DISCUSSION

E. M. Sparrow

In addition to providing interesting information relating to the boiling curve, the present paper also contains additional data for turbulent heat transfer in circular tubes under nonboiling conditions. By inspection of Fig. 4, it is seen that the nonboiling data fall about 10 percent above the McAdams correlation. Other investigators have also found that the McAdams equation predicts Nusselt numbers which lie below experiment in the Prandtl number range of liquid water. In particular, recent measurements by Allen and Eckert (reference [14]) at a Prandtl number of 8 have demonstrated that the predictions of the McAdams equation are from 10 to 20 percent below their constant-property data (Fig. 15 of reference [14]). The experiments were carried out in a systematic manner which eliminated the effect of variable fluid properties. The conclusion which follows from the work of Allen and Eckert is that the underprediction of the Nusselt number by the McAdams correlation is not due to variables property effects.

By good fortune, the Nusselt numbers predicted by analysis by the writer and his co-workers [15, 16, and 17] display excellent agreement with the data of Allen and Eckert. It is of interest to see how the analysis compares with the data of the present paper. If one enters Fig. 1 of reference [17] at the probable Prandtl number range (~3-4) of the present investigation, it is found that the writer's analysis predicts Nusselt numbers which are about 10 percent above those of the McAdams equation. This finding coincides with the present data.

Additional References


Authors' Closure

The authors appreciate Professor Sparrow's comments on the nonboiling aspects of the present study. Additional data for the turbulent heating of water in circular tubes are included in Fig. 12. The local heat-transfer data were taken sufficiently far downstream so as to be representative of fully developed flow. The data are seen to lie approximately 10 percent above the McAdams' correlation.

The slight stratification of data according to test section could be due to tube roughness or inaccuracies in the estimation of the heated-surface temperature. Additional scatter is due to the radial variation of properties as discussed in a paper by A. E. Bergles and W. M. Rohsenow and reference [14]. This effect is small, however, and even if the data were extrapolated to zero heating rate, they would lie above the McAdams' prediction. All of the present data, then, are in substantial agreement with the constant-property predictions of Sparrow, et al. [15].

Additional References

1 Heat Transfer Laboratory, Department of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. Assoc. Mem. ASME.
2 Numbers in brackets designate Additional References at end of discussion.

Fig: 12 Correlation of data for fully developed turbulent heat transfer