Reply to Professor McKelvey's Note

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Professor McKelvey's note shows that the diffusion process could contribute as much as 12% of the total resistance to mass transfer at very low heat flux, based on a Nusselt number of 7.4 and the limiting slope of the graph for run V. However, based on the same Nusselt number and the same equation, the ratio of diffusion resistance to total resistance would vary from 0.16 to 0.55 for the individual data points of run V. For data points from the other four runs this ratio is even higher, and the ratio exceeds 1 for several points of runs I and II. A ratio of 1 or greater means that all the resistance could be attributed to diffusion. A ratio greater than 1 means that the Nusselt number *is actually greater than the assumed* value of 7.4.

As another way of showing the probable importance of diffusion, the mass transfer coefficients have been calculated for typical data from runs I to V, with equilibrium assumed at the interface. The calculated Nusselt numbers range from 4 to 40, generally increasing with the over-all temperature drop. The increase could be explained partly by the increased density difference and partly by the increased flow of vapor in the system. The expected Nusselt numbers for natural convection would be about 5 to 10; the exact values are not easily calculated since the lower molecular weight at the interface tends to offset the effect of the lower temperature at the interface. The fact that the calculated values are about the same as those expected for natural convection is strong evidence that diffusion is important. Eddy currents in the condenser might make the Nusselt numbers 2 to 3 times the values for natural convection, but it seems unlikely that they would be 10 to 20-fold higher, as would be required to make the *diffusion resistance negligible.* (To get a Nusselt number of 100 would require a Reynolds number of about 20,000 either for flow in a pipe or flow past a flat plate.)

Nusselt Numbers for Condensation of Methanol with Air Present (Data of McKelvey and Baer)

Run	ΔT_1, °C.	$r \times 10^3$, g./sq. cm.-sec.	*Apparent Nusselt number
I*a*	0.59	0.56	41
I*f*	1.48	1.40	40
II*a*	0.53	0.49	12.7
II*f*	1.56	1.44	20
III*a*	0.40	0.37	6.5
III*h*	1.33	1.23	13.3
IV*a*	0.40	0.37	5.8
IV*g*	1.44	1.33	12.9
V*a*	0.26	0.24	4.0
V*d*	0.70	0.64	7.1
V*g*	1.23	1.13	10.4

* Based on a length of 6 cm and D = 0.48 sq. cm./ sec. at 0.37 atm

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HEAT TRANSFER—CHICAGO, Vol. 55, No. 29, 1959.

Hard-Water Scaling of Finned Tubes at Moderate Temperatures, J. G. Knudsen and H. K. McCluer. With the increasing use of finned tubes in industrial heat transfer equipment it is important to know their heat transfer characteristics. A list of recommended fouling coefficients to be used in the design of plain-tube exchangers has been published; however very little information on the behavior of finned tubes under scaling conditions has been reported. This investigation is concerned with a study of the rate of scaling of transverse finned tubes in a double-pipe heat exchanger. **The Effect of Thermal Cycling of Integral-Finned Duplex Tubes,** Edwin H. Young and Marvin L. Katz. The effect of thermal cycling to 350° and 600°F. on the heat transfer performance of duplex integral-finned tubes is reported. The primary heat transfer variable affected by thermal cycling was the bond resistance of the tubes. The phenomenon of bond resistance is discussed, and an apparatus for the measurement of bond resistance is described. Curves indicating the variation in bond resistance as a function of the number of thermal cycles for (a) four copper-liner tubes cycled to 350°F., (b) ten admiralty-liner tubes cycled to 350°F., and (c) four admiralty-liner tubes cycled to 600°F. are presented and discussed. The effect of bond resistance on the over-all coefficient of an air cooler is indicated. **Coefficients for Evaporation of Neutral Sulfite Spent Liquors,** S. T. Han, B. D. Andrews, and W. G. Dedert. This paper presents the results of an investigation of the evaporation of neutral sulfite spend pulping liquor in a semicommercial, forced-circulation, external heat-exchanger evaporator. A series of runs was made at each of four conditions simulating quadruple-effect operation. The principal variable studied at each condition was the liquor velocity through the tubes of the heat exchanger. Data are presented on over-all heat transfer coefficients, and these are analyzed to yield film coefficients on both the liquor and the steam sides.

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