Oxygen cathode using concentrated the carbon-PTFE dispersion by phase separation

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The electric power saving is necessary from the environmental problem for the chlor-alkali industry. One of the solutions is to use oxygen cathode for chlor-alkali membrane cell. The use of the oxygen cathode saves 1/3 of the power consumption of this process. Gas diffusion layer (GDL) of oxygen cathode for chlor-alkalri electrolysis cell was prepared by dispersion of carbon black and PTFE in water with nonionic surfactant such as Triton X-100(1). This dispersion has only 10 wt% solid composition. The much water must be removed in order to obtain the necessary film thickness. The water content wants to lower in order to improve the workability by simple method. Then, the cloud point of the surfactant property was noticed. It is well known to become hydrophobic property, when the surfactant is heated over the cloud point. The dispersion is separated to two phases of top and bottom. The upper part is thin, and the lower becomes thick. It is reported that the making process of the gas diffusion electrode using concentrated dispersion for oxygen cathode of the chlor-alkali electrolysis.

Triton X-100 (Octyl phenol ethoxylate) is used as a nonionic surfactant with 65.5 °C as the cloud point at 1 wt%. The carbon black is AB-6 (Denka Black, DENKIKAGAKU KOGYO, INC.), and polytetrafluoroethylene (PTFE) dispersion (Fluon AD911, ASAHI GLASS CO., LTD). The dispersions were contained with 7.8 wt% AB-6 and 5.2 wt% PTFE in water containing the 1~30 wt% nonionic surfactant.
The carbon black was mixed with pure water (milliQ, Millipore) containing Triton X-100. The dispersing carbon black mixed solution was dispersed a jet mill (Genus PY, GENUS Co., Ltd) at 100 MPa, and it is done 5 times. The particle size was measured in Fiber-Optics Particle Analyzer (FPAR 1000, Otsuka Electronics Co., Ltd). The average particle size of the carbon black in the dispersions was ca. 500nm. The temperature of the heat treatment are 65~85°C by 0.5 to 24hr in water bath with a temperature accuracy of +/- 0.1°C. After heat treatment, the separated interface height of dispersion was measured. The concentration of the concentrated dispersion and the concentration of the surfactant were measured from the specific gravity.

The water containing a few percent of Triton X-100 takes place 2 phases at upper 66 °C. In the 2 liquids region, it is divided into upper layer with the less concentrated region of Triton X-100 and lower layer with the more concentrated region of Triton X-100. The dispersion of carbon black and PTFE containing Triton X-100 was separated 2 liquids at upper temperature of the cloud point of Triton X-100 - H2O system. It is divided into upper layer with the less concentrated region of the total solid (carbon black and PTFE) and lower layer with the more concentrated region of the total solid. Many results were separated to dilute phase and thick phase. On certain conditions, the upper layer became a clear phase. Figure 1 shows an image of separated dispersions. Figure 2, 3 show separation rate of the dispersion containing various percent of Triton X-100 at 67.0°C and 69.0 °C. The separation rate depends on heat treatment temperature and concentration of Triton X-100 in the dispersion. The separation rate is dependent on the concentration of Triton X-100. It was the most quickly separated at 7 % TR dispersion. It proves that concentration dispersion with the solid (carbon black and PTFE) over 42 wt% was possible. The concentrated dispersion was diluted at original concentration again, and then, the particle size was measured. It was almost equal to the particle size before and after heat treatment.

A gas diffusion electrode was made using this concentrated dispersion with carbon cloth by application method. The gas diffusion electrode can be operated as oxygen cathode for chlor-alkali electrolysis.

1. N. Furuya, H. Aikawa, Electrochimica Acta 45 4251-4256 (2000)

Fig.1 Photo image after heat treatment of various concentration of Triton X-100 at 70°C. After 15 hr.

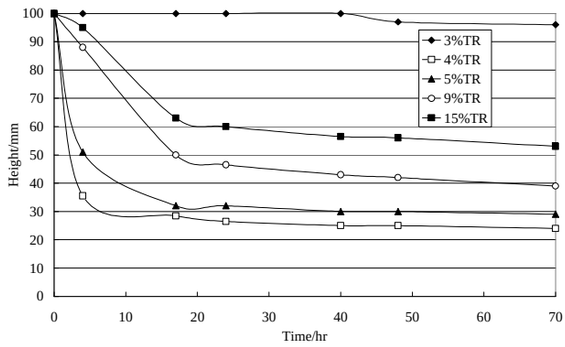

Fig.2 Separation rate of the dispersion containing various Triton X-100 concentrations at 67.0 °C.

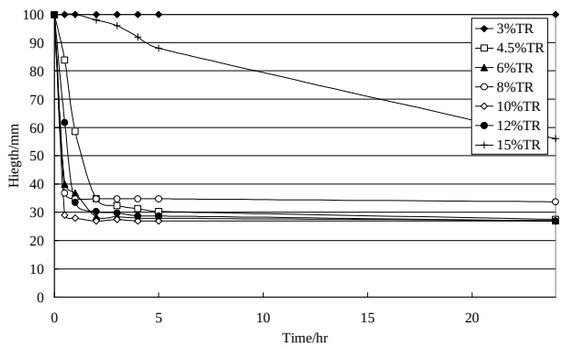

Fig.3 Separation rate of the dispersion containing various Triton X-100 concentrations at 69.0 °C.