ICOM2023 Makuhari Messe, Chiba, Japan

Prof. Shoji Kimura memorial Session

2023.07.12

In Memory of Professor Shoji Kimura

Shin-ichi Nakao

Professor Emeritus, The University of Tokyo

Professor Emeritus, Kogakuin University

Professor Shoji Kimura

Passed away: May 21, 2020, Age 85

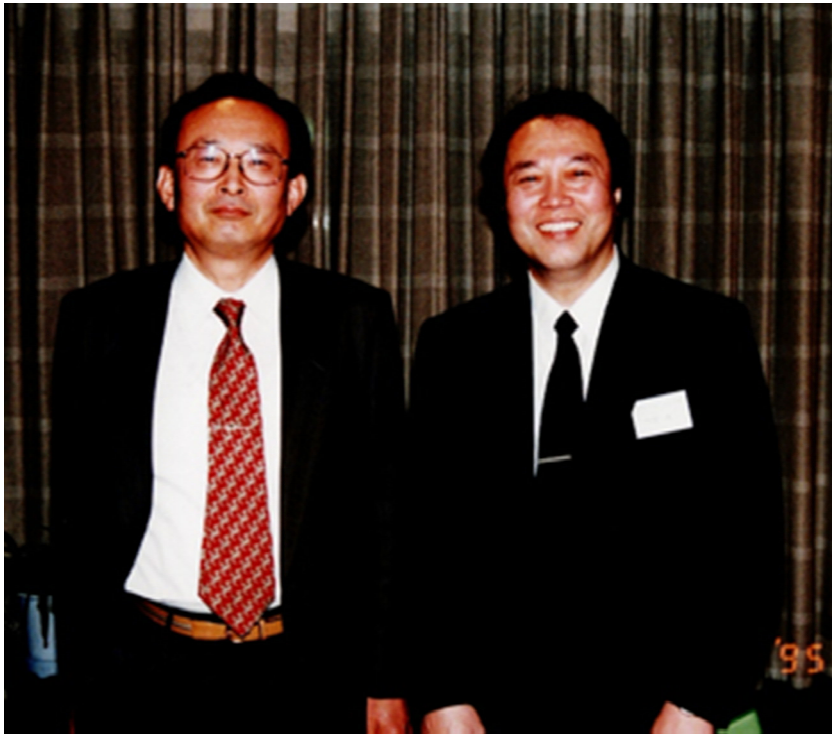
Biography

Birthday: 11 June, 1934
Birth place: Dalian, China

Before WWII: Back to Kanazawa
(his fater's home town)

1957, May: BE from the Univ. of Tokyo
Faculty of Eng., Dept. of Appl. Chem.,
Chem. Eng. course

1962, Mar. : DE from the University of Tokyo
Apr. : Research Asistant
1964, Jul. : Lecture
1965, Nov. : Post Doc. Fellow
National Research Council, Ottawa
Dr. S. Sourirajian Lab.
1967, Dec. : Retuned to the University of Tokyo
1968, May : Associate Professor
1978, Apr. : Professor at Inst. of Ind. Sci. UT
1986, Apr. : Professor at School of Eng,, UT
1995, Mar. : Retirement of UT
May : Professor Emeritus



At retirement party, March 5, 1995

1995, Apr, : Professor of Osaka University
1998, Mar..: Retirement
1998, Apr. : Professor of Kogakuin University
2002, Mar. : Retirement

2020, 21, May : Passed away at the age of 85

He worked on membranes from 1965 to 2002 for 37 years. He trained many membrane researchers and engineers.

Society Activities

1978, Jan. : Establishment of The Membrane Society of Japan

1984, Jun. : Europe-Japan Congress on Membranes and membrane processes, Stresa, Italy


EUROPE - JAPAN
congress on
MEMBRANES AND MEMBRANE PROCESSES
JUNE 18 - 22, 1984 - STRESA, ITALY

Society Activities

1978, Jan. : Establishment of The Membrane Society of Japan

1984, Jun. : Europe-Japan Congress on Membranes and membrane processes, Stresa, Italy

1987, Jun. : ICOM, Tokyo
Chair of the executive committee

1996, Aug. : ICOM, Yokohama
Chair of the organizing committee

Society Activities

1987, Jun.-1992, Jun.

President of The Society of Sea water Science, Japan

1989, Jun.-1993, May

President of The Membrane Society of Japan

1994, Apr.-1995, Mar.

