A Microfluidic Method To Assess Demulsification Kinetics For Oil-Water Separation

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The control of emulsion stability is of crucial importance in the process of crude/oil water separation, which is a key step in industrial oil production. Separation is enhanced if coalescence between droplets takes place, the extent of which will depend on the flow parameters as well as on the presence of emulsifying agents. Current theoretical models cannot satisfactorily predict the timescale of coalescence in flowing emulsions, especially when chemical additives, such as surfactants are present in the system. For that reason, a reliable and easy-to-use experimental method to assess crude-oil emulsion stability would be useful, but has not been available until now.

In this work we present the results of microfluidic experiments on coalescence in an oil-in-water emulsion. Using a custom-designed microfluidic circuit, monodisperse droplets of a model oil in water formed at a microfluidic T-junction were injected into a wide channel where droplets are accumulated and undergo shear-induced collisions. The droplet interactions were followed with a microscope and a high-speed camera.

The experimental method allows direct measurement of the kinetic parameters governing demulsification, which are the total coalescence rate of the emulsion and the distribution of individual coalescence times of colliding droplet pairs.

The kinetic parameters were mapped as a function of the droplet size, fluid flow rates, electrolyte concentration and dispersed phase volume fraction and viscosity, respectively. All those measurements can be performed in a short time using a simple experimental setup. The proposed method is thus a useful tool to aid in the design or optimization of a separation process for a given produced crude oil/water mixture.