Behavior of water-oil-water emulsion films in relation to the stability of inverse emulsions

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Summary

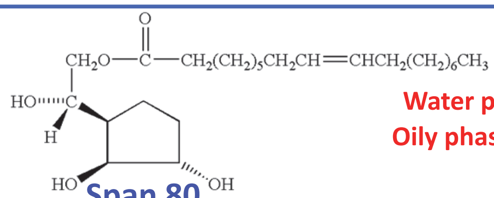
Despite the importance of water-in-oil emulsions in several technological areas like cosmetics, foods, petrochemistry, the main types of forces and factors which control their stability and the other properties are poorly understood.

In this study we perform a systematic series of experiments, aimed at determining the effects of several factors on the stability and behavior of water-oil-water emulsion films. These factors include (1) surfactant concentration in the oily phase for two oil-soluble nonionic surfactants, Span 20 and Span 80; (2) electrolyte concentration in the aqueous phase, and (3) drop size.

The main conclusions from the performed experiments can be summarized as follows:

- **Under all conditions studied, Span 80 leads to more stable water-oil-water films;**
- **For both surfactants, the stability of the emulsion films increases with the increase of surfactant concentration;**
- **At low surfactant concentrations, the films rupture after the formation of a thin (black) spot in the interior of the film, whereas at higher surfactant concentrations a film with thickness of ca. 20 nm is formed and remains stable for a certain period of time before rupturing;**
- **There are three well pronounced areas in the dependence of the drops lifetime with increasing their size: first decrease of the stability for the smallest drops, $d \leq 20$ μm, then a plateau in the curve for drops with sizes between 20 μm and 100 μm, and increase of the stability for drops with $d > 100$ μm.**
- **The obtained experimental results are compared with theoretical predictions, available in the literature and a good agreement is established.**

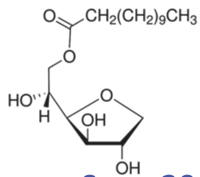
Materials



Span 80

Water phase: 150 mM NaCl or pure water

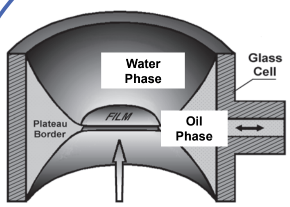
Oily phase: Span 20 or Span 80 + Hexadecane



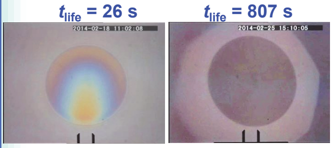
Span 20

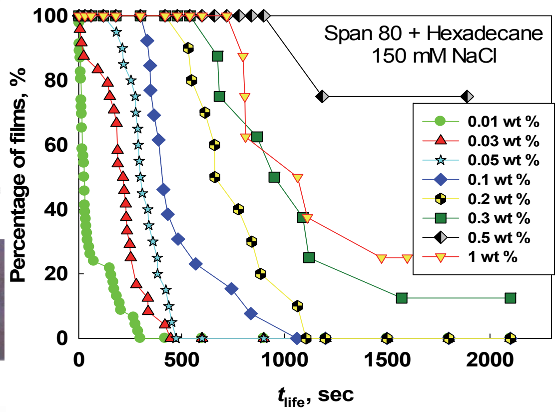
Results and Discussion

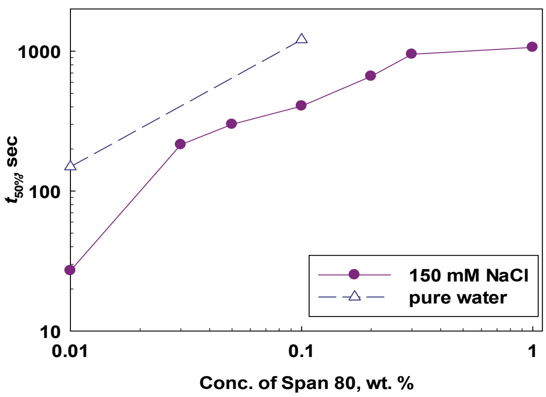
Emulsion films in capillary cell

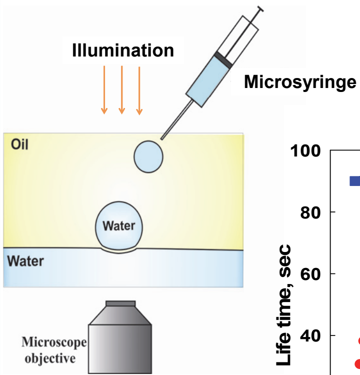


0.01 wt %; t_{life} = 26 s | **1 wt %; t_{life} = 807 s**





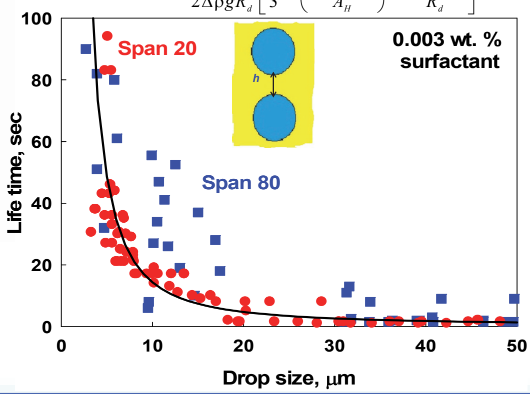


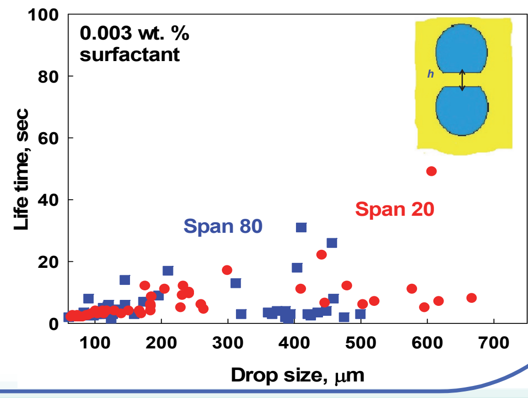


Water drops against homophase

Theoretical considerations

$$t = \frac{9\eta_C}{2\Delta\rho g R_d}\left[\frac{1}{3}\ln\left(\frac{12\pi\sigma R_d^2}{A_H}\right)+\frac{h_{in}-R_d}{R_d}\right]$$





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