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Experimental Investigation on the Condensation of R134a in a Multiport Flat Tube

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Extended Abstract

This contribution presents the validation of a new test facility in order to investigate heat transfer and pressure drop characteristics of the pure refrigerant R134a as well as R134a-lubricant-mixtures in a multi-port flat tube as used in compact flat tube condensers of modern AC systems. Due to the use of oil-lubricated compressors the nominal oil content within the refrigerant cycle of AC system can reach up to 10 % by weight with local oil contents up to 100 % by weight. New correlations for heat transfer and pressure drop for this application are needed, as previous investigations on the condensation of refrigerant-lubricant-mixtures (e.g. [1], [2] and [3]) have revealed a significant influence of the lubricant and poor agreement with correlations for pure refrigerants. Therefore, an experimental facility has been set up to measure both the heat transfer coefficient and the pressure drop value in the two-phase flow regime for refrigerant-lubricant-mixtures. The test section is based on an extruded aluminium multi-port flat tube with a total length of 800mm containing 18 parallel channels with square-shaped cross section and a hydraulic diameter of 0.91 mm. In order to provide an even distribution of the two-phase flow in the multi-port flat tube, a special transition section including a sight glass for observation purposes has been designed. The test conditions have been varied for the pure refrigerant R134a within a saturation temperature of 40 up to 67 °C, the mass flux between 200 and 800 kg/(m²s) as well as the vapour quality from 10 % up to 90 %. In future investigations a variation of the lubricant content will range between 0 and 10 % by weight. As a wide diversity of heat transfer and pressure drop correlations as well as experimental data is available in literature, a well-founded validation of the new test facility is crucial. Therefore experimental results for the pure refrigerant will be discussed in detail and compared with renowned literature. It will be shown that a very good accordance of the experimental value for the pressure drop in comparison with the calculated value from the Friedel correlation [4] can be observed across all operation conditions. Concerning heat transfer properties a good accordance of the experimental data with the data from literature, e.g. the Akers correlation [5], can be stated. Furthermore the suitability of this approach to determine the condensation properties of pure refrigerants as well as refrigerant-lubricant-mixtures can be verified by considering the average uncertainty of measurement as well as the reproducibility. The investigation based on the "Guide to the Expression of Uncertainty in Measurement" [6] shows that the uncertainty for the heat transfer coefficient mainly ranges between 5 to 10 % and for the pressure drop even below 5 %. In addition one can estimate a mean value for the reproducibility below the value of the uncertainty in measurement. This confirms the performance of the test facility.

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