within the slot has no vertical component of velocity, the only force producing acceleration of the film down the wetted wall would be the force of gravity. This assumption is not even approximately correct; the assumption of zero velocity across the *A-C* plane would require an infinite film thickness at that point. Indeed a consideration of the forces acting within the film shows that the film thickness at *A-C* will generally be equal to or less than the slot spacing as long as δ' is greater than the steady state film thickness.

Equation (1) is valid for this flow situation if the appropriate coordinate system is used. However because of the curvature of the liquid surface the pressure of the liquid in the region *A-B-C* is still above atmospheric, and the pressure term in the equation cannot be neglected. Furthermore as in the case above the liquid layer on the surface is accelerated by the faster-flowing liquid within the film as soon as it emerges from the slot. Thus the surface of the film is caused to accelerate not only by the action of gravity but also by the effect of surface tension and by momentum transfer within the film.

A numerical example will serve to illustrate the order of magnitude of some of the quantities involved. The authors' calculations were based on a column of the type used by Vivian and Peaceman (3) in which a typical slot width was 1.3 mm. (Vivian and Peaceman actually used slots which sloped either up or down at about a 45-deg. angle, but this does not affect the basic argument presented here.) Consider a liquid flow rate of 25 cc./cm.-sec. of a fluid having a kinematic viscosity of 0.01 sq. cm./sec. and a surface tension of 75 dynes/cm. This corresponds to a Reynolds number of 1,000 on the column and would produce a film thickness of about 0.42 mm. and an average velocity of about 60 cm./sec. for the film at steady state. The pressure due to surface tension in a cylinder of fluid is equal to the surface tension divided by the radius of curvature. This pressure exerted over the area of the slot provides the force necessary to change the momentum of the stream from the horizontal to the vertical direction. The change in horizontal momentum in going from *A-B* to *A-C* is approximately $1.2\rho\, u^2_{av}$, that is 480 dynes/sq. cm. for this example. If the radius of curvature of the film were just equal to the slot width, the pressure in the region *A-B-C* would be about 580 dynes/sq. cm. above atmospheric. Since this pressure is more than enough to produce a vertical momentum at *A-C* equal to the horizontal momentum at *A-B*, it follows that the radius of curvature of the film will actually be somewhat greater than δ' and the film thickness at *A-C* will be somewhat less. (Since the film below *A-C* can only be getting thinner, the center of the radius of curvature must lie in the plane *A-C* or above it.)

The authors derived equations showing how the acceleration of the film at the inlet end of a wetted-wall column results in a lowered rate of absorption. Their equations consider not only the greater residence time of the surface of the film in this region but also the effect of the stretching of the film as it accelerates. That these two effects tend to be mutually compensating is apparent from the results obtained by the authors for a 4-cm. column at *Re* 1,000. They calculate a rate of absorption of about 84% of the rate which would obtain with instantaneous acceleration of the film. They calculate that the film will be accelerating over the entire length of the column, and the calculated contact time of an element of film surface is about twice what it would be with rapid acceleration. Based on contact time alone the calculated rate would have been only about 70% of the rate with rapid acceleration.

On the basis of the model study and the semiquantitative discussion presented above it appears that the authors' estimate of the distance over which the acceleration of the film takes place is five to ten times too great. It would thus seem likely that the effect of the acceleration would be noticeable only on columns shorter than 1 cm. This conclusion is in agreement with the work of Vivian and Peaceman (3), who found no effect of slot width or slot orientation in a column 4.2 cm. long. Of more importance under most circumstances in this range of column heights is the outlet end effect mentioned in reference *1*. This effect is the formation of a stagnant layer on the lower part of the falling film, which acts as an effective barrier to gas absorption.

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NOTATION

- g = acceleration due to gravity, cm./sec.^{2}
- P = pressure, dynes/sq. cm.
- u = velocity in x direction, cm./sec.
- u_s = velocity of surface in x direction, cm./sec.
- v = velocity in y direction, cm./sec.
- x = distance in direction of flow, cm.
- y = distance normal to direction of flow, cm.

Greek Letters

- Γ_v = volumetric flow rate, cc./cm.-sec.
- δ = film, thickness, cm.
- δ' = slot width, cm.
- θ = time, sec.
- ν = kinematic viscosity, sq. cm./sec.
- ρ = fluid density, gm./cc.
- τ = shear, dynes/sq. cm.
- ϕ = angle of inclination of flow channel to horizontal

LITERATURE CITED

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2. Scriven, L. E., and R. L. Pigford, *A.I.Ch.E. Journal*, **4**, 382 (1958).
3. Vivian, J. E., and D. W. Peaceman, *ibid.*, **2**, 437 (1956).

Dear Editor:

It has come to my attention that Dr. Joseph Joffe has published a figure relating minimum compressibility factor to reduced temperature.

Our note on page 171 of the March, 1960, issue of the *A.I.Ch.E. Journal*, in which we utilized the relationships of minimum compressibility factor to reduced temperature and pressure, should have given credit to Dr. Joffe for his earlier work with this relationship: Joffe, Joseph, *Chem. Eng. Progr.*, **45**, 160 (1949).

Very truly yours,

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H. C. Weber
Purdue University
Lafayette, Indiana