Comment on "On Porous-Wall Couette Flow under Slip Flow Conditions"

DONALD M. DIX*
Aerospace Corporation, El Segundo, Calif.

In a recent note, Inman[1] presents a solution for the laminar, incompressible, Couette flow problem with fluid injection, incorporating slip flow boundary conditions. In the interest of avoiding confusion, it is pointed out that the boundary condition at the upper (moving) plate is incorrect; in the notation of the reference, this boundary condition should be

$$u(y = L) = U - \xi_u(du/dy)_{y=L}$$

since the plate is on the positive y side of the fluid.

The solution of the problem then becomes

$$\frac{u}{U} = \frac{e^{R_e\eta} + R_e(\xi_u/L) - 1}{e^{R_e} - 1 + R_e(\xi_u/L)(e^{R_e} + 1)}$$

$$\frac{u_{s,0}}{U} = \frac{R_e(\xi_u/L)}{e^{R_e} - 1 + R_e(\xi_u/L)(e^{R_e} + 1)}$$

$$\frac{u_{s,L}}{U} = \frac{R_e(\xi_u/L)e^{R_e}}{e^{R_e} - 1 + R_e(\xi_u/L)(e^{R_e} + 1)}$$

Thus, as one intuitively would expect, the solutions exhibit no surprising singularities as $R_e(\xi_u/L) \rightarrow 1$.

Received by IAS November 30, 1962.
* Member of Technical Staff.
[1] Inman, R. M., "On porous-wall Couette flow under slip flow conditions," J. Aerospace Sci. 29, 1123 (1962).

Author's Reply to Comment by Donald M. Dix

ROBERT M. INMAN*
Garrett Corporation, Los Angeles, Calif.

In the foregoing note, Dix correctly points out the correct boundary conditions at the moving wall and gives the solution of the problem. Consequently, the author's assertion that velocities become indefinitely large as $R_e(\xi_u/L) \rightarrow 1$ is incorrect.

The correct solution also was kindly pointed out to the author earlier by S. H. Maslen of the Martin Marietta Company, and an errata was being prepared when the forementioned note came to the author's attention. Correct velocity profiles are shown in Fig. 1.

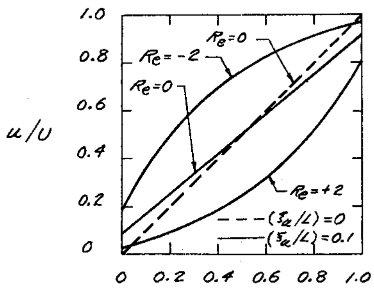

Fig. 1 Velocity distribution for porous-wall Couette flow in the slip flow regime

Received January 11, 1963.
* Formerly with Avco Research and Development Division, Wilmington, Mass.

Comments on the Validity of Ballistic Pendulum Measurements with Pulsed Plasma Accelerators

D. L. CLINGMAN* AND T. L. ROSEBROCK†
General Motors Corporation, Indianapolis, Ind.

A RECENT technical note[1] by Gooding et al. voiced dissatisfaction with the validity of momentum measurements obtained with ballistic pendulums constructed from several different materials. In the cited experiment, both electrically conducting and nonconducting materials were employed.

No points of contention with the reported data of the authors were found. However, it is felt that their general condemnation of the ballistic pendulum as a useful tool with pulsed plasma accelerators was somewhat arbitrary.

The Gooding experiment admittedly[2] was performed in "very rough and preliminary fashion" with no regard for the pendulum configuration. The results so obtained, as well as those of other investigators[3] who have used single-plane pendulum bobs, or variations thereof, are not at all surprising. In fact, it was the early recognition of the deficiencies of the conventional pendulum when applied to pulsed plasma acceleration which led to the unique approach to the problem described herein.

At Allison a ballistic pendulum has been developed, shown in Fig. 1, in which the entire discharge system of a rail-type plasma accelerator, including the electrodes, is surrounded completely by the pendulum bob. With this arrangement, any momentum components due to surface sputtering of the pendulum are cancelled through multiple collisions with the walls, with the possible exception of a negligible error introduced by impingement of sputtered mass onto the electrodes. The error necessarily would be somewhat larger in the case of the coaxial plasma gun due to the considerably larger capture area of the electrodes as contrasted with the small electrodes of the rail accelerator.

The deflection of the containing pendulum is determined by a technique that also is unique with Allison. An opaque shutter attached to the pendulum bob passes between a calibrated light source and a photocell. The amount of light reaching the photocell is inversely proportional to the pendulum deflection, and the cell output is recorded on a conventional data recorder. The actual pendulum deflection then is determined easily through reference to a calibration curve. More complete details of pendulum construction and data interpretation are given elsewhere.[4]

Several of the Gooding experiments have been reproduced, using identical materials in constructing the pendulums, but using the discharge-encompassing (closed) pendulum configuration. A basis for evaluating the results obtained with this configuration is provided by data obtained with the retrograde end of the cylindrical pendulum removed. The latter configuration provides an approximation to the conditions under which the Gooding data were obtained, although somewhat more capture and containment still should be experienced than with the simple single-face pendulum bob. The experiments were performed with a parallel rail accelerator coupled to a 6.4-μf capacitor, with the working media derived from electrically exploded 1-mil-diam silver wires.

No attempt was made to reproduce the data obtained with mica pendulums because of the wide variety of types of mica

Received December 26, 1962.
* Senior Research Engineer, Plasma Physics, Research Activity, Allison Division. Member AIAA.
† Assistant Chief of Plasma Physics, Research Activity, Allison Division. Member AIAA.