ABSTRACT

In the present study, saturated nucleate pool boiling in aqueous surfactant solutions from horizontal tubes is investigated. Sodium Dodecyl Sulfate (SDS), Triton X-100 and Sodium Lauryl Ether Sulfate (SLES) with different concentrations are the test surfactants. A pool boiling test rig is designed and constructed to carry out heat transfer experiments using three test tubes with different materials. brass, aluminum and stainless steel.

Effects of wall heat flux, wall superheat, type of surfactant and concentration of aqueous surfactant solutions (boiling fluids) on the nucleate boiling heat transfer coefficient are the major studied parameters.

A detailed analysis of the experimental data showed reasonable enhancement in the heat transfer coefficient for all test concentrations of SDS and SLES using the three test tube materials. A limited enhancement is found up to concentration of 500 ppm for aqueous Triton X-100 solution.

The three parametric distribution function N(r) for the size of the stable vapor bubbles in active nucleation sites are deduced for the three test tubes using different test concentrations of aqueous surfactant solutions. A successful trial has been achieved to corrolate the size distribution function's constants (N_{max} /A, r_{st} and m) with the concentration of the aqueous surfactant solutions.

Attention is directed to correlate the experimental results of wall heat flux, wall superheat and active nucleation site density; to get a helpful tool for predicting the thermal performance of nucleate pool boiling in aqueous surfactant solutions. Reasonable agreement is found between the present experimental data and the available published data.

The present experimental data confirm that:

1. For a given concentration of aqueous surfactant solution, increasing the wall heat flux; increases the nucleate pool boiling heat transfer coefficient and the active nucleation site density.
2. For a given wall heat flux, increasing the concentration of aqueous SDS and SLES solutions; increases both the nucleate pool boiling heat transfer coefficient and the active nucleation site density.
3. For a given wall heat flux; increasing the concentration of aqueous Triton X-100 solution up to 500 ppm; increases the heat transfer coefficient and the active nucleation site density. Above 500 there is no enhancement in the heat transfer coefficient.
4. It is possible to deduce the size distribution function of a stable vapor bubble in active nucleation sites for pure distilled water and all test concentrations of aqueous surfactant solutions.
5. The form of the size distribution function is affected by the concentration of the aqueous surfactant solution and the test tube material.
6. The size distribution function's constants (N_{max} /A, r_{st} and m) obtained from the heat transfer measurements for all concentrations of aqueous solutions, using the three test tubes, showed a defined trend with the concentration. It should be concluded that the exponent (m) is constant with concentration, while the constant (N_{max}/A) is increasing with concentration, while the constant (r_{st}) is decreasing with concentration.
7. The aqueous surfactant solution SDS improved the heat transfer coefficient of Aluminum, Brass and Stainless Steel by 267 %, 253% and 241% respectively.

8. The aqueous surfactant solution SLES improved the heat transfer coefficient of Aluminum, Brass and Stainless Steel by 223 %, 206% and 185% respectively.
9. The aqueous surfactant solution Triton X-100 improved the heat transfer coefficient of Aluminum, Brass and Stainless Steel by 168 %, 153% and 133% respectively.
10. Based on the present results, the wall heat flux, wall superheat and active nucleation site density are correlated with the test tube material and concentration of aqueous surfactant solutions.
11. The present results show a reasonable agreement with one of the available published data.