Indeed, it seems possible to conclude that, for the separator with the outer inlet wall tangent to a circular chamber, the interaction of the vortex with the straight incoming flow will cause a contraction and hence an increase in velocity. This contraction was demonstrated by plotting the streamlines of a potential-flow two-dimensional inlet with the aid of an electrical analog field plotter. For the one case considered, the average angular momentum of the vortex was 1.6 times the average angular momentum of the parallel flow. It has been reported[4] that the angular momentum in the vortex, under some circumstances, may be 1.4 times the average inlet angular momentum. This may explain partially why some experimental values of head loss were found greater than the theoretical value.

In this paper, the general plan of the exit separation was taken to be the same as for the flow without swirl, and the free streamline was adjusted to account for the swirl. It seems that a better approximation under some conditions might be obtained by assuming that the flow also separates down the center so that the outflow is a hollow cylinder. Indeed this center separation would be quite obvious if the fluid were liquid discharging into air In fact, the separation would penetrate to the bottom of the chamber. If the fluid were air discharging into air, the center separation would be the center core which rotates with constant angular velocity because of friction. The center separation also eliminates the unrealistic singularity in v and p at zero radius.

Authors' Closure

The authors wish to thank Professor Landis and Mr. Smith for their discussion of the paper.

Professor Landis has shown that the entire problem of real fluid flow in a vortex chamber is extremely complicated. Evaluation of separate portions of the problem may be the most fruitful.

Mr. Smith has a very valid point regarding the increase of angular momentum possible in the asymmetric flow entering the cyclone. The other effect of flow separation in the center of the vortex actually appears as an inflow of gas at the center with a large axial outflow near the exhaust pipe walls. The latter phenomenon is especially noticeable as the diameter of the exhaust pipe is increased, and would also lead to an increased head loss. In Fig. 4 of the paper the head loss does increase over the theoretical as the exhaust-pipe diameter increases.

[4] "Study on the Cyclones," by Iinoya, Memoirs of the Faculty of Engineering, Nagoya University, vol. 5, 1953, p. 153.

Corrections for the Oscillating-Disk Viscometer[1]

F. G. Keyes.[2] The desire to measure the viscosity of fluids has led to the employment of essentially two principal devices based on the measurement of the volume flow in a known interval of time under a measured constant pressure difference through a tube held at constant temperature, and the damping at constant temperature and pressure of a suspended oscillation geometric form in the fluid relative to the oscillatory properties of the identical system in a vacuum. The necessary observations can be carried out with greatest ease of control and compactness of equipment in the case of the oscillating-disk viscometer. However, the development of the relevant theory required to deduce the viscosity exactly for the latter type of viscometer, as the authors indicate in the present and earlier publications, has a long and somewhat painful history. The authors show in detail in the present paper how the theory may be advanced to yield accurate viscosity values to better than 1 part in 500.

The growth of the theory of the effects in evidence when fluids are in motion, or bodies are moving at velocity in fluids, has emphasized the practical importance of accurate values for the viscosity of fluids. The viscosity is a function of both pressure and temperature, and the oscillating-disk viscometer is markedly convenient for investigating the pressure effect.

It is a fortunate circumstance that the authors combine the competence and insight required for the advance of the theory with skill in the arts of experimentation. Their work goes far to raise the oscillating-disk viscometer to the class of instruments providing absolute values. There remains at this time, however, the task of verifying by independent means the pressure dependence of the viscosity of nitrogen which, for calibration, depends solely on the excellently consistent results of Michels and Gibson reported 25 years ago.

Authors' Closure

We owe thanks to Professor F. G. Keyes for his amplifying remarks on the substance of the paper. Although it is true that it is necessary to verify by independent means the pressure effect on the viscosity of nitrogen, it should be realized that the close agreement obtained for several gases provides such an indirect proof. It is possible to take the view that the instrument had been calibrated by another gas, in which case the pressure effect on the viscosity of nitrogen would have been derived from it.

[1] By J. Kestin and H. E. Wang, published in the June, 1957, issue of the Journal of Applied Mechanics, Trans. ASME, vol. 79, pp. 197–206.

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Effect of Stress on Creep at High Temperatures[1]

C. D. Starr.[2] The authors are to be congratulated for continuing this fundamental research program to elucidate the basic mechanism for creep. The previous papers by the authors on the relation between temperature and time have demonstrated the applicability of their functional relationship to calculate and correlate the creep strain for the same applied stress.

The effect of stress on the creep behavior is more difficult to evaluate. For example, the structure parameter S' in Equation [5] must continually change in order to yield the shape of the creep curve obtained experimentally. Thus, in order to study the effect of stress on the creep rate, the authors point out that the comparison must be made under conditions where the structure is identical. Accordingly, their correlation in Figs. 2 and 3 was made by evaluating the initial creep-rate data shown in Figs. 1 and 10. Under these conditions identical structures are evaluated; namely, the structure of the annealed alloy. Presumably, under other conditions, different structures would be obtained and simple correlations of the σ^n type would be invalid.

The writer would like to point out, however, that the data in Fig. 1 correlate equally well when the strain-time data for the linear portion (major portion) of the curves are used. In fact, as close as he can ascertain, the same exponent n that the authors evaluated from the initial creep rate is obtained. Since some

[1] By H. Laks, C. D. Wiseman, O. D. Sherby, and J. E. Dorn, published in the June, 1957, issue of the Journal of Applied Mechanics, Trans. ASME, vol. 79, pp. 207–213.

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