THE DIFFERENTIAL VOLTAMETRY METHOD FOR STUDYING THE COMBINED CATHODIC PROCESSES IN AQUEOUS NaCl SOLUTION

K. Rutkovska , G.Tulsky, A. Tulska, V. Homozov

National Technical University "Kharkiv Polytechnic Institute",

Kharkiv, Kyrpychova Str. 2, 61002

Due to the growing number of cases associated with variousviral or bacterial infections, a lot of attention should be paid to the production of a disinfectant solution of sodium hypochlorite at local facilities, directly in the area of its use. Small units for electrochemical synthesis of sodium hypochlorite generally do not consider the diaphragm scheme. The maximum possible content of sodium hypochlorite produced at such units is 10…14 $g \cdot dm^{-3}$. The limiting factor for production the concentrated hypochlorites solutions through the electrochemical synthesis of aqueous hypochlorite solutions is the reduction of number of hypochlorite ions at the cathode without a diaphragm [1].

To increase the concentration of the main product in non-diaphragm electrolysis unit it is sensible to use a gas diffusion electrode to minimize the depolarization of the cathode process [2]. Manganese oxides, cobalt oxides, ruthenium oxides, cobalt, cobalt-molybdenum, cobalt-molybdenum-titanium oxide have been studied as perspective materials for the gas diffusion electrode made as a lattice [3]. These materials are characterized by low overvoltage in the oxygen release.

1. Aim and scope of the research

Study of the kinetics of combined cathode processes on the gas diffusion cathode in aqueous NaCl solutions depending on different electrode materials. Search of electrode materials that provide catalytic activity for the reduction of oxygen dissolved in the electrolyte and inhibition of hydrogen release and the reduction of hypochlorite ions.

2. Experimental part

A graphite gas diffusion electrode has been used to study the kinetics of electrode processes. Porous graphite PG-50 has been chosen as a cathode base whereas a steel lattice (steel X5CrNi18-10) has been attached to the front side of graphite base. Graphite PG-50 has a high chemical resistance in a wide range of concentrations. The cathode process has been performed in a heterophase medium on the steel lattice surface. This surface was activated by materials that have catalytic activity in oxygen release reaction: manganese oxides, cobalt oxides, ruthenium oxides, cobalt, cobalt-molybdenum, cobalt-molybdenum-titanium oxide [3–4]. The oxygen supply was arranged from an air compressor on the back of the graphite electrode with the ability to control the supplied air volume. The affect of electrode material was studied in aqueous solution with the concentration 3 mol/dm^3 NaCl. Current-voltage curves were obtained at MTech PGP-550M pulse potentiostat. Potential sweep rate was 50 mV/s. The cathode is gas diffusion, the anode is platinum. The reference electrode is silver chloride. All potential values are listed relative to the hydrogen electrode.

3. Resulrs and discussion

In terms of studying the kinetics of combined cathode processes in aqueous solution of 3 mol/dm^3 NaCl, current-voltage curves have been obtained. To analyze these curves and assess the influence of the studied electrode materials on the ongoing cathode processes, the obtained current-voltage curves were rearranged into differential ones. The potential peaks of the differential curves made it possible to evaluate the catalytic activity of research materials in the reaction of cathode oxygen reduction (see table).

Table. Potentials of oxygen reduction peaks in 3 mol/dm^3 NaCl depending on the material of the gas diffusion electrode

Material	*E*, V		
	Without air	Air	Difference
X5CrNi18-10	–0,7	–0,5	0,2
Co_2O_3	–0,74	–0,54	0,2
MnO_2	–0,77	–0,67	0,1
RuO_2	–0,61	–0,6	0,01
Co	–0,9	–0,59	0,31
Co-Mo	No peaks	No peaks	–
Co-Mo-TiO_2	–0,9	–0,42	0,5

Analyzing the current-voltage curves it has been found that the catalytic activity in the reaction of cathode oxygen reduction was performed by: Co_2O_3, MnO_2, Co, Co-Mo-TiO_2. According to the *dj/dE* value at the potentials of the oxygen reduction peaks, the materials can be arranged in the following row: Co> Co_2O_3> Co-Mo-TiO_2 (Fig., a). According to the value of the depolarization of the cathode process, the studying materials under can be arranged in the following row: Co-Mo-TiO_2> Co> Co_2O_3 (Fig., b). On other researched materials (Co-Mo, RuO_2, X5CrNi18-10), oxygen reduction was inhibited by the predominant hydrogen release process. Analysis of the current-voltage and differential curves of the course of combined processes made it possible to substantiate the choice of the cathode material for the gas diffusion electrode.

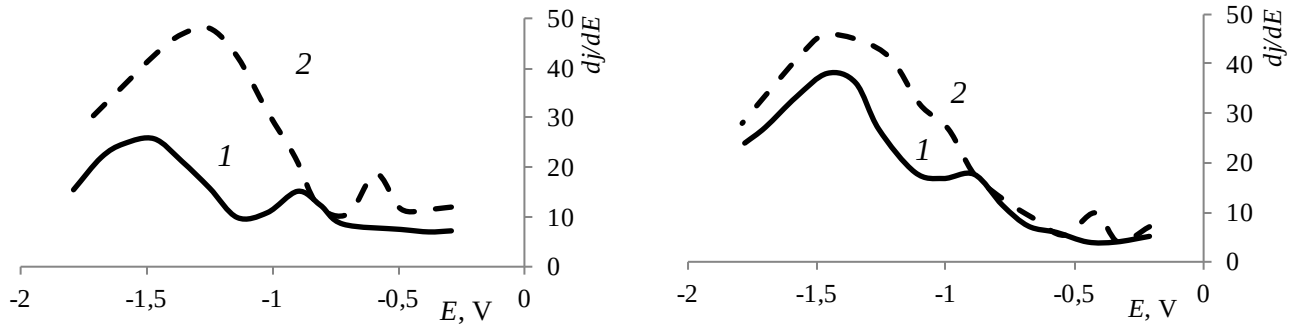

Fig. Differential curves at 3 mol/dm^3 NaCl without air (*1*) and with air (*2*): **a** – Co, **b** – Co-Mo-TiO_2.

4. Conclusions

Method of differential voltammetry made it possible to substantiate the choice of the cathode material for the gas diffusion electrode and evaluate its effect on the kinetics of combined cathode processes in an aqueous solution of 3 mol/dm^3 NaCl.

5. References

[1] V.G. Nefedov, A.G. Atapin, Voprosy khimii i khimicheskoi tekhnologii 4 (2019), 120–126.

[2] V.G. Nefedov, D.V. Bondar Voprosy khimii i khimicheskoi tekhnologii 4 (2007), 121–126.

[3] V.V. Stefan, A.S. Epifanova, O.V. Kobzev, M.M. Metenkanych Visnyk NTU “KhPI” [Bulletin of the National Technical University “KhPI”] 39 (2018), 80–83.

[4] B.I. Bayrachny, A.G. Tulskaya, A.A. Mihno, O.M. Borsuk, Visnyk NTU “KhPI” [Bulletin of the National Technical University “KhPI”] 47 (2013), 153–158.