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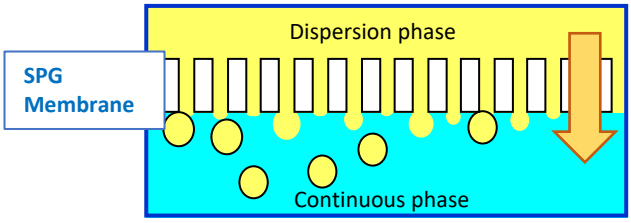
Injection speed of Dispersion phase for Direct Emulsification

This emulsification method disperses the dispersion phase directly from the SPG membrane into the continuous phase.
The emulsion size is 3 - 4 times the SPG membrane pore size (Dm). And monodisperse emulsion can be obtained with high accuracy. In addition, the emulsion particle size can be controlled by changing the pore size of the SPG membrane.

In Direct Emulsification, injection speed control is the most important factor in preparing monodisperse emulsions.

There are two types of control of the injection speed of the dispersed phase. **"Mechanical control"** controlled by syringe pump and **"Pressure control"** controlled by pressurized gas.
We will post the data we got from the test. please refer.

***This data may change as the composition changes. Please test to find the conditions tailored to the composition used by the customer.**



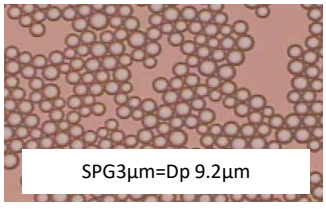
about Injection Speed

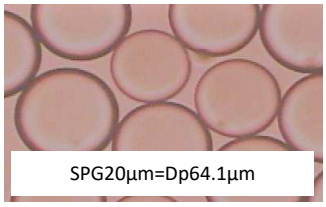
: It depends on the pore size of SPGmembrane.
Larger pores = fast. Small = slow.

: It is proportional to the effective area of the SPG membrane.
If the area is doubled, the injection speed is doubled.

"Direct Connector (Effective area = 0.4cm^2)" Mechanical control

SPG Pore Size	Injection speed (*1	Emulsion size	Monodisperse	Continious phase Stirrer rotation speed
1µm	0.2ml/h	3.6µm	◎	400rpm
3µm	0.5ml/h	9.2µm	◎	400rpm
5µm	1.0ml/h	13.2µm	◎	400rpm
10µm	2.0ml/h	29.5µm	◎	300rpm
20µm	4.0ml/h	64.1µm	◎	300rpm
30µm	6.0ml/h	99.6µm	◎	300rpm
50µm	10.0ml/h	167.0µm	◎	300rpm


SPG3µm=Dp 9.2µm


SPG20µm=Dp64.1µm

Emulsified composition O / W Emulsion : O = Soybean oil, W = 1wt% HCO60 + 0.3wt% NaCl solution

*1 : Setting value of "Syringe pump".

“Internal pressure micro kit (MN) / External pressure micro kit (MG)

(Effective area = 3.2cm^2)” **Pressure control**

SPG Pore Size	Pressure	Injection speed (*1	Emulsion size	Monodisperse	Continious phase Stirrer rotation speed	Use Device
0.1μm	0.500MPa	0.03ml/h	0.45μm	◎	400rpm	MG
0.4μm	0.221MPa	0.1ml/h	1.34μm	◎	400rpm	MN/MG
1.1μm	0.078MPa	1ml/h	3.7μm	◎	400rpm	MN/MG
3.3μm	0.029MPa	3ml/h	11.7μm	◎	400rpm	MN/MG
5.5μm	0.010MPa	5ml/h	19.1μm	◎	400rpm	MN/MG
10.5μm	0.004MPa	10ml/h	34.9μm	◎	350rpm	MN/MG
15.8μm	0.004MPa	15ml/h	49.2μm	◎	350rpm	MN/MG
18.5μm	0.001MPa	20ml/h	56.8μm	◎	350rpm	MN/MG
50.0μm	0.001MPa	720ml/h	152.1μm	◎	300rpm	MN

Emulsified composition O / W Emulsion : O = Soybean oil, W = 1wt% HCO60 + 0.3wt% NaCl solution

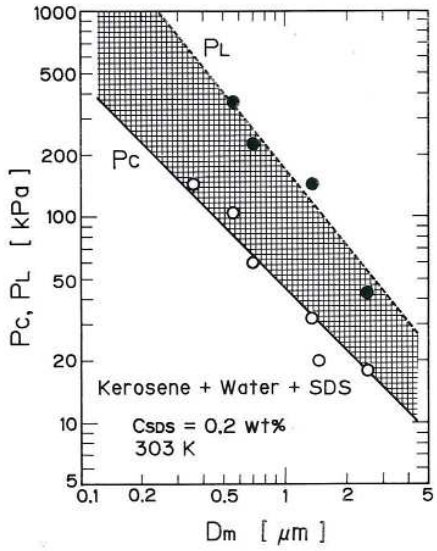
*1 : The value calculated by weight after emulsification.

Setting emulsification pressure

“Membrane wetting” is the most common reason why monodisperse normalization cannot be obtained. This can happen when the dispersed phase or emulsifier is not appropriate.
And, there are many cases that occur when the pressure is set too high to increase the injection speed of the dispersed phase.
There is a pressure range that allows monodispersion in direct emulsification, and the emulsification must be operated in these pressure ranges. When the lower limit value of pressure is Pc (critical pressure) and the upper limit value is PL, Pc is obtained by equation (1). The upper limit of PL can only be determined experimentally.

(1) $Pc = 4\gamma ow \cos\theta / Dm$
: γow = surface tension at oil / water interface
: θ = Contact angle of oil with water
: Dm = SPG pore size

The figure on the right shows the Pc-PL pressure chart when an O/W emulsion is made with kerosene as the disperse phase and 0.2 wt% SDS solution in the continuous phase.
It is very convenient if the experimenter prepares such a pressure chart for each emulsion composition.



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