The seawater pretreatment facilities for electrodialysis at sanuki salt manufacturing co., Ltd

Kazuyuki Takashima[a], Shigeo Futaki[a], Fumio Hanada[b] and Mitsugu Yamamoto[b]

[a] Sanuki Salt Manufacturing Co., Ltd., Sakaide city, Kagawa, Japan

[b] Tokuyama Corporation Tokuyama City, Yamaguchi Japan

Sanuki Salt Manufacturing Co., Ltd., one of the users of Tokuyama's ion-exchange membrane salt production facilities, has been using advanced pretreatment facilities for the stable operation of the electrodialyzer. Attempts have repeatedly been made to improve the operation of the electrodialyzer and reduce the production cost.

1. Introduction

By introducing Tokuyama's ion-exchange membrane electrodialyzer system in 1973, Sanuki Salt Manufacturing Co. Ltd. is engaged in the production and the sales of salt obtained from concentrated seawater in the electrodialyzer brine process and the evaporating crystallization process.

The production cost of salt depends on the electric power consumption for the electrodialyzer and the density of electrodialyzer brine. The density of the produced electrodialyzer brine and the power consumption depend on the basic performance of the ion-exchange membrane. Although the unit cell type electrodialyzer had been used from the viewpoint of easy maintenance and control, it was switched over in 1976 to the large-size filter press type electrodialyzer of model TSW-200, which was superior in energy saving.

In 1986, the new type of ion-exchange membrane NEOSEPTA CIMS/ACS-3 (energy saving type) was introduced for the electrodialyzer, model TSX-200. To cope with increasing performance of the electrodialyzer, the distance between the membranes has been reduced to decrease the electric resistance of the membranes and to decrease the electric resistance of liquid.

For the purpose of supplying the raw seawater filtered by the pretreatment facilities to the electrodialyzers, operation condition has been established to secure stable quality.

This report deals with the seawater pretreatment system, its operation method and results for the filter press type electrodialyzers TSW-200 and TSX-200, in addition to the unit cell type electrodialyzer, adopted by Sanuki Salt Manufacturing Co.

2. Outline of seawater pretreatment facilities for filter press type electrodialyzer

Seven units of the TSX type electrodialyzer and a unit of TSW type electrodialyzer are installed in Sanuki Salt Manufacturing Co., annually producing 230,000 tons of salt.

Table 1 shows the characteristics of the seawater and of the pretreatment facilities for the electrodialyzers. To meet the technical improvement of the seawater pretreatment facilities, the filtered seawater is required to be cleaner.

Table 1. Seawater pretreatment facilities

System	Unit cell type	Filter press type TSW-200	Filter press type TSX-200
Pretreatment	Sand filter	Sand filter	Coagulating 2nd sand filter
Filter	1st sand filter	1st sand filter 2nd PW filter	1st sand filter 2nd sand filter
Filter cleaning method	Automatic cleaning	Part manual cleaning	Full automatic cleaning
Turbidity of Filtered seawater measured by light scattering photometry (ppm)	0.7	0.3	0.05
Electrodialyzer : Ion-exchange membrane Distance between membranes Electric power consumption ED. brine density	 A-10KS/C-10KS - 280 180	 ASC-2/CIM 0.75/0.5 200 190	 ACS-3/CIMS 0.4/0.4 155 195
Interval months between ion-membrane cleaning without assembly	2	4	84

Originally the 1st sand filter was used in the pretreatment facilities for the unit cell type electrodialyzer. However, the high turbidity in the filtered seawater, as well as the process of providing monovalent cation permselectivity to the cation ion-exchange membranes, resulted in frequent cleaning of the foul membrane surface, consequently requiring a large amount of manpower cost.

This called for introducing an advanced pretreatment technique, i.e. installation of a filter press type electrodialyzer and the reduction in electric power consumption by reducing the thickness of the seawater compartment.

