Demonstrations of Electrolyses by Optical Projection

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This paper contains nothing new. It is a reminder of the usefulness of the projection lantern in lecture demonstration of the processes occurring when the electric current traverses aqueous solutions with the intervention of electrodes. This subject has already been thoroughly discussed in a manual of lecture experimentation,[1] but the author feels that perhaps it is not as widely used as appears warranted, and hence calls attention of the Academy to it by this paper.

The apparatus may be varied according to what is at hand. The essential items are: (a) a projection lantern, (b) an electrolytic cell with electrodes, solutions, etc., (c) source of electrolytic current, with any regulating and measuring devices desired in conjunction with it, and (d) a screen, which for this purpose is somewhat different in its best form from the conventional type. We will briefly consider acceptable forms of each of these.

The author prefers a "bench" type lantern with illumination furnished by an electric arc lamp drawing about 15 amperes of current. A suitable instrument was formerly produced by the McIntosh company, but appears to have been withdrawn from the market. For this use, it is necessary to cut out the top of the slide holder so that access may be gained to the electrolytic cell from the top. With the bench lantern, an extra slide holder for use with the usual slide carrier may be readily substituted for the mutilated one when desired. The power of the arc light makes darkening the room unnecessary. Lacking this particular equipment, almost any modern stereopticon using an incandescent bulb may be adapted by cutting out the top of the slide holder; and usually a metal cover with bolts may be provided to replace this sawed-out portion when the regular slide carrier is in place. The objective of the lantern should be of short focus, so that the lantern may be set up on the lecture table in front of the class and the image projected on a screen hung on the wall in front and to one side of the observing class. This arrangement is almost necessary for facile operation of the outfit by the lecturer alone.

Electrolytic cells are commercially available from several standard supply houses. They replace the slide carrier of the lantern. They are made of three plates of glass cemented together, the central one being cut out to provide a U-shaped cavity with plane sides. Platinum foil electrodes suitably mounted come with the cell. We have preferred, however, to provide our own electrodes. They were made by fusing No. 28 platinum wires to balls about ½ mm in diameter, and sealing the wire-ends attached to the balls in 1mm glass tubing of suitable length. Mercury and copper leads provided conventional contacts, and a holder for the electrodes has been

[1] Newth, Chemical Lecture Experiments, pp. 311 ff. (Longmans, 1928.)

arranged of two wooden spring clothespins secured by small screws to a bakelite strip. This is set upon the top of the slide holder and the electrodes are fastened in the clothespins at the proper depth. The wires are conveniently fused both at once by making them the terminals of a high-tension arc. We use a Thordarson transformer rated at 8000 volts and 75 K.V.A. for this job.

The screen should be adapted to receiving writing. As has been pointed out by Taft[2] an ordinary wall blackboard will serve; but a white chalkboard, prepared as suggested by Taft in this same article, works better. It may be written upon with colored chalk. The author has found it possible to purchase from a local printing establishment large squares of glazed cardboard, which he uses upon both sides and then discards.

Dry cells are convenient and cleanly sources of current. Two or three of standard size serve for solutions which conduct well. For systems which conduct poorly (e.g. hydrosols) a 22½ volt radio C battery is better. Standard voltmeters and variable resistances may be used to control the output fraction applied to the electrodes. Spring clips of the smallest available size are most convenient for applying the delivered voltage to the cell.

The setup is used at Monmouth College ordinarily for the demonstrations of the electrolyses of (a) 1 N. hydrobromic acid, (b) .1 N. potassium bromide, (c) .1 N. lead salt—acetate or nitrate, (d) ferric hydroxide sol and (e) arsenious sulfide sol.

The explanation accompanying the demonstration may be divided into three parts: one each to serve for each electrode-solution interface, and one for the "midcell," i.e. the solution intervening between the electrodes. Thus, to explain for the electrolysis of potassium iodide the observed evolution of (hydrogen) gas at the cathode and iodine at the anode, there is lettered upon the screen between the electrode images, the symbols H_3O^+, K^+, OH^-, I^-; arrows are drawn to show the direction of motion of each species; and the ionic equations $2e + 2H_3O^+ \rightarrow 2H_2O + H_2\uparrow$; and $2I^- \rightarrow I_2 + 2e$ are written near the cathode and anode respectively to represent occurrences there. The class, reciting, should contribute much of the information here pictured.

It has been found possible to rig up a fairly satisfactory projector for electrolysis using an automobile headlamp bulb and toy transformer for the illumination, and cheap single or double convex lenses of one or two inch diameter as condensers and objective. A flat-sided bottle filled with water contains a small vial or test-tube provided with electrodes. Economy of reagents is very great with this device, but the room must be dark, and the projected pictures are not so clear.

[2] Taft, J., Chem. Educ. 6, 1643 (1929).