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Predictive model for the scale out of small channel two-phase flow contactors

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Abstract

In this paper, double manifolds are theoretically investigated for the scale-out of two-phase incompressible flows in small channels. Statistical descriptors are proposed to characterise the maldistribution of the total flow rate and the ratio of the flow rates in the two-phase channels, based on the variances and covariance of the flow rates of the two fluids. A novel resistance network model is developed that relates the flowrates of the fluids in the two-phase channels to the hydraulic resistances of the manifold. The statistical descriptors and the resistance network model are then used to develop relationships between the maldistribution coefficients and the hydraulic resistances of the double manifold, the overall pressure drop and the pumping power requirements for different parallel channel numbers. Based on these, scaling laws are proposed that maintain a constant degree of maldistribution for a scale-up factor of up to 10^2. Double manifolds designed using these scaling laws have a constant pressure drop as the number of channels increases, whilst the power requirements increase linearly. The power requirements are inversely proportional to the phase ratio maldistribution descriptor. Recommendations for the design of double manifolds for the scale-out of two-phase systems are proposed.

Keywords

Scale-out; Number-up; Microreactor; Flow distribution; Resistance network; Incompressible two-phase flow