In contrast to the old type TSW-200 electrodialyzer system which required partially manual cleaning, the present filter press type electrodialyzer TSX-200 system achieves full automatic cleaning, so that the cost for cleaning of the filter and the membrane has been decreased.

Furthermore, in the TSX-200 type system, introduction of monovalent cation permselective membranes and supply of cleaner filtered seawater has reduced the fouling on the membrane surfaces, thus dramatically decreasing the scale of trouble during operation. Together with periodical chemical cleaning, this has shortened the cleaning period without disassembly to approximately one fortieth of that of the previous 1st sand filter system.

3. Results of TSX-200 type electrodialyzer system and seawater pretreatment operation

This electrodialyzer system is comprised of the seawater pretreatment facilities to supply clear seawater to the electrodialyzer and the electrodialyzer facilities. A coagulating 2nd sand filter is adopted for fully automatic high-precision filtering. Fig. 1 shows the flow of the TSX-200 type of seawater pretreatment facilities. Table 2. shows its specification.

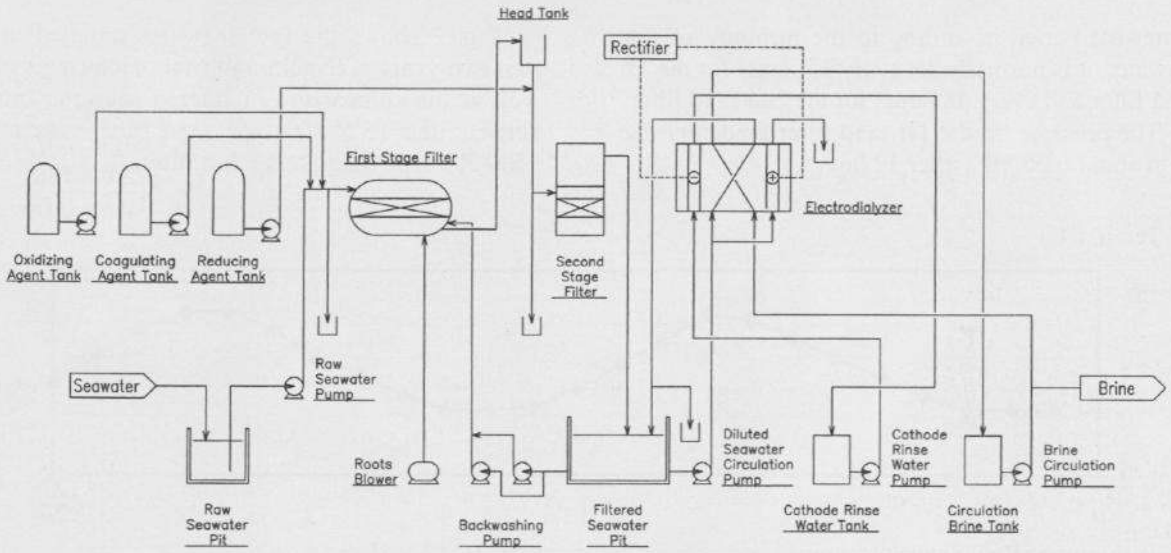

Figure 1. Flow diagram of the TSX-200 electrodialyzer system.

Table 2. TSX-200 Pretreatment Facilities

	1st Sand Filter		2nd Sand Filter
Type	Pressure type		Gravity type
Line Velocity (m/hr) Filtering Process Back Washing Process	14 ~ 16 30		14 ~ 16 40
Filtering Material	Filter Anthracite	Sand Filter	Sand Filter
Height (mm)	500	400	800
Particle Size Distribution (mm)	0.9	0.45	0.3
Uniformity Coefficient (-)	1.4	1.4	1.4
Turbidity (ppm)	0.1		0.05
Flow Rate (m^3/hr)	500 ~ 600		500 ~ 600
Facilities (Units)	7		7

In this system, the pumped up seawater is supplied with oxidizing agent and coagulating agent, before entering the 1st stage sand filter. The number of total fungi measured in seawater is decreased by adding chlorine for oxidization. Then, free chlorine is neutralized by the reducing agent. The supply conditions of those agents are varied according to the characteristics of the seawater by the seasonal changes.

