SUMMARY

Mass transfer for fully-developed laminar flow in a 0.5-inch diameter horizontal tube was studied in this work. Naphthalene, which sublimed into a laminar air stream, was coated on the inside surface of the tube. During a test run the temperature was kept constant for the system of air and pipe. Temperatures of 28.8°C and 43.8°C were used for this study. At each temperature, several runs were made at various Reynolds numbers in the laminar range.

Overall mass transfer coefficients and logarithmic mean Nusselt numbers were calculated from the measured weight loss of two coated sections of the test pipe. Experimental logarithmic mean Nusselt numbers were compared with the Graetz solution (7) which assumes a parabolic velocity profile and constant physical properties.

The mass transfer logarithmic mean values obtained during this study were higher than the theoretical solution mentioned above. Better agreement with the theoretical solution was obtained for the lower temperature. Near the pipe entrance the agreement was also better. Apparently the deviations of experimental results above the theoretical values are caused by free convection currents induced by the density differences between the fluid near the wall of the pipe and the center of the pipe.

At 28.8°C, the log mean Nusselt numbers near the entrance were found to be approximately 6 per cent above the theoretical values, and 13 per cent above at 43.8°C. At the end of the test pipe the deviation above the theoretical values were approximately 9 per cent at 28.8°C and 16 per cent at 43.8°C. It was also found that at lower Reynolds numbers there tended to be greater deviation above the theoretical values. However, this was not the case on every run.

An attempt was made to correlate the experimentally determined mass transfer log mean Nusselt numbers with available equations for heat transfer in which free-convection is considered. Expressions presented by Eubank and Proctor (15) and Oliver (17) which are based on heat transfer data for horizontal tubes with fully-developed flow were used. The correlations were more satisfactory near the entrance of the pipe than at the end of the pipe and the correlations were also better for lower temperature than higher temperature runs.

LAMINAR MASS TRANSFER FOR FULLY-DEVELOPED FLOW IN A HORIZONTAL TUBE

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