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Construction of Electrochemical System for Hydrogen and Oxygen Overvoltage Determining under High Current Densities in Alkaline Water Electrolysis

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***Abstract**: The construction considered Electrochemical System based on the use of the rotating disk working electrode with pressed to the electrode immobile thread has obtained farther evolution:*
1) *Elimination of the air penetration to the rotating, working electrode surface,*
2) *Utilization of hydrogen reference electrode with the same electrolyte and temperature that for rotating working electrode,*
3) *Elimination of the electrolyte and gas movement in electrolytic switch and Luggin capillary,*
4) *Application of the simple nut arrangement for Luggin capillary vertical movement up and down on the given distant between Luggin capillary end and the rotating working electrode surface.*

***Keywords**: hydrogen and oxygen overvoltage, high current densities, gas shielding of electrode, gas filling of electrolyte, rotating disk electrode, concentrating polarization, pressed to electrode thread, mobile Lugging capillary.*

I. INTRODUCTION

The Industrial alkaline water electrolysis for obtaining hydrogen and oxygen most often carry out under high current densities (i>0.1 A/sm^2). At usually method for of the hydrogen and oxygen overvoltage determination gives positive mistake because of influence of the working electrode surface gas shielding, electrolyte gas filling and concentrating polarization [1]. Two ways were proposed for elimination of the indicated factors: 1) the placing of the working electrode in the flowing electrolyte [2], 2) the use of the rotating working electrode wire [3,4] or disk with pressed to the electrode surface thin polymeric immobile thread [5,6]. Second way respect to construction and exploitation is considerably simpler than first way and his follows to prefer, especially if to discount that the rotating disk electrode (without thread) is made by different firm. Therefore in our work the second way with more perspective the rotating disk working electrode with pressed thin polymeric immobile thread has been chosen.

Tasks of our work were the improving of electrochemical system construction in directions of containments and elimination of gas and electrolyte movement in electrolytic switch and Luggin capillary..

II. ROTATING DISK WORKING ELECTRODE

Rotating disk working electrode (1) with pressed immobile polymeric thread (2) considered in part I given on the fig.1. Rotating disk working electrode (1) has diameter 4-5 mm. Diameter of the polymeric thread (2) 0.1-0.2 mm is considerably lower the diameter disk electrode that allows to neglect thread shielding.

Usually hydrogen and oxygen overvoltage determine at different covering. For this covering is better to choose as the base produced chemical stable rotating electrodes from graphite or glassy carbon. It allows us to use the same base repeatedly. The construction rotating working electrode with pressed to its surface immobile thread (2) developed in work [5] shown on fig.1. This construction provides the thread "soft" stretching and its "soft" pressing to the electrode surface due to nuts (3), (4) and rubber washers (5), (6). Simultaneously with pressing the containment of hole (7) in cover (8) takes place.

Additional containment for the elimination of the air penetration across tube (9) to rotating electrode surface, that especially undesirably at the hydrogen overvoltage determination in work [5], has been not considered. The construction on fig.1, taking into account this effect and using lid (10) with rubber laying (11),allows us to obtain the full containment of the rotating working electrode.

Besides indicated in part I advantages of the rotating working electrode the presence of the pressed to the electrode surface immobile thread must decrease the limiting speed of the working electrode rotation [4] and hence to increase of Luggin capillary stability.

III. HYDROGEN REFERENCE ELECTRODE

The construction of the reference electrode (Fig.1) consist of following nodes performing different functions: a) platinized platinum wire (12) provides for reversibility of electrochemical hydrogen redox reaction; b) electrolytic glass switch (13) with polishing glass stopper (15) for elimination of the gas and electrolyte movement; c) Luggin glass capillary (16) for the potential measurement in the flatness parallel to electrode surface (1); d) rubber stopper (17) with holes: (18) – for the platinized platinum electro contact, (19) – for hydrogen inlet, (20) – for hydrogen outlet; holes (21), (22), (23) in the electrolytic switch for hydrogen bubbles; f) directing plastic tube (24) provides the contact of Luggin capillary (16) end with electrode surface free from pressing thread;