Vice President of The Society of Chemical Engineers, Japan

Awards

1979, Jun. : Academic award of The Society of Sea Water Science, Japan

1993, May : Minister of International Trade and Industry Award

1993, Nov. : International Desalination Association (IDA) President Award

1994, Apr. : The Society of Chemical Engineers, Japan Award

2019, Nov. : The Order of the Sacred Treasure, Gold Rays with Neck Ribbon

Scientific Achievements

AIChE Journal Vol. 13, No. 3 May, 1967 Page 497—503

Analysis of Data in Reverse Osmosis with Porous Cellulose Acetate Membranes Used

SHOJI KIMURA and S. SOURIRAJAN
National Research Council, Ottawa, Canada

- Transport equations
- Concentration Polarization equation

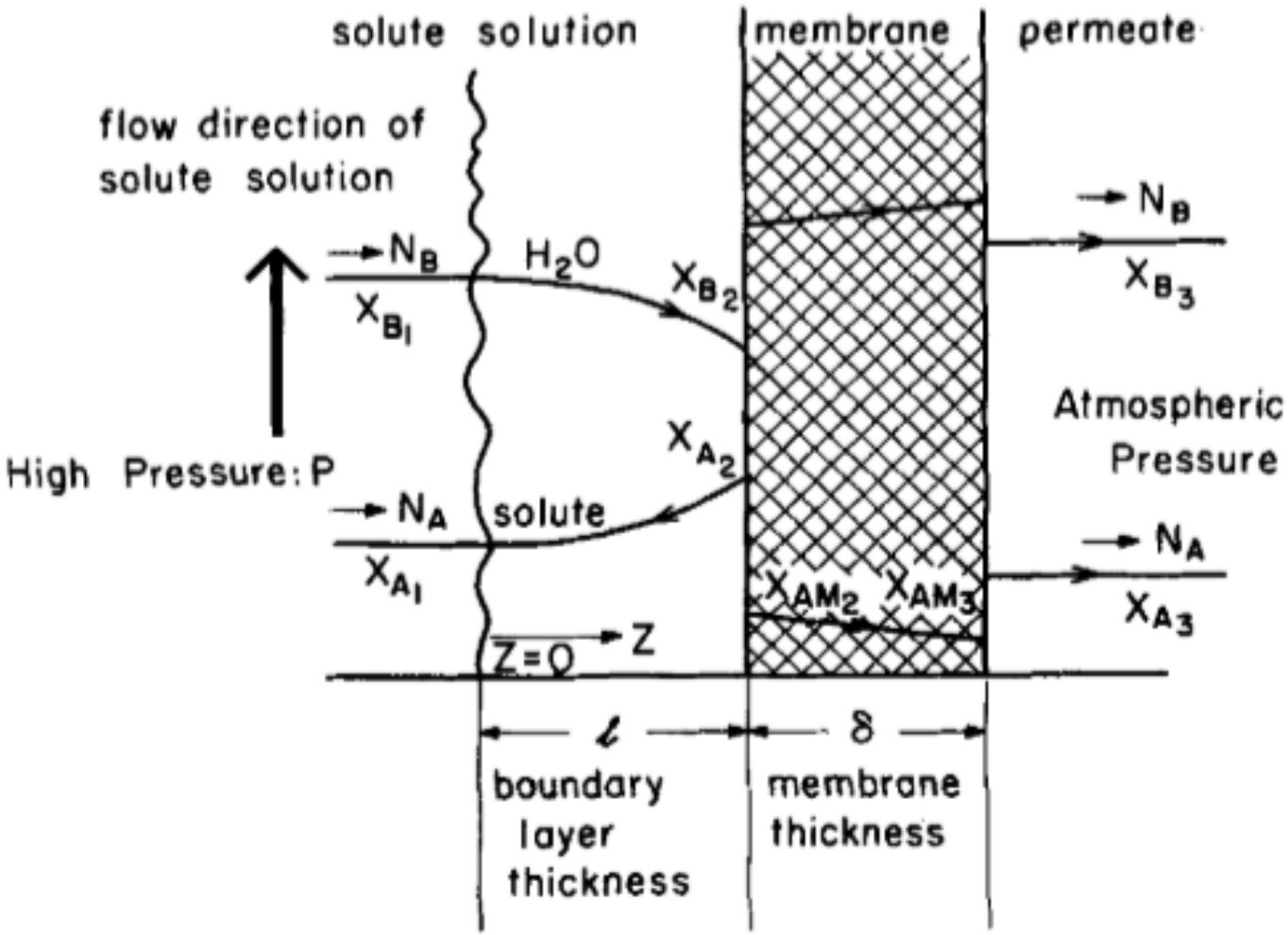


Fig. 1. Concentration distribution in the boundary layer and the membrane.

