DISCUSSION

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The authors are to be congratulated for a very informative paper in a still rather nebulous field. This discusser was particularly interested in the presentation of cavitation as a subject which can be studied statistically. In looking at the free jet data, another approach would be to employ an Arrhenius-type, rate-theory treatment. One might then say that

\[
\text{Rate of bubble inception} = Ae^{-\Delta G/kT}
\]

(1)

where \( A \) is a frequency factor and \( e^{-\Delta G/kT} \) is a measure of the probability of a favorable collision. The term \( A \) may be essentially constant over the range of data considered. \( \Delta G \) represents the activation energy expressed in this paper and by Frenkel as

\[
\Delta G = \frac{10\pi \sigma^2}{3(D_L^2 - D_{sm})^4}
\]

(2)

Also, conventionally, \( k \) is the Boltzmann constant and \( T \) the absolute temperature. For a test of the applicability of (1) one may write

\[
\ln \text{const} - \ln \text{time} = \ln A - \Delta G/kT
\]

and, with the previous assumption of \( A \) constant, a plot of \( \ln \) versus \( 1/T \) should yield a straight line with \( \Delta G/kT \) as the slope. This plot is shown in Fig. 12. Calculation of \( \Delta G \) from the slope of the line gives

\[
\Delta G = 8.3 \times 10^{-20} \text{lb} - \text{in}.
\]

Calculation of \( \Delta G \) from (2) for the lowest temperature (267 deg F) point gives

\[
\Delta G = 6.1 \times 10^{-14} \text{lb} - \text{in}.
\]

The relationship between these figures seems reasonable as in the experimental situation other factors such as foreign bodies, ions, and dissolved gases may be present to reduce the experimental activation energy below that proposed by this paper and by Frenkel. This simply suggests a slightly different approach may be used in examining cavitation statistically, this is, the application of very simple rate theory. It would appear that further work along the lines presented in this paper would be promising in improving the predictability and understanding of this very difficult phenomenon.

Authors' Closure

We are grateful to Mr. Smith for suggesting an alternative representation of our exploding-jet data. We shall present some arguments against this representation, not because we are sure that it is incorrect, but rather to explore further what we find to be a very interesting idea.

Nesis and Frenkel have used the Arrhenius form of relationship in their discussion of the stability of liquids with respect to homogeneous nucleation. In this instance it arises in a formal way out of the Boltzmann distribution for a gas-liquid-vapor system. Unfortunately our data represent an instance of inhomogeneous nucleation and the validity of the Arrhenius relationship is not obvious.

Furthermore, the fact that both we and Mr. Smith represent the modal points with straight lines, implies that our correlation variable, \( \ln(\Delta p)^{1/2} \), should also be proportional to \( 1/T \). We have plotted \( \ln(\Delta p)^{1/2} \) against \( 1/T \) and found that it is not in general proportional to \( 1/T \). It is approximately proportional (by coincidence) in the range of our data, however. In other words, if we had data over a larger range, either his relationship, or ours, or both, would have to fail.

Since our correlation has accounted: the contribution of jet area; the temperature dependence of \( \Delta G \); and some details of inhomogeneous nucleation and early growth, we are inclined to feel that it should have the greater predictive value. Indeed, had Mr. Smith included the fact that \( \Delta G \sim \Delta p^{1/2} \), the exponential relationship would not have represented our data as well as it did.

We must nevertheless point out (in deference to the Arrhenius form) one feature of equation (5)—the expression for \( \Delta G \) for inhomogeneous nucleation. A plot of this equation (see reference [9]) shows that Mr. Smith’s 10-fold disagreement in the absolute value of \( \Delta G \) might well be attributed to inhomogeneities, as he suggests.