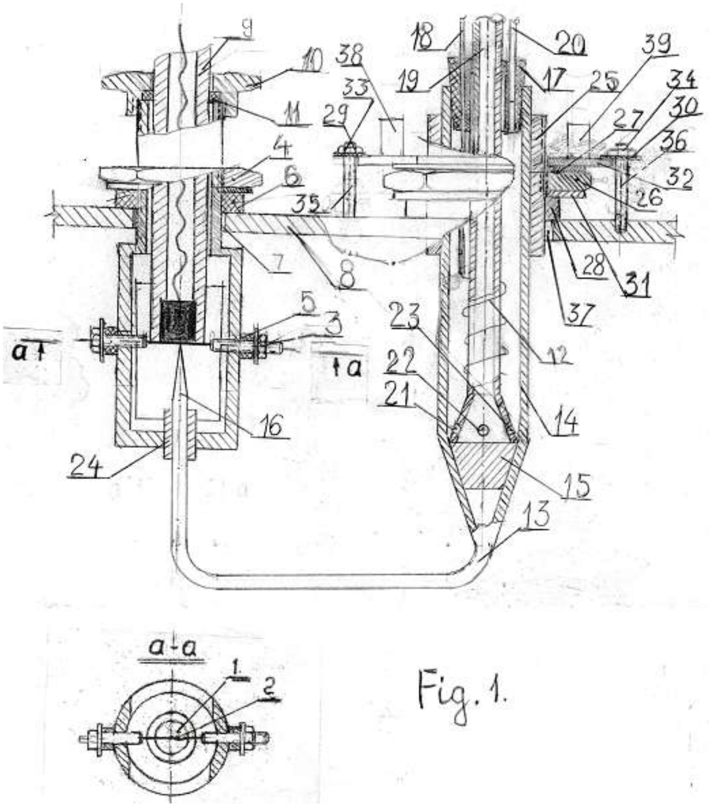

Fig. 1.

g) plastic nut (26) screw up to cylinder (25) glued to glass tube (14) provides vertical transfer of Luggin capillary (16); h) rubber washer (28) for hydrogen reference electrode containment; j) circular disks (27), (32) for hydrogen and oxygen overvoltage estimation, circular disk (27) is fastened to nut (26).

At rotation nut (26) on clockwise Luggin capillary (16) is vertical transferred down to up. This is caused by the vertical movement in the same direction of cylinder (25). Luggin capillary (16) movement is completed by the "soft" pressing of Luggin capillary (16) end to the electrode surface. At this also the containment of hole (37) occurs. Rotation nut (26) do not stimulate rotation of the other construction parts including Luggin capillary (16) because of immobile directing tube (24).

At rotation nut (26) counter clockwise the vertical movement Luggin capillary (16) from up to down takes place. It is caused by the movement of cylinder (25) from up to down. Movement of Luggin capillary (16) from up to down allows us to obtain the dependence of the potential from distance between Luggin capillary (16) end

Disk (32) made from organic glass for in order to see the diametric line on disk (27).On disk (32) also there is circular minute clock dial with 12 marks for hours and 5 marks for minute every hour. Rotation of nut (26) and disk (27) with diametric line is indicated on disk (32) (dial) proportionally to Luggin capillary movement. .

At receipt initial condition of Luggin capillary (16) unscrew little nuts (33, 34) and disk (32) turn with help handless (38, 39) to confluence the mark 12 on disk (32) with the line on disk (27). After that nuts (33, 34) screw up to compact pressing to rubber washers (29, 30). The potential measurement in the direction of the increase distance between Luggin capillary (16) end and electrode surface are carried using the rotation of nut (26) counter clockwise to confluence the line on disk (27) with chosen (in minute) marks on the dial. The extrapolation found potentials to the “zero time” gives an overvoltage.

Thus proposed construction of the hydrogen reference electrode with displaced Luggin capillary (16) for potential extrapolation to “zero position” of Luggin capillary (16) simpler and exacter than proposed [2,7] the use for this object several Lugin capillaries. Possibility to work with very small distance between luggin capillary (16) and electrode surface is also by the important peculiarity of our construction when diameter cylinder form of the working layer electrolyte corresponding to diameter working electrode is kept. At this the proportionality between potential ohmic drop and the distance between Luggin capillary (16) end and electrode surface must be kept.

IV. AUXILIARY ELECTRODE

Platinum wire is used mostly as the auxiliary electrode (anode or cathode) without some diaphragm. The function of the diaphragm carries out the electrolyte layer in vertical glass tube opened down. The auxiliary electrode presents in the upper part of tube in the same this layer. The external layer of the electrolyte for working electrode and hydrogen reference electrode is same. This construction is analogous to U-tipe electrochemical cell for hydrogen and oxygen obtaining without diaphragm.

V. CONCLUSION

Proposed construction of the electrochemical system allows to improve the containment of the rotating disk working electrode and hydrogen reference electrode and the Luggin capillary vertical transfer instead of several Luggin capillaries use [2, 7].

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