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# Convective Boiling of $CO_2$/R744 in Macro and Micro-Channels

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**Abstract :** The current panorama of technology in heat transfer and the scarcity of information about the convective boiling of $CO_2$ and hydrocarbon in small diameter channels motivated the development of this work. Among non-halogenated refrigerants, $CO_2$/ R744 has distinct thermodynamic properties compared to other fluids. The R744 presents significant differences in operating pressures and temperatures, operating at higher values compared to other refrigerants, and this represents a challenge for the design of new evaporators, as the original systems must normally be resized to meet the specific characteristics of the R744, which creates the need for a new design and optimization criteria. To carry out the convective boiling tests of $CO_2$, an experimental apparatus capable of storing (m= 10kg) of saturated $CO_2$ at (T = -30 ° C) in an accumulator tank was used, later this fluid was pumped using a positive displacement pump with three pistons, and the outlet pressure was controlled and could reach up to (P = 110bar). This high-pressure saturated fluid passed through a Coriolis type flow meter, and the mass velocities varied between (G = 20 kg/m².s) up to (G = 1000 kg/m².s). After that, the fluid was sent to the first test section of circular cross-section in diameter (D = 4.57mm), where the inlet and outlet temperatures and pressures, were controlled and the heating was promoted by the Joule effect using a source of direct current with a maximum heat flow of (q = 100 kW/m²). The second test section used a cross-section with multi-channels (seven parallel channels) with a square cross-section of (D = 2mm) each; this second test section has also control of temperature and pressure at the inlet and outlet as well as for heating a direct current source was used, with a maximum heat flow of (q = 20 kW/m²). The fluid in a biphasic situation was directed to a parallel plate heat exchanger so that it returns to the liquid state, thus being able to return to the accumulator tank, continuing the cycle. The multi-channel test section has a viewing section; a high-speed CMOS camera was used for image acquisition, where it was possible to view the flow patterns. The experiments carried out and presented in this report were conducted in a rigorous manner, enabling the development of a database on the convective boiling of the R744 in macro and micro channels. The analysis prioritized the processes from the beginning of the convective boiling until the drying of the wall in a subcritical regime. The R744 resurfaces as an excellent alternative to chlorofluorocarbon refrigerants due to its negligible ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) rates, among other advantages. The results found in the experimental tests were very promising for the use of $CO_2$ in micro-channels in convective boiling and served as a basis for determining the flow pattern map and correlation for determining the heat transfer coefficient in the convective boiling of $CO_2$.

**Keywords :** convective boiling, $CO_2$/R744, macro-channels, micro-channels
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