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LETTER TO THE EDITORS

COMMENTS ON 'THE EFFECT OF SUBCHANNEL SHAPE ON HEAT TRANSFER IN ROD BUNDLES WITH AXIAL FLOW'

NOMENCLATURE

p	rod pitch
d	rod diameter
Stg	gap Stanton number, as defined by Seale [1]
de	subchannel equivalent diameter
b	minimum clearance between adjacent rods
Re	subchannel Reynolds number

THE PAPER by Seale [1] provides a useful addition to the knowledge of inter-subchannel heat exchange in rod bundles such as those used in nuclear power reactor fuel assemblies.

In his paper, Seale makes certain comparisons of his theoretical predictions for heat flow by turbulent interchange between two subchannels simulating a section of a rod array with predictions obtained from the empirical correlation of Rogers and Rosehart [2] for turbulent interchange mixing between 'simple-geometry' subchannels. Using Seale's nomenclature, the Rogers and Rosehart correlation is:

$$Stg = 0.004\left(\frac{de}{b}\right)Re^{-0.1}. \qquad (1)$$

Seale concludes from these comparisons that the correlation proposed by Rogers and Rosehart is unlikely to predict correctly the effect of subchannel shape. On the basis of the comparisons made by Seale, his conclusion is partly correct, but it is irrelevant because he applies the Rogers and Rosehart correlation under conditions for which it is not valid.

As with any empirical correlation, that of Rogers and Rosehart should not be used outside the ranges of the parameters for which it was established. Of the 66 experimental points used to establish equation (1), all but two were obtained in geometries which consisted of two actual square-array subchannels (S-S arrays), a square-array subchannel adjacent to a triangular-array subchannel (S-T array) or else two subchannels formed by rods and flat parallel boundaries in which the subchannel equivalent diameters were equal to those for subchannels in an infinite square array. Therefore, the correlation of Rogers and Rosehart should only be used to predict inter-subchannel turbulent mixing between subchannels whose equivalent diameters are equal to those of actual S-S or S-T arrays. Therefore, it should only be applied to geometries 1b, 2a and 3a of Seale's Table 1 in which the subchannel equivalent diameters are equal to those of an infinite square array and not for the other geometries used by Seale in which the subchannel equivalent diameter is varied while p/d is kept constant. Furthermore, only four points of the 66 used in developing the correlation of equation (1) were obtained with $p/d > 1.4$, so that this correlation should not be used for p/d greater than this value. Thus it should not be applied to geometry 3a of Seale.

Therefore, comparisons between Seale's theoretical predictions and those of the empirical equation of Rogers and Rosehart should be made only for Seale's geometries 1b and 2a. These comparisons are shown in Table 1. Table 1 shows that, for valid conditions of comparison, there is very good agreement between the theoretical predictions of Seale and the empirical ones of Rogers and Rosehart. Obviously, also, the trend of gap Stanton numbers with p/d is the same for both methods of prediction.

In their paper, Rogers and Rosehart recognized the importance of subchannel shape on turbulent interchange mixing between subchannels, which the work of Seale helps to confirm. In view of this fact, Rogers and Rosehart also recognized that it was unsatisfactory to correlate turbulent interchange mixing for S-S and S-T geometries by the same equation, as they had done in their 'simple geometry' correlation, equation (1). They suggested tentative separate correlations for S-S and S-T geometries, but did not recommend their use because of the scarcity of the data available, especially for the S-T geometry.

Later, Rogers and Tahir [3], using the extensive data of Singh and St Pierre [4] for S-S and S-T geometries with $p/d = 1.1$ and 1.4, as well as the earlier data used in ref. [2], proposed separate correlations for these geometries as well as for the T-T geometry, based on the same model as that used in establishing equation (1). Since geometries 1b and 2a of Seale closely represent an S-S geometry, only the predictions of the Rogers and Tahir correlation for S-S geometry should be compared to those of Seale. This correlation is given by:

$$Stg = 0.005\left(\frac{b}{d}\right)^{0.106}\left(\frac{de}{b}\right)Re^{-0.1}. \qquad (2)$$

Again, this correlation is only valid for $b/d < 1.4$.

The predictions of this correlation for Seale's 1b and 2a geometries are also given in Table 1. It can be seen that there is not much change from the previous predictions by the Rogers and Rosehart 'simple geometry' correlation and that there is again very good agreement with the theoretical predictions of Seale.

To summarize, the empirical equations (1) and (2) and other correlation equations of Rogers and Rosehart and Rogers and Tahir, like all empirical equations, should be used only within the ranges of the experimental parameters for which they were established. With this restriction, excellent agreement is

Table 1. Valid comparisons of gap Stanton numbers by various predictions

		$Re = 90\,000$		
		$Stg \times 10^4$		
Geometry	p/d	Seale [1]	Rogers and Rosehart, simple-geometry [2]	Rogers and Tahir, S-S array [3]
1b	1.1	72.21	69.27	67.84
2a	1.375	49.70	47.82	53.87

obtained between the theoretical predictions of Seale and those of equations (1) and (2). Conclusion (i) of Seale's paper while true in the sense used by Seale is irrelevant since it is based on an invalid use of the Rogers and Rosehart correlation.

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