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A Comparative Study of Flow Boling Heat Transfer in Coated and Uncoated Plate Heat Exchangers

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Plate heat exchangers are used extensively in industrial applications and, owing their compact size and high thermal efficiency, they are key components of Organic Rankine Cycles (ORCs). A key aspect that strongly affects the performance of these heat exchangers, particularly when used in two-phase heat transfer, is the heat transfer surface condition. For this reason, surface modifications have been subject of numerous studies aiming at obtaining enhanced heat transfer performance. Surface structure has been found to strongly affect phase change mechanisms and boiling regime. Well-engineered surfaces are able to significantly improve the heat transfer rates as well as the pressure drop characteristics. Such enhanced performance can result in even smaller systems, further reducing materials of construction and installation space required while providing higher plant efficiencies.

Several works in the literature report the enhancement of boiling heat transfer rates obtained using microscale surface modification with application both to the refrigeration and power industries. However, only a few attempts to modify the heat transfer surface structure of PHEs to enhance their performance have been reported. This work presents the results of an investigation on the effect of coated plates on the flow boiling heat transfer characteristics of refrigerant R245fa in PHEs. This is part of a large project aimed at improving the overall performance of ORC systems with enhanced heat transfer at the evaporator to help improve performance in low temperature applications. Tests using a non-coated heat exchanger were performed to establish the baseline performance of the exchanger with uncoated surfaces, including the effect of heat flux and mass flux on heat transfer coefficient and pressure drops. The results of these test were compared with past literature correlations. In a second step, an equivalent heat exchanger, coated on the refrigerant side using a chemical deposition process of metallic nanoparticles, was then tested. Boiling heat transfer characteristics and pressure drop were then compared with the non-coated heat exchanger to assess the benefits.