Proceedings of the 12th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT 2025)
July 15, 2025 - July 17, 2025 | Imperial College London Conference, London, United Kingdom
Paper No. 230
DOI: 10.11159/ffhmt25.230

Two-Phase Heat Transfer Performance of Ethylene Glycol-Water Binary Mixture in Nucleate Pool Boiling

Ravi Raushan, Yogesh M. Nimdeo*
Department of Chemical Engineering, Indian Institute of Technology Jammu
Jammu, Jammu and Kashmir, India
ravi.raushan@iitjammu.ac.in;
**Author of correspondence:*
Dr. Yogesh M. Nimdeo
Email: yogesh.nimdeo@iitjammu.ac.in

Extended Abstract

Modifying the base fluid water with addition of organic & inorganic solvents, surfactants, suspensions, and organic salt solutions is a prominent passive strategy for enhancing two-phase heat transfer, playing a crucial role in thermal management across industrial and commercial applications. This approach has attracted substantial research interest in boiling heat transfer due to its potential to overcome the boiling crisis phenomena [1], [2].

The present study explores the effects of ethylene glycol (EG) in EG-water binary mixtures on two-phase heat transfer behaviour under nucleate pool boiling conditions. The primary objective is to understand how variations in the molecular weight and concentration of EG influence single bubble dynamics during pool boiling at saturation temperature and atmospheric pressure. The pool boiling experiments were conducted using three different molecular weights of EG: Mono ($\overline{\mathrm{M}} = 62.07\ \mathrm{g/mol}$), EG-400 ($\overline{\mathrm{M}} = 400\ \mathrm{g/mol}$), and EG-1500 ($\overline{\mathrm{M}} = 1500\ \mathrm{g/mol}$), at concentrations of 2%, 5%, and 10% by weight in deionized water as a bulk fluid. A custom designed stainless steel boiling chamber (internal volume = 400 cm^3) was employed to carry out the desired boiling experiments, which has the provision maintaining bulk fluid saturation temperature and atmospheric pressure. An Indium Tin Oxide (ITO)-coated glass substrate was employed as the superheating heating surface for generation of the isolated single vapour bubble, under a controlled heat flux supplied by a DC power source. The isolated vapour bubble ebullition cycle was recorded in real time frame through a Rainbow Schlieren Deflectometry- A non-intrusive optical imaging technique integrated with high-speed colour imaging camera in real time frame [3]. Key parameters including bubble departure diameter, departure frequency, dynamic contact angle, bubble base diameter, and local temperature variation at the vapour-liquid interface were extracted via image analysis. The results demonstrate that increasing the both EG concentration and molecular weight suppresses thermal hydrodynamic instabilities near the heating surface.

References

[1] J. Kim, "Review of nucleate pool boiling bubble heat transfer mechanisms," *International Journal of Multiphase Flow*, vol. 35, no. 12, pp. 1067-1076, 2009.
[2] G. Liang, and I. Mudawar, "Review of pool boiling enhancement with additives and nanofluids," *International Journal of Heat and Mass Transfer*, vol. 124, pp. 423-453, 2018.
[3] S. Narayan, A. Srivastava, and S. Singh, "Rainbow schlieren-based direct visualization of thermal gradients around single vapor bubble during nucleate boiling phenomena of water," *International Journal of Multiphase Flow*, vol. 110, pp. 82-95, 2019.