Pure water flux

$$N_B = A[P - \{\pi(X_{A2}) - \pi(X_{A3})\}]$$

Solute permeation flux

$$N_A = \frac{cD_{AM}}{K\delta}(X_{AM2} - X_{AM3})$$

Concentration polarization equation

$$\ln\left(\frac{X_{A2}-X_{A3}}{X_{A1}-X_{A3}}\right) = \frac{1}{ck}(N_A + N_B)$$

$$\text{where} \quad k = \frac{D_{AB}}{\ell}$$

X : mole fraction

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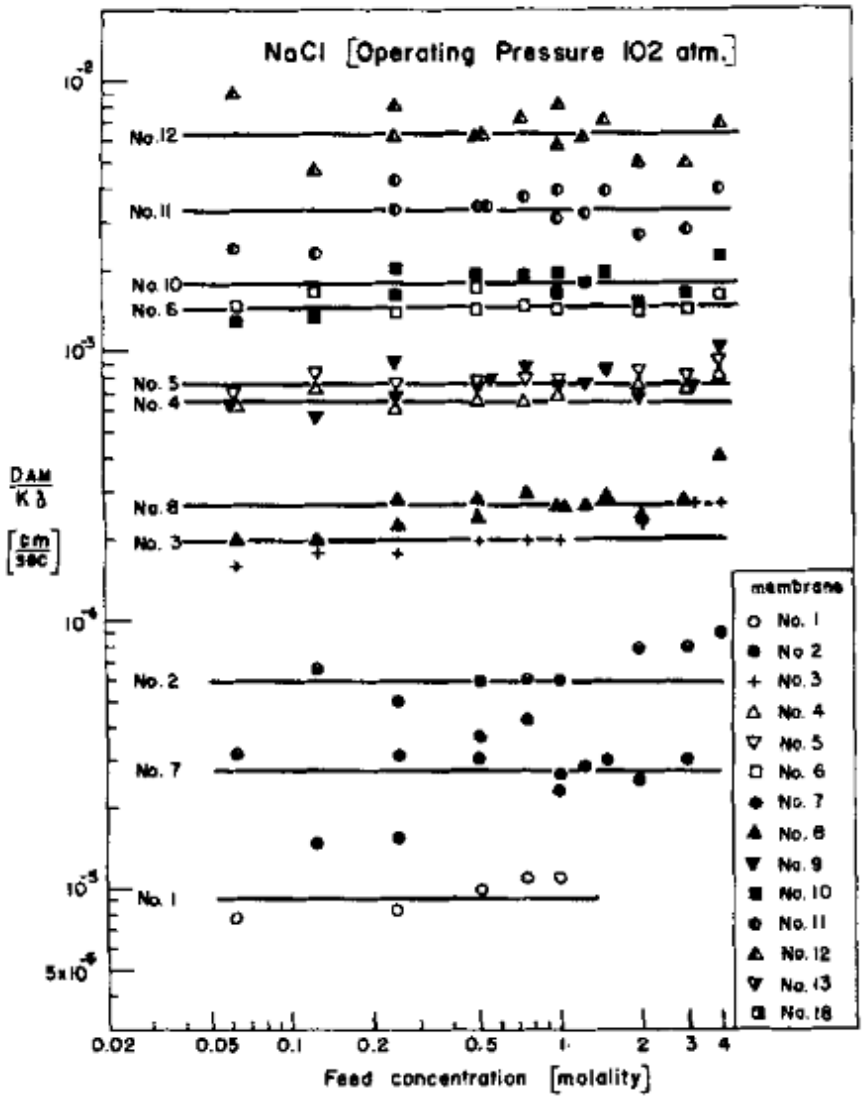
NaCl