The 1st sand filter, consisting of a 2-layer sand filter, i.e., anthracite and silica sand, entraps and removes nearly all of the turbidity. The 2nd sand filter entraps a very small amount of turbidity not removed by the 1st sand filter. The cleaning of the filter is accomplished by automatic back washing controlled by a timer. Precipitating separation tank separates the sludge discharged by back washing. Although the frequency of the back washing is

somewhat varied according to the turbidity of raw seawater, it is normally set every 12 hours for the 1st sand filter and every 48 hours for the 2nd sand filter.

The pressure on the 1st sand filter gradually rise up to about 0.06 MPa after 12 hours.

Fig. 2 shows the raw seawater sampled in the past two years at Sanuki Salt Manufacturing Co., as well as the comparison in filtered seawater quality between the TSW-200 type sand filter system and TSX-200 type coagulating 2nd filter.

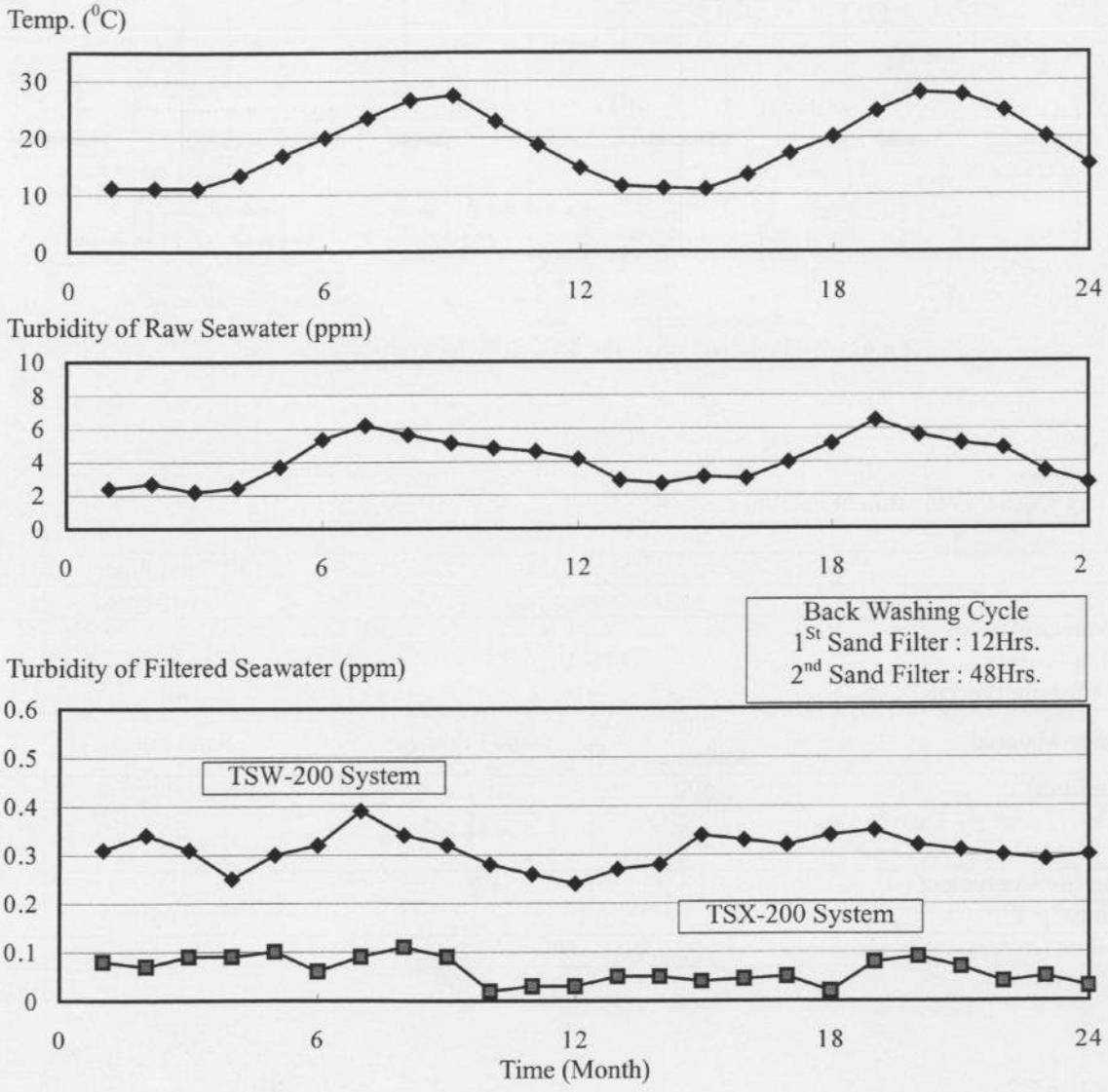

Figure 2. Performance of TSXεTSW Pretreatment System

The turbidity of the raw seawater rises in summer to approx. 7 ppm. The filtered water quality by TSW-200 type filter system is 0.3 ppm on the average. In the case of the TSX-200 type coagulating filter system, the amount of additives and the back washing are varied to achieve the filtered water quality of 0.05 ppm. Fig.3 shows the filtering performance by the TSX-200 coagulating 2nd filter, when the turbidity of raw seawater has increased to 10 – 25 ppm. The amount of oxidizing agent and coagulating agent was varied according to the increased turbidity of the raw seawater. The interval between the back washing was also shortened.

