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Premix emulsification using a packed bed of glass beads

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INTRODUCTION

A drawback of premix membrane emulsification is membrane fouling that may become serious depending on the formulation components, and related to that their interaction with the membrane and their ease of removal. In this research, an alternative system consisting of a packed bed of glass beads, introduced by van der Zwan (2008), which is intrinsically easy to clean, was further investigated for emulsification.

EXPERIMENTAL

The emulsification (Fig. 1) consists of a pressure vessel containing 5% hexadecane in water emulsion having 0.5% Tween 20 (initial droplet diameter 25-30 µm) connected to the module (a Plexiglas column) having a bed of glass beads supported by a sieve (11.6 × 330 µm pore size). The emulsification was started by opening the outlet valve and collecting the homogenized emulsion in a flask placed on an electrical balance for recording the flux. The droplet size was measured in a Malvern, Mastersizer.

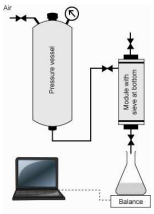

Fig. 1. Experimental setup

RESULTS & DISCUSSION

• Effect of particle bed thickness on emulsification

The droplet uniformity increases when using the particle bed, but compared to the support sieve, the droplet diameter was always higher and increased with bed height. With increasing bed height there is a reduction in local pore velocity and hence, a decrease in shear stress required for droplet break up is expected; this effect can be counter-acted by an increased pressure.

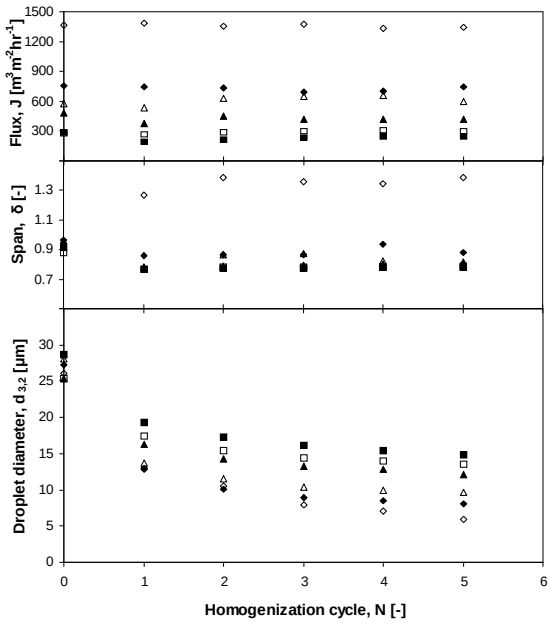

Fig. 2. Effect of bed thickness on droplet diameter and span, at a transmembrane pressure of 200kPa: (◊) support sieve, (♦) 2.5mm, (Δ) 5mm, (▲) 10mm, (□) 15mm, and (■) 20mm

• Effect of particle size on emulsification

There was a great reduction in the droplet diameter using the smallest fraction of particles (50µm) and the produced emulsion was rather monodisperse having droplet span around 0.7. The flux did not decrease with the number of recycles, and fluxes were high compared to other examples from literature, indicating the robustness of the system.

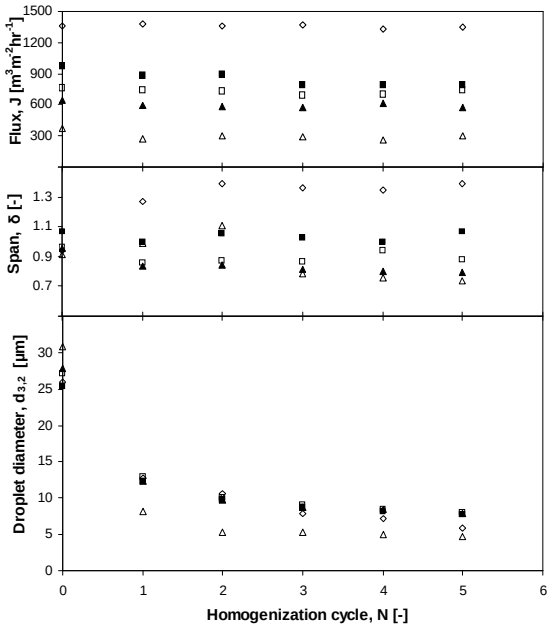

Fig. 3. Effect of particle size on droplet diameter and span, at a transmembrane pressure of 200kPa and bed thickness of 2.5mm: (◊) support sieve, (Δ) 50µm, (▲) 63µm, (□) 75µm , and (■) 90µm

CONCLUSIONS & PROSPECTS

- Premix emulsification using a packed bed of spherical glass particles results in rather monodisperse emulsions at relatively low transmembrane pressures without obvious flux loss due to fouling.
- Emulsion properties like size and monodispersity can be tuned through combination of particle size and bed height (and pressure).
- Next, various experimental conditions including disperse phase content and viscosity ratio, need to be investigated. Based on these findings, scaling relations will be derived to define the window of operation of this new emulsification technique.

REFERENCES

van der Zwan, E.A., C.G.P.H. Schroën, et al. (2008). "Premix membrane emulsification by using a packed layer of glass beads." AIChE Journal 54(8): 2190-2197.

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