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Influence of temperature on production of water-in-oil emulsions by microchannel emulsification

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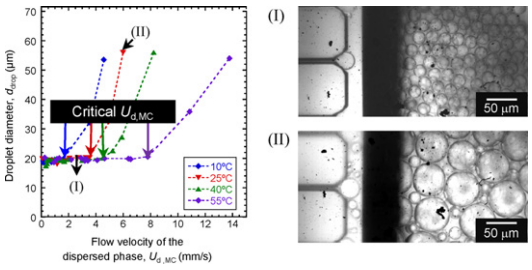
HIGHLIGHTS

- The influence of temperature on the production characteristics of W/O emulsions by MCE was investigated.
- The contact angles of the dispersed phase to the MC wall were high enough to stably produce monodisperse W/O emulsions.
- Maximum droplet productivity increased exponentially with increasing temperature.
- At each temperature, the size of the generated uniform droplets was not sensitive to the flow rate of the dispersed phase.
- An adapted capillary number proposed in this study is a useful indicator of understanding droplet generation behavior.

GRAPHICAL ABSTRACT



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ABSTRACT

In this paper, we report the influence of temperature on the production characteristics of water-in-oil (W/O) emulsions by microchannel emulsification (MCE). The temperature of an emulsification module including a hydrophobic microchannel (MC) array chip was controlled between 10 °C and 55 °C. The continuous phase was a decane oil solution containing 5 wt% tetraglycerin monolaurate condensed ricinoleic acid ester as a surfactant. The dispersed phase was a Milli-Q water solution containing 1 wt% of sodium chloride and 5 wt% of polyethylene glycol. The contact angle of the dispersed phase to the MC wall exceeded 152°, strongly suggesting that the MC array surfaces are not wetted by the dispersed phase during MCE. At the breakthrough pressure of the dispersed phase, monodisperse W/O emulsions with coefficient of variation below 5% were produced via hydrophobic MC arrays, irrespective of the temperature. At each operating temperature, the resultant droplet diameter was also almost constant below a critical flow velocity of the dispersed phase. The maximum droplet generation rate from a channel gradually increased with increasing operating temperature due to the decrease in viscosity of both phases. An adapted capillary number that considers the influence of the wettability and surfactant adsorption had a low maximum/minimum value ratio of 1.2.

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