$NaNO_3$

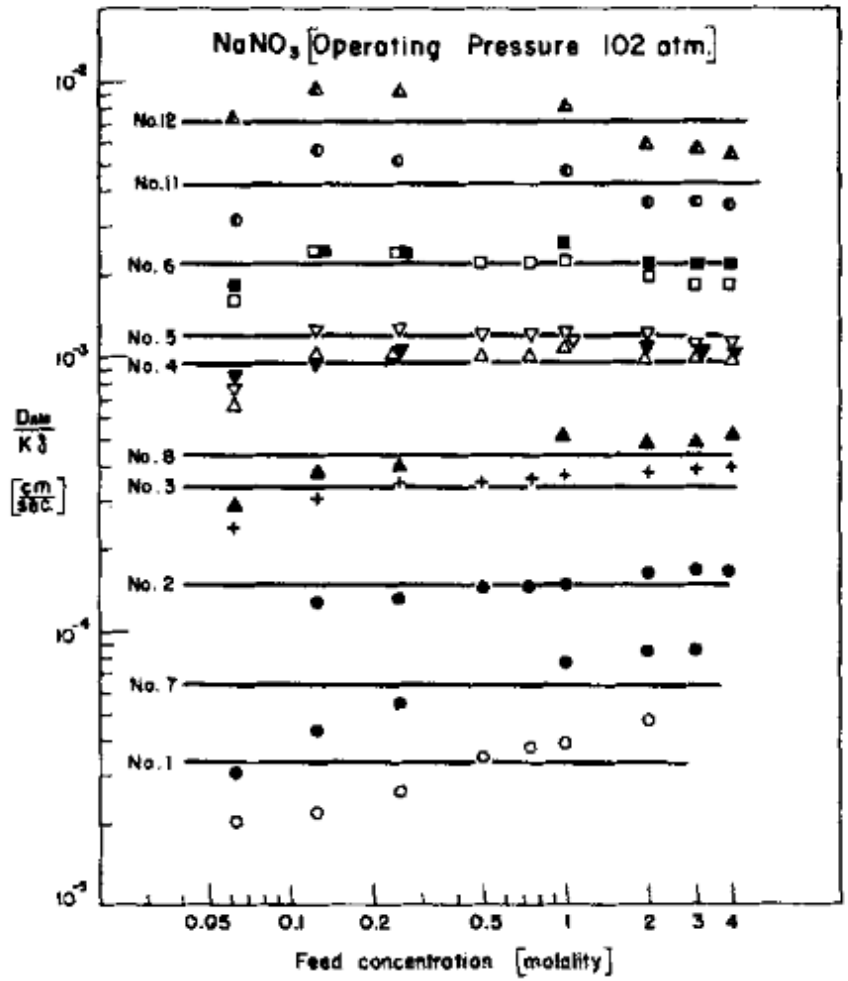


Fig. 2. Values of $D_{AM}/K\delta$ for different membranes for different solutes.

Current transport equations and concentration polarization equation

Pure water flux

$$J_v = A[\Delta P - \{\pi(C_2) - \pi(C_3)\}]$$

Solute permeation flux

$$J_s = B(C_2 - C_3)$$

Concentration polarization equation

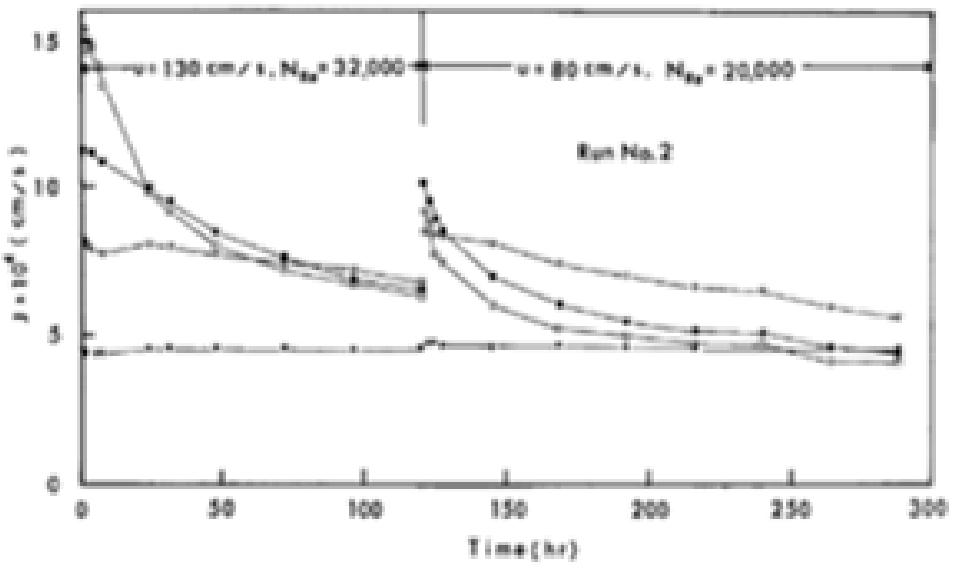
$$J_v = k \ln\left(\frac{C_2 - C_3}{C_1 - C_3}\right)$$