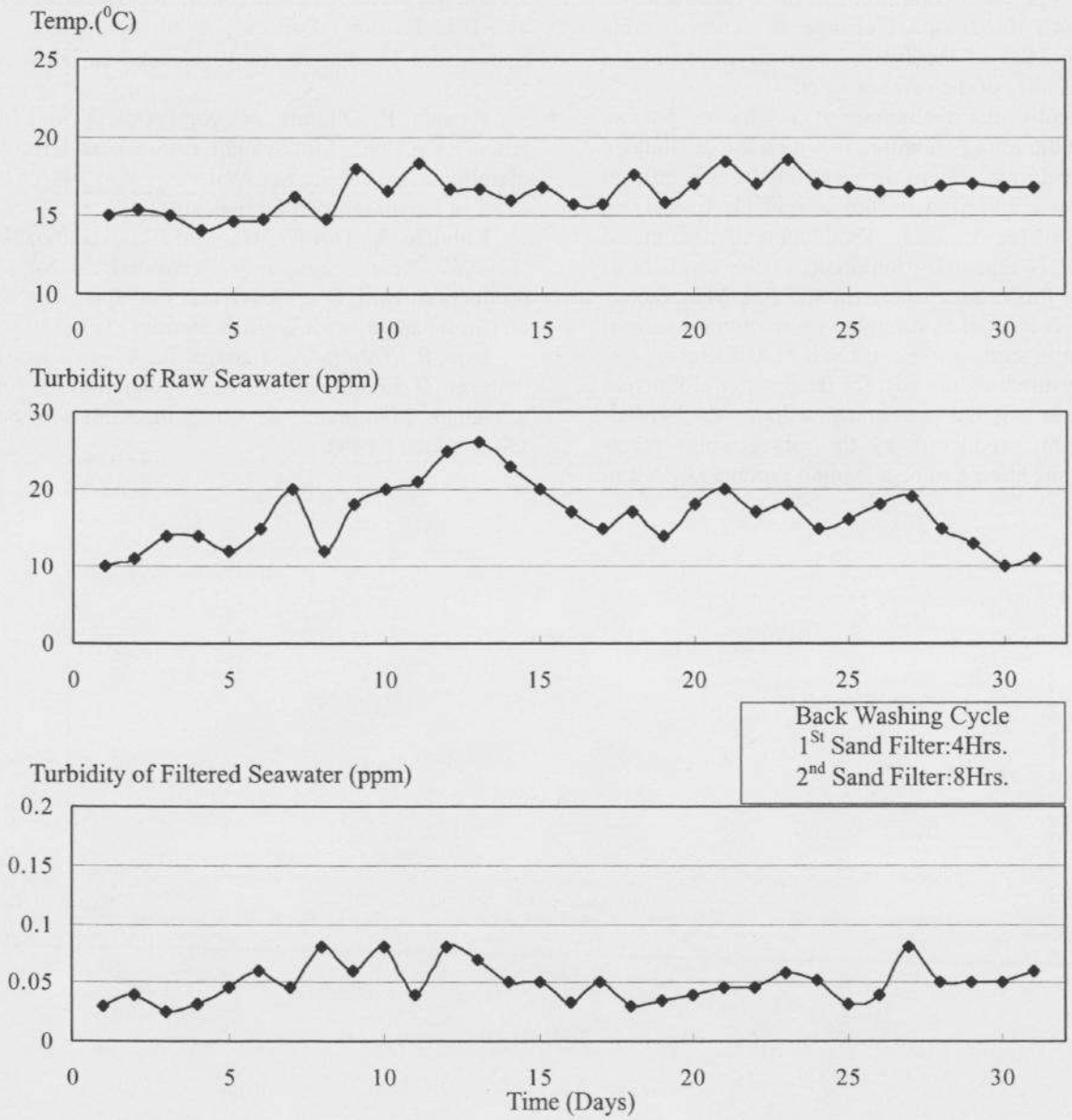

Figure 3. Performance of TSX Pretreatment System

4. Conclusions

Sanuki Salt Manufacturing Co. is operating the filtering facilities of raw seawater for seawater concentration by the ion-exchange membrane system. It is capable of filtering the raw seawater of turbidity 1 – 7 ppm to 0.05 ppm. The total seawater filtering capacity of the system is 3850 m^3/hour.

The operation condition has been established to cope with the seasonal change to achieve stable characteristics of the filtered seawater, even at the high turbidity of the raw seawater.

Recently the technique of producing potable water is attracting attention, in which the desalinated seawater coming out of the electrodialyzer is utilized for water conversion by the second electrodialyzer or the reverse osmosis. Production of desalinated seawater is especially important to the dwellers of Kagawa Prefecture, where Sanuki Salt Manufacturing Co. is located as drought is sometimes a serious problem in summer. Sanuki Salt Manufacturing Co. is now estimating the cost for fresh water production by reverse osmosis membrane, utilizing the byproduct of salt production by the ion-exchange membrane, thus hoping to be a leading producer of salt in Japan.

REFERENCES

Shimamura, T., Sakuma, M., Miyatake, N. and Yamano, M.,1990. Title Abstracts for presentation at the annual meeting of the Society of Sea Water Science, Japan 41 (in Japanese).

Tani, Y., Kobuchi, Y. and Terada, Y., 1985. The first salt plant in the Middle East using electrodialysis and ion exchange membranes. In : B.C. Schreiber and H.L. Harner (Editors), Sixth Symposium on Salt, Vol.α. The Salt Institute, Alexandria, USA. pp. 541-555.

Hanada, F., Ohmura, N., Kagiyama, Y. and Mizutani, Y., 1990. Monovalent cation permselective membrane. Bull. Soc. Sea Water Sci. Jpn., 44 : 116-118 (in Japanese, with English abstract).

Kobuchi, Y., Doi, K., Hanada, F. and Shinozuka, H., 1987. New technique of electrodialyzer for salt production. Bull. Soc. Sea Water Sci. Jpn., 41 : 47-50 (in Japanese, with English abstract).

Izuo, R., Tomita, A., Hanada, F., A New Electrodialyzer Technique for the Salt Production by Ion-Exchange Membrane, Seven Symposium on Salt Vol.α. 65-70 (1993)