Mathematical Model of Two-Phase Flow Incorporating Flow Pattern Phenomena

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Two-phase flow is still recognized today as one of the most challenging fluid dynamic problems to be explored since the 1940s (Lockhart and Martinelli, 1949; Govier and Aziz, 1972; and Vance and Lahey, 1982). In particular, flow pattern phenomena are not usually incorporated quantitatively into two-phase flow models nor are they measured objectively. Consequently, in order to successfully analyze, control, and describe any of two-phase flow systems, it is necessary to firstly obtain a fundamental understanding of the two-phase flow and heat transfer and then develop a model which incorporates flow pattern phenomena beyond those used recently in mini and microchannels. This can be accomplished through the development of a quantitative model that incorporates such parameters like in-situ concentration/void fractions, velocities, and flow patterns. The model presented here describes pressure losses in two-phase flow incorporating flow pattern phenomena by defining and using flow pattern coefficient. This approach significantly reduces the differences between the experimental and the simulated values that are typically encountered using other approaches. The incorporation of flow patterns into the proposed models occurred due to the development of a flow pattern coefficient, which is proportional to the square of the mixture Reynolds number and concentration to the power of 3.5 (as defined in Eq. 9). Although, the experiments were conducted for air-water mixtures in a horizontal small channel, due to incorporation of mixture parameters like components viscosities, and channel's parameter like diameter, the proposed model has a high potential to be applied for extrapolation for different channel's sizes and different mixtures.