Relation between Performances of the Air-Depolarized Cell and Catalytic Activity of Charcoals

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By Berl⁽¹⁾ and Weisz⁽²⁾ the production of peroxy ion and its catalytic decomposition was acknowledged at the cathode process of the air-depolarized cell and the cathode potential was determined by the thermodynamic relation between peroxy ion and partial pressure of oxygen at the electrode surface. According to the theory it is the most important thing to select a charcoal as a cathode material which react as a strong catalyst for aqueous solution of hydrogen peroxyde. But it has been often experienced that a charcoal which has strong decomposition ability for aqueous solution of hydrogen peroxyde shows poor discharge characteristics when the air-depolarized cell is constructed from the charcoal. On the contrary a charcoal which has poor catalytic activity shows better characteristic than the former⁽³⁾. It is assumed that the result opposite to the theory is caused by the comparison among charcoals which differ from each other in physical state-density, surface area and particle size distribution, and by the method of discharge characteristic measurement. To make sure this assumption surface complexes of charcoal are prepared without changing any physical state of coal by treating with ammonia, chlorine and oxygen at a temperature ranging from 400 to 800°C. The resulting charcoals contain nitrogen, chlorine and oxygen by chemisorption (Fig. 1) and differ only in catalytic activity. Ammonia and chlorine adsorbed physically by the reaction are eliminated sufficiently by washing with hot water.

Acid and base adsorption of each surface complex are shown in Fig. 2 and 3. The order of base

Fig. 1 Content of nitrogen, oxygen and chlorine in the surface complexes of charcoal.

Fig. 2 Adsorption of acid by the surface complexes of charcoals

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adsorption value is chlorine complex, nitrogen complex and oxygen complex and that of acid adsorption is in the reverse order of base adsorption. Acid adsorption of each complex hardly changes by the treating temperature. Base adsorption of nitrogen complex and chlorine complex gradually increases from the temperature of about 700°C and of oxygen complex decrease from the same temperature. Surface complexes prepared from soft coal of the pine show higher adsorption value of acid and base than from hard charcoal of the oak.

The order of catalytic activity for the decomposition of aqueous hydrogen peroxide is nitrogen, oxygen and chlorine complex. (Fig. 4) The catalytic activity of chlorine complex markedly decrease than the coal before treating. The surface complexes from soft coal show higher activity for hydrogen peroxide than that of hard coal by ten to twenty times. The decomposition velocity shows maximum at the treating temperature of about 850°C but this is not distinct by the chlorine complex. The discharge charac-

Fig. 3 Adsorption of base by the surface complexes of charcoals.

Fig. 4 Treated temperature and decomposition velocity of hydrogen peroxide.

teristics of the air-depolarized cell constructed using these complexes are shown in Fig. 5. In order to measure the discharge characteristics of the cell as reproducible as possible and to prevent physical and chemical change of the coal, without adding any binder and without sintering, the sample treated with 5% paraffine wax solution of benzene is pressed under the pressure of 100 kg/cm² for thirty min-

“N-800” means a surface complex of nitrogen prepared at 800°C

.....: Hard coal of the oak —: Soft coal of the pine

Fig. 5 Discharge characteristics of the surface complexes of charcoals.

Decomposition velocity constant (min^{-1})
(A), Soft coal of the pine
(B), Hard coal of the oak

Fig. 6 Relation between the output of the cell and decomposition velocity of hydrogen peroxy.

utes in a metal tube which is plated with nickel and serves as well for terminal of the cathode.

Only the bottom surface of the tube contributes as a reaction surface. By this method we can measure the characteristics of cells within 2% of deviation. Nitrogen complexes of charcoal generally show better performance than oxygen and chlone complexes. Discharge characteristics of surface complexes from hard coal are remarkably inferior to that of soft coal.

Between the performance of cell and the catalytic activity of charcoal as shown in Fig. 6 a definite relation, $\log K = a + bw$ (K ; velocity constant, w ; output of the cell, a, b ; numerical constant) is recognized at the coal derived from the same source, but there is no relation between charcoals whose physical state differs from each other. From above mentioned result it is confirmed that the higher catalytic activity of charcoal is not a sufficient condition but a necessary condition as a cathode material of the air-depolarized cell.

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