Purification of Fermentation Products by Inorganic Membranes

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Hiroshi Hasegawa (Chem Eng. Nagoya Univ.)

Director, General Manager, Engineering Department, NGK FILTECH, LTD.

PURIFICATION OF FERMENTATION PRODUCTS BY INORGANIC MEMBRANES

HIROSHI HASEGAWA

ENGINEERING DEPARTMENT, NGK FILTECH, LTD.

2791, Hagizono, Chigasaki-city, Kanagawa, 253 JAPAN

ABSTRACT

The membrane separation process is being utilized to save energy in various fields such as the food, biotechnology, chemical, enviromental fields.
Especially the use of ceramic membrane among various inorganic membranes is expected to expand to their excellent thermal, chemical and mechanical resistance.
In this presentation, we would like to explain our ceramic membrane CEFILT MF for micro-filtration and CEFILT UF for ultra-filtration, and the purification of fermentation products as the application example using CEFILT MF.

1. CHARACTERISTICS OF CERAMIC MEMBRANE

CEFILT(R)-MF consists of a porous support layer and on active layer, 0.1 to 5 μm, and are made of Al_2O_3. Their shapes are tubular and monolithic.
CEFILT(R)-UF consists of a porous support layer and on active layer, MWCO *1 10,000 to 150,000. The support layer consists of Al_2O_3, the active layer consists of TiO_2. Their shapes are monolithic.
The characteristics of CEFILT(R)-MF,UF are shown in Table 1.

TABLE 1. CHARACTERISTICS OF CEFILT(R)-MF,UF

	CEFILT(R)-MF		CEFILT(R)-UF
	Tubular	Monolithic	Monolithic
Pore size *2	0.1, 0.2, 0.5, 1.0 2.0, 5.0 μm	0.1, 0.2, 0.5, 1.0 2.0 μm	MWCO (10,000) 20,000 50,000 150,000
Material support layer active layer	 $\alpha-Al_2O_3$ $\alpha-Al_2O_3$	 $\alpha-Al_2O_3$ $\alpha-Al_2O_3$	 $\alpha-Al_2O_3$ TiO_2
Diameter (mm)	ϕ10 × ϕ7, ϕ30 × ϕ22	ϕ4 ×19 holes ϕ3 ×37 holes	ϕ4 ×19 holes
Length (mm)	max. 1,000	max. 1,000	max. 1,000
Bursting pressure	ϕ10 : 60 kgf/cm^2 ϕ30 : 30 kgf/cm^2	100 kgf/cm^2	100 kgf/cm^2
Operating pH	0 ~ 14	0 ~ 14	0 ~ 14
Solvent	Full resistance	Full resistance	Full resistance
Steam sterilization	121 °C	121 °C	121 °C

* 1 : MWCO ; molecular weight cut off
* 2 : CEFILT(R)-MF ; measured by Hg-porosity-meter
CEFILT(R)-UF ; measured by BET

Main Advantages of Ceramic Membranes

- Steam sterilization at 121 ℃
- High corrosion resistance
  Can withstand clearing by strong chemicals.
- Mechanical resistance
  Can withstand high pressure and high shear filtration (high feed velocity).
  Pore size unchanged by creep or compaction.
- Filtering accuracy
  Good separation thanks to sharp and uniform pore distribution.

Figure 1. and 2. shows pure water flux at 25 ℃. Figure 3. shows pore size distribution of CEFILT(R)-MF and Figure 4. shows property of MWCO by CEFILT(R)-UF.

