Analysis and Test of the Screw Seal in Laminar and Turbulent Operations

R. A. BURTON

This paper will stand for a long time as a major reference on screw-thread seal behavior. It represents a convincing synthesis of analysis and experiment and is broad in scope. My only comments, other than endorsement, are concerned with the basic approach to theoretical treatment of the turbulent film case. The mixing length equations, as integrated, cannot provide more than an estimate on the film's flow-resistance relationships. It is not an accurate analytical approach, unless the presence of a laminar sublayer, not following this equation, is accounted for independently. I say this principally because of the general use of this approach, without stated reservations or conditions.

As the authors have used the mixing length approach, they have avoided these questions by leaving two empirical constants to be evaluated in their final result. In this sense, they have used the mixing length approach to provide the general form of their equations and have then drawn upon measurement to provide the numerical magnitudes. As used, the method is appropriate and proper. I call attention to this, so that future discussions of incorrect application of the mixing length approach elsewhere will not obscure the essential validity of its use here.

The discussion to the paper by J. M. McGrew and J. D. McHugh, published in the March issue of the Journal of Basic Engineering, Trans. ASME, Series D, vol. 87, 1965, p. 153, was received at ASME Headquarters after the paper was published.

Southwest Research Institute, San Antonio, Texas, Menl. ASME.
either upward or downward, depending in a complicated way on
that the displacement in an internal hydraulic jump may be
a finite wave and the direction of the "body force" or equivalent
principle exists relating the direction of the initial displacement in
"elastic" effect in the system. It is well known, for instance,
evidently has no simple answer, and certainly no simple general
tative" or not in different physical examples. This question
the factors determining whether the first undulations are "posi-
at most, onty two or three undulations may be distinguishable.
vortex breakdown breaks up very quickly in practice so that,
wavelengths whereas the wavy structure predicted behind a
trains often can be observed experimentally over many
velop the theory in this other context, since the respective wave-
theory can also account for undular hydraulic jumps or bores oc-
curring as "internal waves" in fluids whose density varies with
the form of the density distribution and conditions at the upper
boundary of the fluid.
I agree that Gartshore's work [10] merits careful attention and that extensions of it would be worthwhile. In my opinion, however, the method of approach adopted by him is essentially circumscribed in its capacity to explain the facts of vortex breakdown, being limited to a description of viscous effects in a vortex core subject to assumed external conditions. In other words, Gartshore's theory may well serve to elucidate some details of the flow immediately preceding breakdown but, by its nature, it cannot afford the overall interpretation that is the aim of the present theory. Thus I believe one would be misguided to regard his theory as a rival to the present one; rather it is a complementory approach, seeking to account for an "inner" detail of certain prescribed flows and so contrasting with the present more general method of explanation. The position can best be defined, I believe, by analogy with the familiar position regarding hydraulic jumps in two-dimensional flows along uniform open channels or normal shock waves in compressible flows along uniform ducts. The basic theory of the flow "discontinuity" has a well-recognized standing in these two cases; but there remains the problem of the gradual changes produced by the action of viscosity on the approaching flow, which finally produce a local condition admitting the sudden change in flow structure described by the "shock" theory. Treatment of the latter class of problem—for instance, concerning the retarding effect of turbulent friction on super-
critical open-channel flows—are of course very useful; but they obviously cannot suffice to explain the complete events observed in practice, and one must always revert to the basic "shock" theory in order to formulate a complete interpretation, in particular accounting for the dependence of the shock on conditions downstream.
In short, the present explanation for vortex breakdown has much the same analytical standing and generality of application as the familiar basic theories of hydraulic jumps and shock waves, which also circumvent explicit analysis of viscous effects. Nevertheless, the observed phenomenon always depends on viscosity to some extent; and so to understand it fully, supplementary theories are needed, such as Gartshore's, which account for the effects of viscosity on the details of particular vortex flows.