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SATURATED POOL BOILING AND SUBCOOLED FLOW
BOILING OF MIXTURES AT ATMOSPHERIC PRESSURE

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
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ABSTRACT

An experimental and theoretical investigation of heat transfer to liquid mixtures has been performed using binary and ternary mixtures of acetone, isopropanol and water. Two databases were established which contain measurements of the heat transfer coefficient under saturated pool boiling and subcooled flow boiling conditions. A third database comprises measurements of heat transfer and pressure drop in a plate heat exchanger. The performance of two heat transfer enhancement techniques, namely the coating of the heat transfer surface with teflon and a perforated brass foil, was studied under saturated pool boiling conditions.

A model was developed, which can be used to predict the heat transfer coefficient. The model is based on the additive superposition of convective and boiling heat transfer coefficients. It is applicable for heat transfer to mixtures and single component fluids under saturated and subcooled boiling conditions. The empirical parameters in the correlations used in the model were not altered to fit the measurements of this study. The predictions of the model were compared to the experimental data, which covers the convective heat transfer regime, the transition region and the fully developed nucleate boiling regime. It was found that the best agreement between predicted and measured values was achieved, if the linear mixing law was used to calculate the ideal heat transfer coefficient rather than the correlations by Stephan-Preußer or Stephan-Abdelsalam.

The heat transfer coefficient under saturated pool boiling conditions could be predicted with an accuracy of 12.6 %. A comparison between over 2000 measured heat transfer coefficients under subcooled flow boiling conditions in an annulus and the predictions of the model showed good agreement with a mean error of 10.3 %. The accuracy of the model was found to be independent of the fluid velocity and composition, as well as of the magnitude and mechanism of heat transfer. The heat flux in a plate heat exchanger could be predicted with a mean error of 6.9 % for a wide range of fluid velocities, subcoolings and compositions. The heat transfer coefficient on the test liquid side of the exchanger could be predicted with a mean error of 10 %.

The heat transfer model was used for a theoretical study of the heat transfer to mixtures boiling on a finned surface. It was found that the fin geometry and thermal conductivity have a distinct influence on the local and mean heat transfer coefficients. The results indicate that
the application of fins is more effective for boiling of mixtures than for boiling of single component liquids.
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