Low cost ceramic membranes for premix membrane emulsification

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Overview and Scope

Food industry is increasingly interested in producing healthy foods, typically enriched in bioactive compounds or probiotics, with good sensory properties. Encapsulation enables to provide industry with the ingredients required to optimize food formulations and meet market needs. Emulsions and solid microcapsules have evolved as main strategies to encapsulate. In premix membrane emulsification (ME) a coarse emulsion is forced through a membrane emulsification system to reduce the size of the droplets. The low cost ceramic membranes, made of white clay and chamotte, show a porosity and pore size distribution similar to those of inorganic membranes suitable for producing emulsions, but of higher cost.

Premix membrane emulsification with ceramic membranes

(a) Schematics of a premix ME process; (b) image of the premix ME system designed to hold low-cost ceramic membranes

Flux and droplet size during ME with ceramic membranes

5% lemon oil emulsion stabilized with 2% Tween 20

- Mechanical stirring ($d_{1,2} = 3.53 \mu m$)
- Cycle 1 ($d_{T,2} = 3.21 \mu m$; span = 1.19)
- Cycle 2 ($d_{T,2} = 3.14 \mu m$; span = 1.06)
- Cycle 3 ($d_{T,2} = 3.03 \mu m$; span = 0.95)

95% distilled water
5% lemon essential oil
2% Tween 20
1% whey protein

The low cost ceramic membranes can be used to produce oil-in-water emulsions with a low oil disperse fraction (5-7%). However, when the oil fraction was increased (increasing the viscosity), a higher pressure should be applied, since droplet break up depends, among others, on the velocity inside the pores. We have found that to increase the oil fraction to 10% the pressure applied has to be higher than the maximum working pressure for the membrane.

When Tween 20 was used to stabilize the emulsion, a reduction of droplet size was achieved after each cycle. However, when whey protein was used, membrane fouling occurred, affecting the performance of the process, with a drop in the flux and a clear trend in the droplet size pointing out to emulsion destabilization. The ceramic membranes were cleaned and reused, but their performance was not restored.

References:


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