C : mole concentration

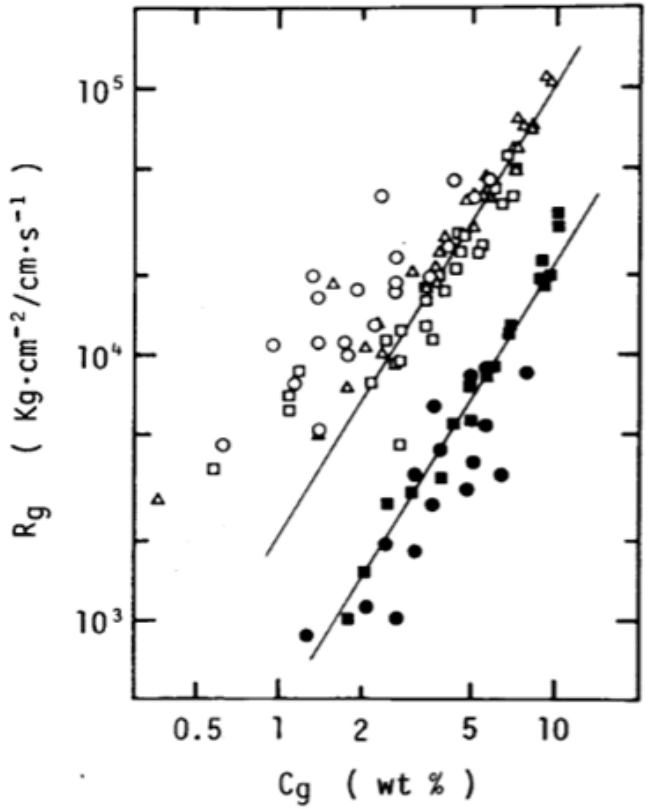
Scientific Achievements

- Analysis of fouling phenomena

$$J_v = k \ln \frac{C_g}{C_b}$$



S. Kimura and S. Nakao, *Desalination*, **12**(1975)267



S. Nakao, T. Nomura and S. Kimura, *AIChE J.*, **25**(1979)615

Scientific Achievements

- Transport equations and Concentration polarization equation for UF

$$J_v = L_p(\Delta P - \sigma \Delta \pi)$$

$$R = \frac{\sigma(1-F)}{1-\sigma F} \qquad where\ \ F = exp\frac{-(1-\sigma)J_v}{P}$$

$$J_v = k \ln\left(\frac{C_2 - C_3}{C_1 - C_3}\right)$$

S. Nakao and S. Kimura, *J. Chem. Eng. Japan*, **14**(1981)32

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S. Nakao and S. Kimura, *J. Chem. Eng. Japan*, **14**(1981)32

Scientific Achievements

- Pore flow model for UF
  (Determination of pore structure)

