

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

POOL FILM BOILING HEAT TRANSFER
FROM HORIZONTAL SURFACES TO SATURATED LIQUIDS



by

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Declaration

I do hereby declare that this dissertation has not been submitted for a degree or qualification at any other University or Institution.

Richard Jean Michel Messiha

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To

My wife Wafaa and daughter Carole

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ABSTRACT

A theoretical study was carried out to solve the governing equations for conservation of mass, momentum, and energy in the boundary layers of the vapour and saturated liquid during pool film boiling around an isothermal horizontal cylinder. The study took into consideration the radiation effects of both the heating surface and the vapour phase. The vapour phase was considered as a radiatively participating gas and the radiation transfer equation in its differential approximation form was solved together with the conservation equations. Numerical solutions were obtained for the velocity and temperature fields, and radiation heat flux at different circumferential positions of various tube diameters and for different wall emissivities. Thus the mean heat transfer coefficient was computed.

Linear stability analysis was done for the problem of the interfacial instability of the vapour and its saturated liquid taking into consideration the effects of heat and mass transfer on such instability. Results concerning the most dangerous wave length, most dangerous growth rate, and most dangerous physical frequency were obtained and analyzed. These results, in conjunction with the undisturbed vapour film thickness, and the bubble energy and dynamical equations, were used to build a new model to predict the heat transfer coefficients on horizontal surfaces either flat or cylindrical. In order to test the validity of the model, a comparison was held between its results and the available experimental results of the author as well as those of the others. The comparison for different fluids showed a very good agreement, and revealed the generality, and the plausibility of the new model.

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