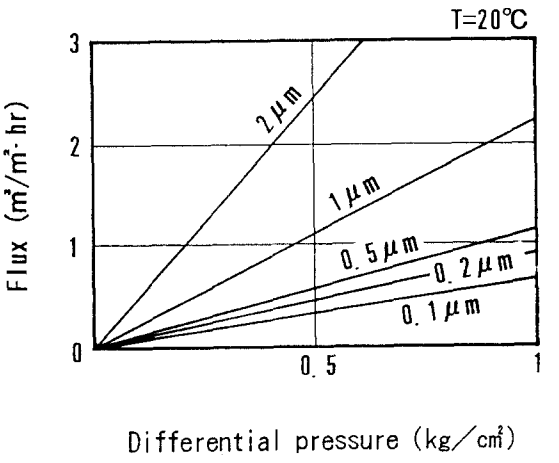


Fig 1. pure water flux of CEFILT(R)-MF

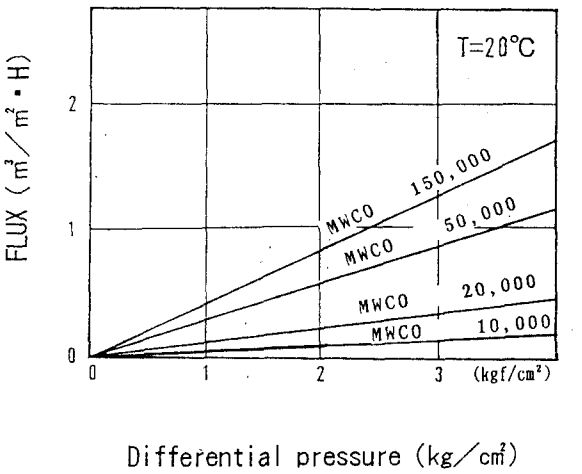


Fig 2. pure water flux of CEFILT(R)-UF

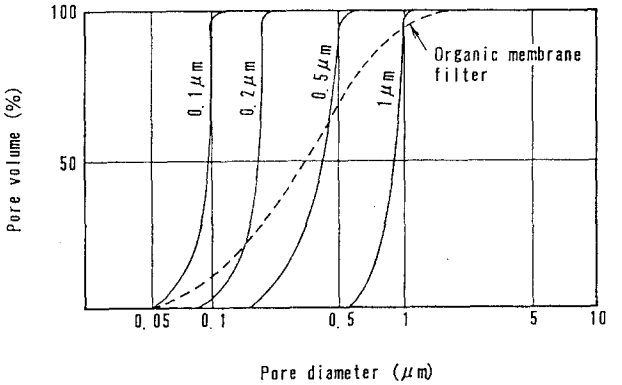


Fig 3. pore size distribution of CEFILT(R)-MF

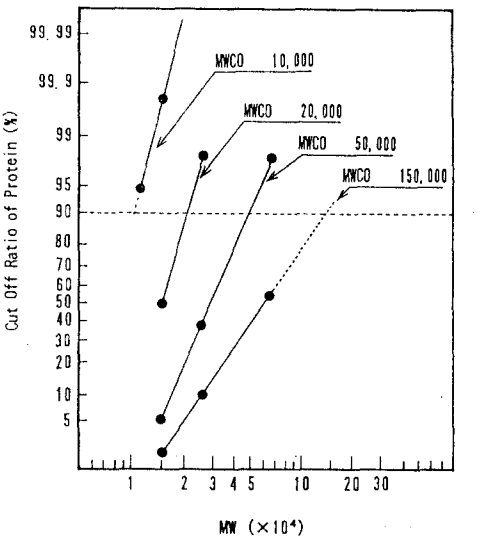


Fig 4. property of MWCO by CEFILT(R)-UF

2. APPLICATION OF CEFILT(R)-MF,UF

Table 2. shows industrial application of CEFILT(R), examples of typical applications each field.
In foods industries, CEFILT(R) are used mainly for removal of bacteria as final check filtration before bottling.
In Bio-industries, CEFILT(R) are used mainly for replace centrifugal or pre-coat filtration system.

TABLE 2. INDUSTRIAL APPLICATION OF CEFILT(R)-MF,UF

	Field	Application	Products and Processes
CEFILT-MF	Foods	Purification (Removal of bacteria)	• Wine, Sake, Lactic drink • Vinegar, Soy sauce, Drinking water
	Bio-industry	Purification Concentration	• Antibiotics, Vitamins, Enzymes • Every kinds of fermentation products • Water used for fermentation
	Chemical	Purification Concentration	• Process fluids (ex.H_2SO_4) • Recovery of catalysts • Functional polymers
	Mechanical	Purification	• Regeneration of machining fluids
	Electronics	Purification	• Prefiltering before UF and RO
CEFILT-UF	Foods	Purification Concentration	• Food proteins • Fruit juice (ex.Apple, Pears) • Animal blood proteins
	Bio-industry	Purification Concentration	• Lactic ferments • Fermentation broths (ex.Enzymes)
	Chemical	Concentration	• Colloidal silica • fine particle of polymer • fine particle of inorganic slurry

3. PURIFICATION EXAMPLE OF FERMENTATION PRODUCTS

Figure 5. shows relation between pore size and flux at pH 3 and pH 7.
In case of biomass separation at antibiotic broth, 0.1 μm is best pore size. As regards the difference of flux between pH 3 and pH 7, we are presuming effect of aggregation of suspended solid.
Usually, actual treated liquid has suspended solid, and resistance for filtrate depends on gel layer of suspended solid. so, we think flux is approximately the same.

