

초청강연 II

RECENT DEVELOPMENTS OF MEMBRANE TECHNOLOGY IN JAPAN

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The first membrane technology applied in the Japanese industry was an electro-dialysis(ED) process using ion-exchange membranes. These membranes were first developed in early 50ties and the Japanese government decided to use this method for concentration of sea water to produce salt, which was then produced by solar evaporation. This development program started from 1960 by the Japan monopoly Coop.(at that time). To apply ED process for sea-water concentration it was necessary to develop ion-exchange membranes having very low electric resistance to avoid energy loss due to Joule heat, and those having selectivity to permeate single valent ions only to avoid scale formation in the ED stacks. These Japanese companies, Asahi Glass, Asahi Chemical and Tokuyama Soda, have succeeded to develop such membranes, and until 1971 all of the seven salt manufacturing companies had adopted ED for production of food salt.

Application of RO for desalination of lake water to produce industrial water for a steel manufacturer(Sumitomo Metal Ind.) at Kashima area started in 1971 using UOP's spiral modules. The initial size was 1,000 m³/day and eventually expanded to 13,400m³/day within 9 years¹⁾. Development of domestic modules were started from 1977 in the R & D project of energy saving desalination technology(RO) conducted by WRPC. Modules that could desalt sea-water by a single stage were manufactured by Toyobo using hollow CA fiber, called Hollosep, and by Toray using spiral PEC-1000 composite membrane. Both modules had been tested in 800 m³/day unit located at Chigasaki^{2,3)}. This result led to produce one of the largest sea-water desalination unit in Saudi Arabia.

Recently in Japan the largest market of RO is pure water production for IC industry and for this purpose various low pressure membranes have been developed. Demands for qualities of ultrapure water are getting harder and harder, and following requirements are given from IC manufacturers.

- 1) Rejection of organic compounds should be large.
- 2) No dissolved substances from membranes and modules.
- 3) Sterilization by hydrogen peroxide can be applied.
- 4) Operation pressure should be low.

Recent developments of various RO and UF membranes in Japan are surveyed in the literature^{4,5)}.

These low pressure RO membranes have also been used for R & D project of water recovery from municipal sewage effluents, which are other large water resources than the sea-water in water shortage areas and seasons. After testing various treatment schemes including UF and RO, WRPC selected low pressure hollow fiber and spiral modules and they had been tested combined with pretreatments, such as coagulation, sedimentation dual-media filtration, pH adjustment and safety filtration. Six years results show that these schemes can work steadily by adopting once-a-month chemical washing, and water cost estimate is lower than 100 yen/m³.

Another water re-use system is now being developed., and is called. Aqua-Renaissance '90. This is a six year R & D project for water re-use and energy recovery supported by MITI. The objective is to develop low cost treatment processes utilizing bioreactors coupled with membrane separation unit to produce reusable water from industrial effluents and sewage.

Polymeric and ceramic membranes in capillary, hollow fiber, tubular and plate and frame modules have been tested in conjunction with bioreactors on a number of actual waste water and sewage streams. The total scheme and target is given in the literature⁶⁾.

Jisedai is also MITI project and the objective is to develop basic technologies for future industries, such as new materials, biotechnology and electronic devices. The development of synthetic membranes for new separation technology is one of them. It's 10 years project will be terminated in 1990. Among various permselective membranes developed in this project, two pervaporation membranes that have very large separation factor for water permeation in ethanol-water system have been developed, and they are now transferred to another MITI project for alcohol dehydration. Here hollow fiber modules are now being developed and tested.

C1 chemistry is a project to develop technology to use CO and H₂ as starting material to synthesize various hydrocarbons, such as ethylene and ethanol. Here membranes separating CO and H₂ were developed. One of them is a polyamide membrane developed by Ube Ind. and now being commercialized. A similar project is now under planning stage. Is is a CO₂ conversion project to reduce CO₂ emission to the atmosphere and separating membranes and conversing catalysts will be sought.

Applications of membranes technologies for food industries have been important subject also in Japan, R & D projects had been organized by the Japan Food Industry Center under the Ministry of Agriculture and Fishery. But speed of development was rather slow, because enough information of membranes was not given to food manufacturers, while membrane manufacturers could not understand real demands for membrane qualities in food industries. To solve this problem a union of R & D of membranes technology

for food processing was organized and 18 pairs of membrane and food manufacturing co. engaged to work on each subject relating various food processing, and exchange their information on behaviors of membranes and modules. This union lasted for six years and now expanded to a "Membrane Research Circle for Food Technology", consisting about 100 people.

Regarding water for medical and pharmaceutical industries, RO, UF and MF membranes have been used for pure water production, which was also encouraged by the Ministry of Public Health and Welfare to reduce energy consumption. But it was not permitted to use them for water for injection. To study this problem the Ass. of R & D of Poly. Memb. for Medical Appl. started to work with the ministry and established validation methods. Following these lines the Japan Pharmacopoeia was revised and water treated by membranes could be used for injection.

During these discussions the Japanese Industrial Standard(JIS) was considered to be established and now membrane manufacturers, various users and neutral scientists and engineers are working together for this purpose.

References

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