Abstract

Condensation process of steam has raised large interest for many heat transfer applications due to the effective utilization of the latent heat released during its process. Considerable significance and study has been focussed on the phenomenon of dropwise condensation, which provides larger heat transfer coefficients as compared to film condensation. However, to obtain dropwise condensation on metal surfaces it is necessary to reduce its surface energy by means of coating with a hydrophobic layer. Different types of hydrophobic coatings were analysed experimentally, for their ability to promote dropwise condensation. For performing the experimental tests on various coated plates, a heat exchanger water-steam test rig is set up at the German Aerospace Center (DLR) in Institute of Technical Thermodynamics. Various hydrophobic layers such as Diamond-Like-Carbon (DLC), Nickel-Phosphorus-Perfluoralkoxy-copolymer (Ni-P-PFA) and tempered Ni-P-PFA were selected as test coatings for the experiments. An uncoated stainless steel plate was taken as a reference for comparison with coated plates. For comparing the performance between these test plates, various experimental conditions were investigated by varying the steam pressures and the sub-cooling temperatures. Visual observation of the condensation process taking place on the test plates was analysed with the help of two observation windows provided at different heights in the condenser. By means of high-speed camera the drop life cycle activity was recorded at relevant experimental parameters. The recordings and experimental results obtained are evaluated and compared at different operating conditions. The experimental results are graphically represented by showing the dependence of measured values such as heat flux and heat transfer coefficient on the operating parameters. It was revealed that the Ni-P-PFA-Tempered plate had larger heat transfer coefficients as compared to other plates, which provides the possibility to promote stable dropwise condensation on this type of coating. The experimental and visual observation results obtained form the basis of numerical simulation model for dropwise condensation taking place in heat exchanger plates. Further attempts at DLR are in progress, for implementation of this type of steady-state model.