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Dimensionless numbers describing the onset of flow transitions in flow-focusing and T-junction microfluidic devices SIVA VANAPALLI, JIHAY KIM, MEHDI NEKOUEI, Texas Tech University, Department of Chemical Engineering — T-junction and flow focusing geometries are the most commonly used drop generators in microfluidic devices. Several studies have documented the different behaviors of dispersed phase in these devices including break-up modes such as squeezing, dripping, and jetting and a non-break-up mode involving co-flowing laminar streams, called parallel stream. However, the control parameters that govern the transitions between these behaviors are not fully known. Using a combination of experiments and numerical simulations, we find that the onset of the dispersed phase transitions can be described by two dimensionless numbers – Weber number based on outer phase and Reynolds number based on the inertia of the inner phase and viscous stress of the outer phase. The flow transition from drop regime to jetting occurs at $\mathrm{We}_o \sim O(1)$, and the flow transition from drop regime to parallel stream occurs at $\mathrm{Re}^* \sim 1$. This scaling of flow transition was not affected by the change in the viscosity ratio, concentration of surfactant, the height of the channel, and the wettability of the device. Thus, our studies suggest that these two dimensionless numbers capture the onset of flow transitions in microfluidic drop generators.

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