$$J_s = DS_D \frac{A_k}{\Delta x}\left(C_m - C_p\right) + J_v \bar{C} S_F$$

$$S_D = (1-q)^2$$

$$S_F = 2(1-q)^2 - (1-q)^4$$

$$\sigma = 1 - S_F\left\{1 + \left({}^{16}/_{9}\right) q^2\right\}$$

$$P = DS_D \frac{A_k}{\Delta x}$$

$$q = \frac{r_s}{r_p}$$

S. Nakao and S. Kimura, *J. Chem. Eng. Japan*, **15**(1982)200

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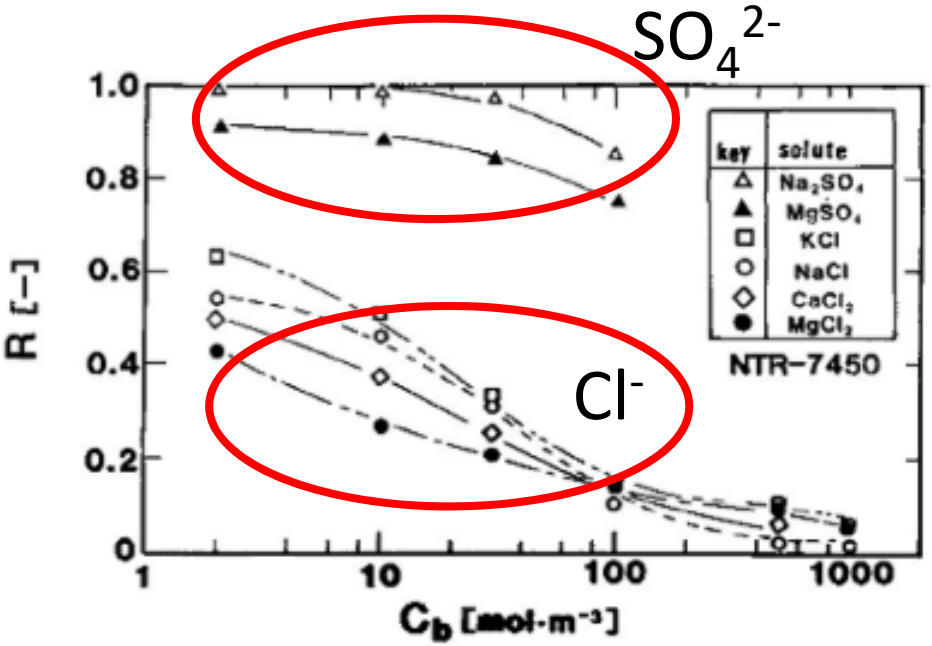
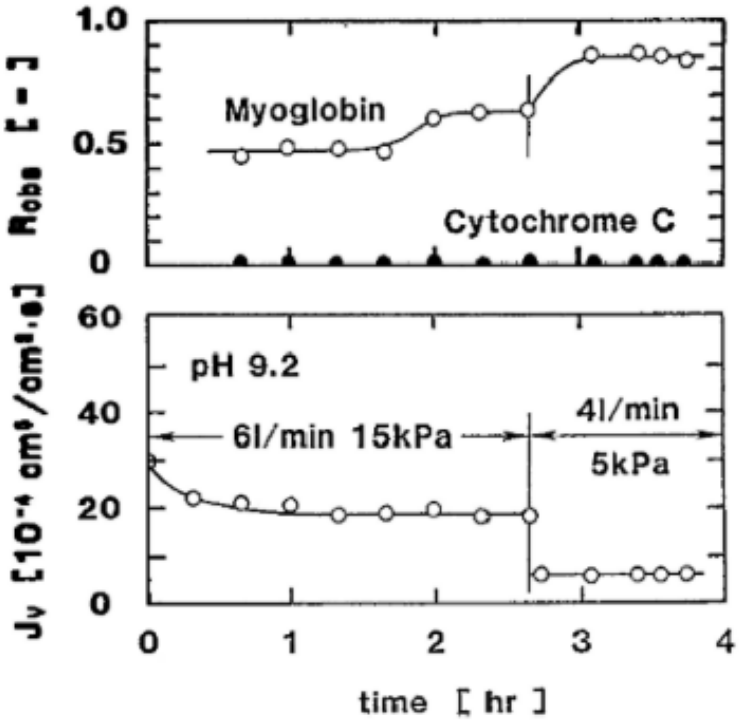
S. Nakao and S. Kimura, *J. Chem. Eng. Japan*, **15**(1982)200

Scientific Achievements

- Development of negatively and positively charged membranes and transport equations