Figure 6. shows influence of flux by linear velocity and trans membrane pressure.
As regards this broth, in case of linear velocity 5m/s, flux increase up to 3kgf/cm^2.
But in case of linear velocity 3m/s, flux is not dependent on trans membrane pressure.
However these behavior is different for each kinds of broth.

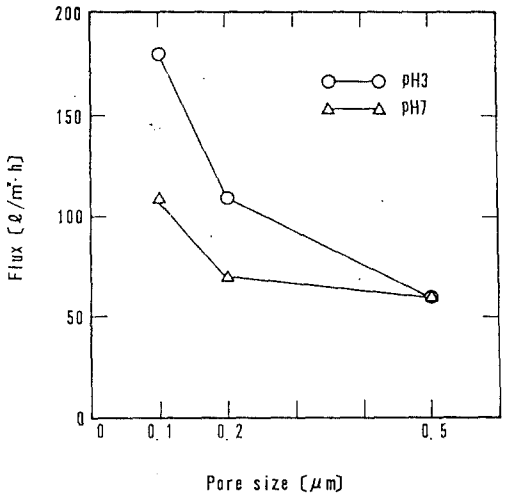


Fig 5. relation between pore size and flux at pH 3 and pH 7.

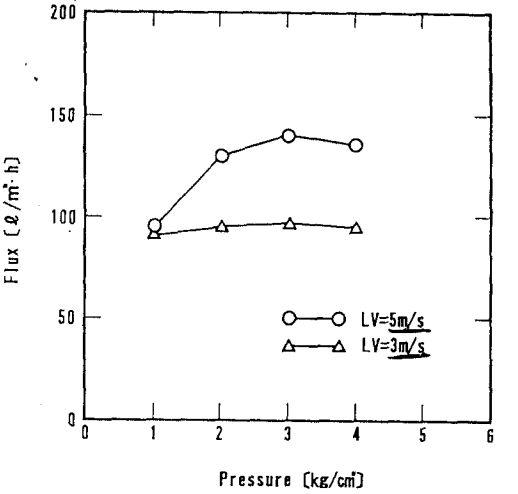
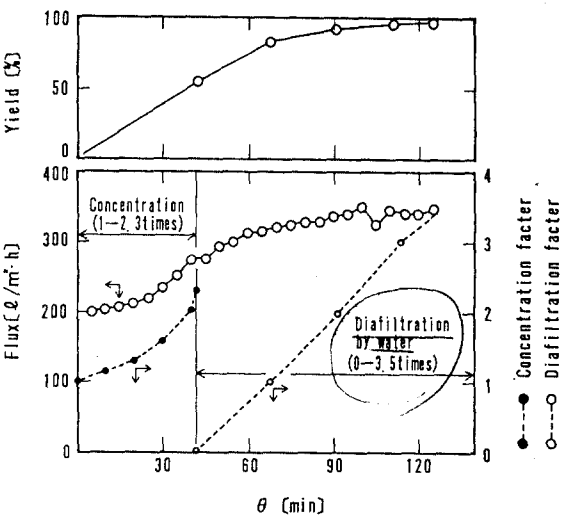


Fig 6. influence of flux by linear velocity and trans membrane pressure

Figure 7. shows flux of vitamin broth. This broth is concentrated to 2.3 times and is dia-filtrated by water to 3.5 times. This flux is very higher than general broth filtration and the yield of purified fermentation products is very high of 99%. This application is lower running cost than pre-coat filtration.

CONCLUSION

Ceramic membrane is a relatively new membrane media and the number of operating equipments are small in comparison of equipments with organic membrane. However, because of the outstanding chemical resistance and mechanical strength, it is expected that the increase application ceramic membrane will progress fast in separation and refining fields in which organic membranes can not be applied in pre-coat filtration, and in centrifugal.



Raw solution	: Broth (Type C)
Pore size	: CEFILT 0.1μm
Biomass concentration	: 20g/ℓ
Linear velocity	: 5m/s
Pressure	: 1kg/cm²
Temperature	: 65℃
pH	: 5.6

Fig 7. flux of vitamin broth

LITERATURE

1) H. HASEGAWA : Bio-industry 7. P.52 (1990)
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