

A LABORATORY ELECTROLYZER FOR OBTAINING HYDROGEN

O. S. Ksenzhek, E. A. Kalinovskii, and N. D. Koshelev

Dnepropetrovsk Chemicotechnological Institute

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To obtain pure hydrogen at a pressure of up to 1 atm in laboratory conditions, it is convenient to use the electrolyzer described below. The principal part of this device is the so-called valve electrode [1] which, in effect, is a multi-layer device made by compacting and sintering powdered nickel (Fig. 1). The external layer of 1, about 0.5-mm thick, consists of a fine-porous mass, while the subsequent two layers 2 are made of a large-grain material and the interior of the valve is a single cavity or a cavity divided into several channels.

When the electrode is in operation, hydrogen is separated mainly inside the pores. It cannot readily flow out through the fine pores of the external layer of the electrode because, in this case, the hydrogen pressure inside the electrode should exceed the capillary pressure of the liquid in the pores. With pores of a radius of the order of $1\ \mu$, this pressure is about one atm. As a result, the hydrogen is collected inside the internal cavity and can be removed through tube 4. In order to reduce the separation of the hydrogen, the external surface of the electrode is amalgamated.

Carbonyl nickel powder, with a grain size of about $5\ \mu$, is used as the raw material for making the valve electrodes. The coarse-grained layer is made of a powder previously sintered to larger grains of 200-250- μ diameter. Ammonium bicarbonate, with a grain size of 100-150 μ , is used as the pore-forming filler. The electrodes are compacted under a pressure of 1.5 tons/cm². Fig. 2 shows how the mold is filled. The sintering of the compacts is effected in a flow of hydrogen. The sintering conditions are: increase of temperature to 680-700°C in 3 h, holding for 1 h, cooling for 2-3 h.

The gas tube is silver-soldered into a hole drilled into the side of the sintered electrode; the same tube is used to take the electric cable. The external surface of the electrode is copper-plated from an acid electrolyte using a current density of 2.5 A/dm²; after plating for 3-5 min, the thoroughly washed surface is electrically amalgamated in a 1-N solution of NaOH saturated with mercury oxide. In this process, a current density of 20 A/dm² is applied for about 5 min.

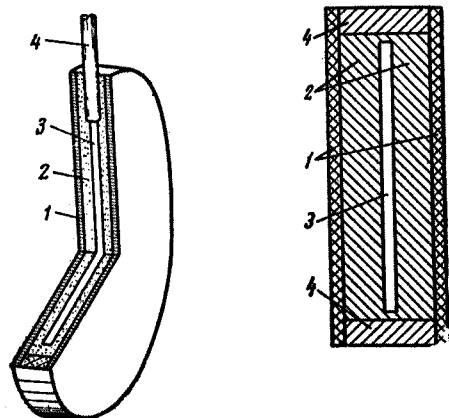


Fig. 1. Valve electrode (cross section).

Fig. 2. Diagram showing the filling of the mold: 1) layer of carbonyl nickel ($0.5\ \text{g/cm}^2$); 2) layer of coarse-grain nickel with 10% filling ($1.5\ \text{g/cm}^2$); 3) plate pressed from ammonium bicarbonate, thickness 0.8-1.2 mm; 4) side layer, a mixture of carbonyl nickel and coarse-grain nickel (2:1).

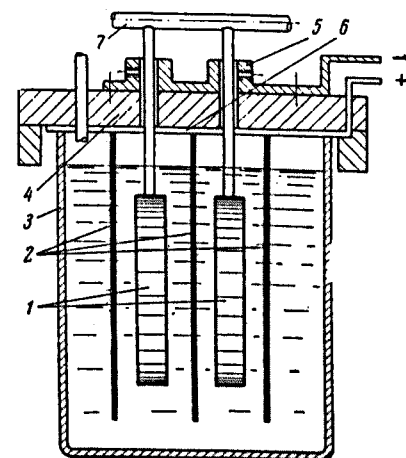


Fig. 3. Laboratory electrolyzer with valve electrodes: 1) valve electrodes; 2) anodes; 3) vessel; 4) PVC cover; 5) terminals; 6) hydrogen collector.

The finished electrodes are mounted in electrolyzers with nickel anodes (Fig. 3); they are stable in work at a current density up to 25 A/dm^2 . The current output reaches 90% and is practically independent of the current density or pressure provided that the latter does not exceed 0.8-1.0 atm. Using a finer nickel powder for the sealing layer, the pressure can be increased. The output of one electrode with a diameter of 55 mm is, at 10 A, about 3.5 liter/h, and at 15 A, 5.2 liter/h. The voltage, with an anode distance of 40 mm, is 5.3 V and 7.1 V respectively at room temperature. The hydrogen obtained is free of oxygen.

When hydrogen is taken at a very low pressure, the electrolyte is carried from the electrode by the gas. This can be avoided by holding the electrode under a pressure of a few centimeters of mercury and subsequently reducing the pressure by passing the hydrogen through a valve, a capillary tube, or any other device of this kind.

LITERATURE CITED

1. E. Yusti, M. Pil'kun, V. Shaibe, and A. Vinzel', High-Activity Hydrogen Diffusion Electrode [Russian translation], IL (1962).