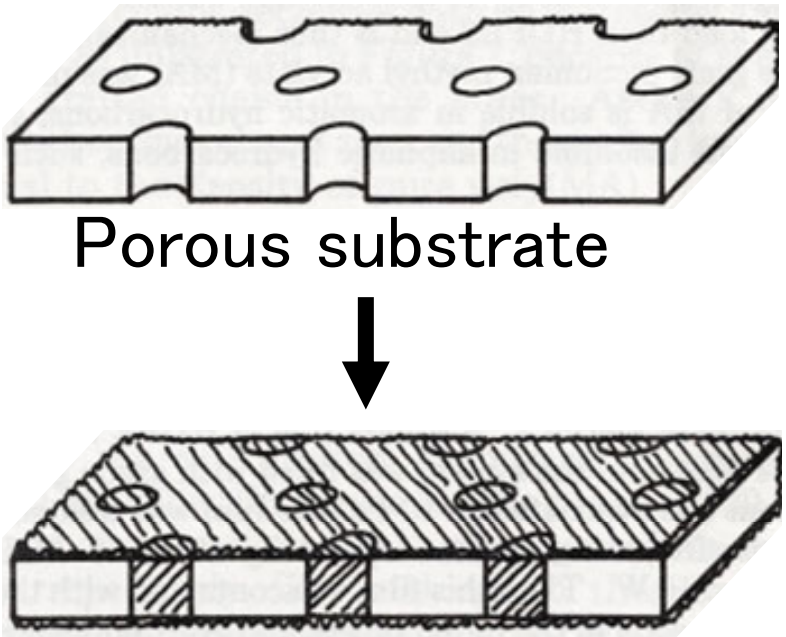


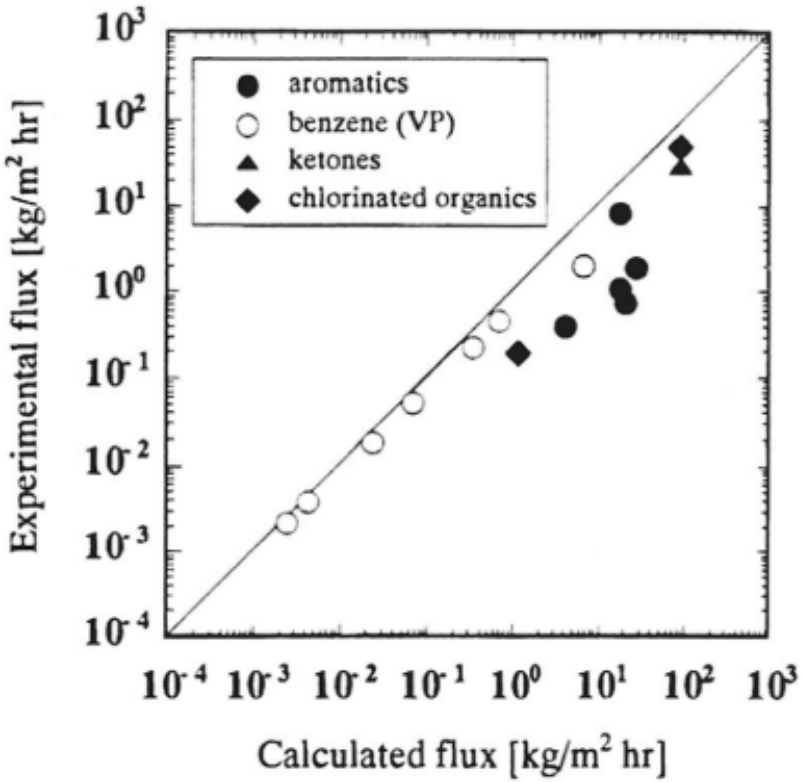
T. Tsuru, S. Nakao, S. Kimura, *J. Chem. Eng. Japan*, 24(1991)511

S. Nakao, H. Osada, H. Kurata, T. Tsuru, S. Kimura, *Desalination.* **70**(1988)191

Scientific Achievements

- Development of plasma graft filling polymerized membranes





Yamaguchi T, Nakao S, Kimura S : Macromolecules, **24**, 5522 (1991)

Yamaguchi T, Miyazaki Y, Nakao S, Tsuru T, Kimura S : I & EC Research, **37**, 177 (1998)

Professor Kimura's Family

Universities

Shin-ichi Nakao (U. Tokyo, retired)
Toshinori Tsuru (Hiroshima U.)
Xiao-Lin Wang (Tsinghua U.)
Takeo Yamaguchi (Tokyo Inst. Tech.)
Mikihiro Nomura (Shibaura Inst. Tech.)
Shigetoshi Ichimura (Kanagawa Inst. Tech.)
Izumi Kumakiri (Yamaguchi U.)

Research Institute

Teruhiko Kai (RITE)

Professor Kimura's Family

Companies

- Hideo Iwahashi (MHI, retired)
- Motohiro Okazaki (Toray, retired)
- Takahiro Kawakatsu (Kurita)
- Masahide Taniguchi (Toray)
- Toshitaka Tanaka (Toyobo)

Professor Kimura was the father of Membrane Research in Japan, and in the world.

We appreciate his great contribution for the Membrane Research.

We pray from the bottom of our heart that Professor Kimura rests in peace.