New EDI system(The technology of decreasing operation voltage of EDI)

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EDI(Electro deionization)is environmentally attractive system to produce pure water, comparing with traditional ion-exchange method. Because EDI is operated with electricity and no chemicals for regenerating ion-exchangers. We have been developing original EDI system(GDI:Graft De-Ionization)with ion-exchangers synthesized by radiation induced graft polymerization process. Environmentally and economically, it is interesting to decrease the operation voltage of EDI. To decrease the operating voltage, we investigated the voltage of GDI and invented new structure of GDI in which decreasing of about 75% voltage is achieved.

Fig.1 shows the structure of conventional type GDI. Between electrode, anion permeable membranes and cation permeable membranes are positioned to separate the deionization compartment, the concentration compartment, and the electrode compartment. Each compartment is filled with non-woven fabrics and ion conductive spacer. Each ion-exchanger contacts with respective pole membrane intimately. Ions are transferred from deionization compartment to concentration compartment smoothly in the solid phase. The operating condition is current density of 13.0A/m^2, and feed water of 5L/h, which are pretreated with reverse osmosis.

Fig.2 illustrates the voltage profile in respective compartments operated with current density of 50.0A/m^2.To investigate the voltage profile, the deionization compartment is constructed with 19 pieces of anion conductive spacers and one non-woven fabric cation-exchanger. In the deionization compartment the voltage drop is very high. In deionization compartment, the voltage drop is especially high in the zone where cation-exchanger and anion-exchanger contacts with each other. In EDI each ion-exchangers is regenerated continuously with protons and hydroxide ions which are generated on the water splitting reaction between anion - exchanger and cation-exchanger. Water splitting reaction is considered as being promoted on the interface between anion-exchanger and cation-exchanger. The high voltage drop feeds the energy to this reaction.

Fig.3 shows the structure of new type GDI. On conventional GDI, current efficiency is less than 10%. This means 90% of protons and hydroxide ions generated on water splitting reaction are directly transferred to the concentration compartment without contribution to the regeneration of ion-exchanger. We have arranged the compartments and exchangers to regenerating the ion-exchanger effectively and to restricting the zone where water is split. The water splitting compartment is arranged to generate protons and hydroxide ions. Anion and cation deionization compartments are arranged to adsorb ions from water. The protons and hydroxide ions generated in water splitting compartment regenerate the ion-exchangers in each deionization compartment countercurrently.

Fig.4 illustrates the comparison of operation voltages between conventional GDI and new type GDI. The new type GDI arrangement allows a voltage decrease of 90Vcompared to the conventional system. This voltage was kept even after 700h of operation. The operation voltage of conventional GDI increased with elapsed time, and that of new type GDI was almost constant. We found that the ion-exchangers which have adsorbed ions rather than protons and hydroxide ions inhibit the water splitting reaction. The operation voltage do not increase on new type GDI, because the inlet water of the splitting compartment is almost deionized by passing through the “pre” deionization compartment.

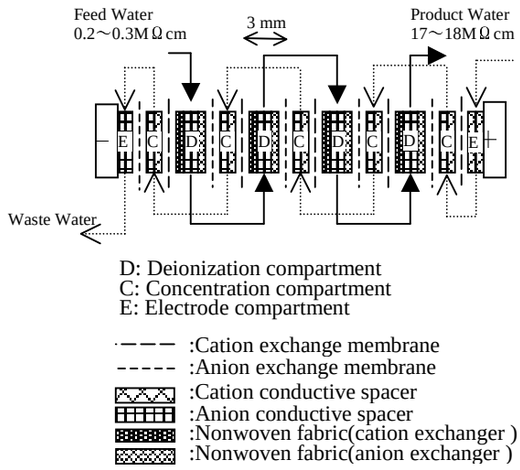

Fig.1 Conventional GDI (deionization system)

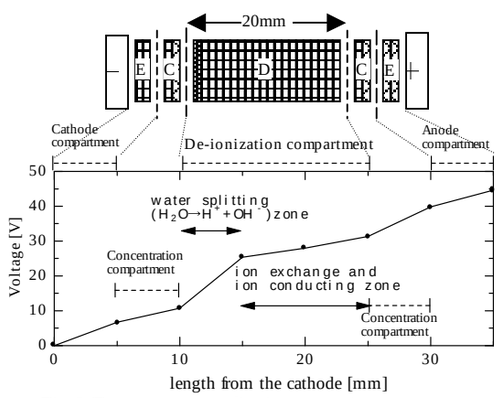

Fig.2 The voltage profile in respective cells

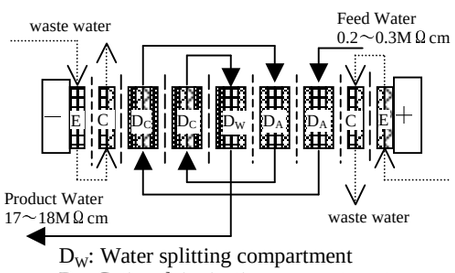

Fig.3 New type GDI construction

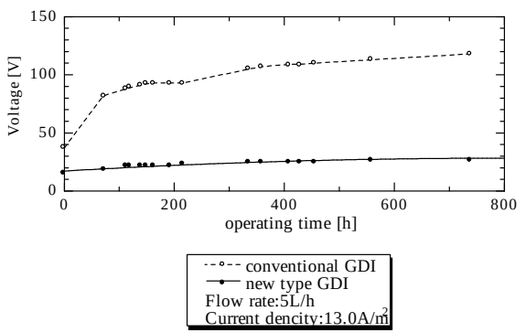

Fig.4 The operation voltage (conventional GDI and new type GDI)