Fusible Filter medium

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Significance

We propose a new filtration method and apparatus using a fusible filter medium (FF). The advantages of FF are:

1) materials captured by the filter can be recovered by melting the filter and subsequent specific gravity separation,

2) the filter medium can be recycled, and

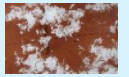
3) the latent heat of solidification removed to produce FF is significantly lower than that of vaporization.

Separation of emulsified-squid oil using ice filter layer

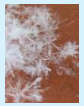
Squid;
the oil is rich in
DHA and EPA

Squid liver

Diluted (33%) liver with 20wt% NaCl aqueous solution:
A mixture to be separated



Granular-like ice crystals (snow)



Dendrite ice crystals (snow)

The diluted squid liver supplied on the fusible-filter layer in a basket centrifuge (-2.5℃, centrifugal effect: 400)

Melting the filter captured oil and subsequent specific gravity separation

Transparent (inoxidized) squid oil was separated.
(recovery rate: around 87%)

Produced fine ice crystals

Fusible Filter layer (ice) that is formed intermittently.

Existing techniques

One preferred mode of our proposed filtration method is an application to oil-containing biomaterials. Existing techniques, such as sedimentation centrifuges (e.g., Batch laboratory equipment, disk centrifuges, and decanter centrifuges), solvent extractions (e.g., using hexane, and acetone), and coalescers with fiber bundles, are frequently associated with difficulties in separation as follows: 1) Oil separated using the sedimentation centrifuges face accumulating of protein-coated oil emulsion droplets, which are stable at ambient temperatures or lower. 2) The solvent extractions reduce the separation efficiencies due to protein surfactants. Moreover, hexane and acetone are extensively used even though they are known to be explosive materials. 3) As for the Coalescer with fiber bundles cannot be applied to putrefactive or liquid/solid mixtures.

a b

Separation of squid oil from the liver by a batch-laboratory equipment with the centrifugal effect of 10,000 at 0℃ (a:100% liver, b:50%). The separated oil form a layer (upper yellow layer in photograph) accumulated the emulsified oils that are coated with proteins.

Ambient-Temperature Fusible Filter (ATFF): Separation of emulsified-rapeseed oil using TME·$3H_2O$ filter layer

The important characteristics of filtration with an ATFF is that melting or solidification of the filter can be carried out at an ambient temperature, resulting in a simpler and more cost-efficient (running and capital) FF apparatus.

The characteristics of TME·$3H_2O$

	TME·$3H_2O$	Water
Solidification point ℃	30	0
Latent heat of solidification kJ/kg	218	335
Specific heat kJ/kg/℃	2.75 (10℃) 3.58 (50℃)	4.19 (0℃) 4.18 (50℃)
Density kg/m³	1,120 (10℃) 1,090 (50℃)	1,000 (0℃) 990 (50℃)

A: TME powder

B: Generation of TME·$3H_2O$ crystal masses by addition of water to TME powder

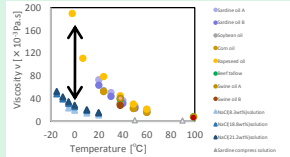
C: Dried TME·$3H_2O$ crystal masses. Drying was carried out at an ambient temperature (around 20℃).

D: Crushed TME·$3H_2O$ crystals make a filter layer

E: Formation of rapeseed oil emulsion by adding a protein surfactant (WPI) and 0.9wt% NaCl aqueous solution

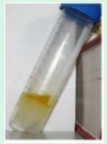
F: The inner cylinder containing the sieved crystal filter layer. The cylinder was placed inside the outer tube (the arrow indicates the height of the filter layer).

G: The state just after centrifugation for 5 min with centrifugal effect of 400 at 0℃. Note that the oil was captured in the upper layer of the filter, while the aqueous solution passed through the filter and into the triangular pyramid bottom of the outer tube. The difference of viscosity at low temperature was exploited.



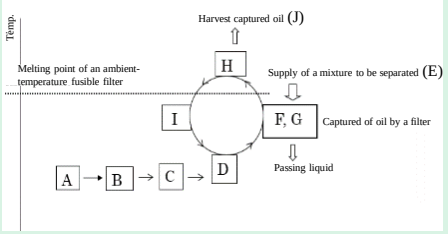
Viscosity differences of oils and aqueous solutions in bio materials

H: Separation of rapeseed oil and liquidized TME·$3H_2O$ due to the difference in specific gravity



I: The TME·$3H_2O$ was solidified at an ambient temperature (around 20℃).

J: Transparent oil was obtained (recovery rate: around 86%).



A proposal of separation process using a reusable ATFF. The capital alphabet indicates each step of the experiment.

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