TECHNICAL METHODS

THE PRODUCTION AND STORAGE OF CONDUCTIVITY WATER

BY

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Ordinary distilled water is not suitable for use in the estimation of lead, or for the production of colloidal gold solutions, and occasionally an ordinary still produces water of such impurity that it is unsuitable even for flame photometry. In such cases, glass-distilled water is used, but all-glass stills are expensive, fragile, wasteful of heat, and often bulky. We have found that we can obtain up to 20 litres a day of high-grade conductivity water suitable for the preparation of colloidal gold solutions or the estimation of lead by passing ordinary distilled water through a column of mixed-bed deionizing resin; the apparatus employed is no more expensive than a glass still, mechanically strong, very economical in running costs, and requires only about 4 sq. ft. of bench space. If 6,000 litres of conductivity water are prepared a year from the poorest quality of distilled water the resin need be replaced not more than four times a year at a maximum cost of £1.

The design is such that water which has passed through the resin column comes into contact only with plastics which can yield no ions into solution: the deionizing column, storage container, and tap are made of polyethylene, the flexible tubing of P.V.C., and the wads of nylon mesh. The purity of the effluent is indicated by the rate of flashing of a neon signal tube.

Principles

Metallic ions are removed from solution by cation exchange resins, acidic ions by anion exchange resins. Water can be purified by successive passage through separate columns of the two types of resin, but a purer effluent is obtained from a single column containing a mixture of the two resins; such a mixture is available commercially as "biodeminrolit" (Permutit Co.) or "amberlite monobed resin" (Rohm and Haas). We have used "amberlite M.B.1"; of this 1 ml. will remove

about 0.6 mEq. of a salt, so that a column containing about 100 ml. resin will remove some 60 mEq. If the crude input contains 0.02 mEq/

FIG. 1

litre (a very poor grade of distilled water), such a column will purify 3,000 litres before it is exhausted; when the resins are exhausted they can be regenerated should it be considered desirable.

Construction

The construction can be followed most easily by reference to Fig. 1.

A is a 5-litre aspirator bottle fitted with a drop sight-feed and tap B; ordinary distilled water is pumped up from a floor-level reservoir through the tube J using a "dymax" electrically driven pump to compress air into the reservoir. CDEF is the de-ionizing column made from $\frac{1}{4}$ in. wall polythene tubing of 1 in. lumen, formed into a U tube to ensure that the water level is always above the resin lest channelling occur with subsequent incomplete contact between resin and water. D is a polyethylene diaphragm occluding the lumen of the U tube, but perforated with 15 to 30 holes each about $\frac{1}{2}$ -1 mm. diameter. Above and below the resin are wads made of fine nylon mesh stockings, decolorized by treatment with stannous chloride-hydrochloric acid and sodium hydrosulphite-sodium hydroxide; they prevent the resin C from leaking through the diaphragm and from disturbance by the inflow.

E is the second limb of the U tube and F a 1-cm. tube sealed through the bottom of the U tube; the effluent flows through this tube into the storage bottle H, thus ensuring that the resin is always under water.

FIG. 3

G is a cap carrying two electrodes used for the neon tube indicator.

Polyethylene softens at a temperature of 150 to 200° C. and can be worked with a nitrogen torch. In this case, however, the U tube was constructed from four pieces of polyethylene tubing and the diaphragm D, which were welded together with a hot, thin, flat brass bit; the joints between the horizontal and vertical limbs were cut at an angle of 45°. The tube F is of polyvinyl chloride and was pushed through a polyethylene sleeve welded around a hole in the horizontal limb, and so tightly fixed therein that no leakage occurred.

Conductivity Indicator

This is a resistance tester based on the design of Knowles, Briggs, and Scragg (1951). The resistance in the circuit is estimated by the frequency with which a neon tube flashes; the higher the frequency the lower the resistance. A D.C. potential is set up across the ends of a circuit such as that of Fig. 2a, when the condenser C slowly charges through the resistance R. When the potential across the condenser reaches the striking potential of the neon lamp N, the lamp strikes and becomes a low resistance through which the condenser discharges. The lamp then ceases to glow and its resistance again becomes very large and the cycle starts again (Fig. 2b).

FIG. 2

In practice the striking and cut-off potential differ by only about 5 volts. The platinum electrodes G (Fig. 1), of 0.7 cm.² area and 0.5 cm. apart, formed part of R_2 in Fig. 3, which is developed from Fig. 2a.

T is a transformer giving 250 volts on the secondary; S are selenium rectifiers, 300 v., 60 mA; C_1 and C_2 are first-quality paper dielectric 4 m.f.d. 500-v. working condensers with an insulation resistance of several megohms. N_1 and N_2 are 5-watt indicator neons from which the ballast resistance has been removed; they strike at about 135 volts and quench at about 130 volts. R_1 is a fixed resistance such that N_1 flashes with a frequency of 20 to 60 per minute, and is of the order 150,000 to 200,000 ohms.

The resistance R_2 is composed of two parts in parallel: a fixed resistor R_{2a} larger than R_1 and the

resistance R_{2b} between the electrodes G in Fig. 1. R_{2a} is chosen so that the frequency of the neon N_2 is considerably less than that of N_1 (about 400,000 ohms), and the electrodes G are such that a mixture of conductivity and distilled water in the ratio 9:1 will give a frequency somewhat greater than that of N_1 . Thus, when N_2 flashes as fast as N_1 it is timed to replace the resin. In practice, the frequency of N_2 is so low that the charge on C_2 leaks away before N_2 discharges, so that a testing switch Sw, which reduces R_2 to about 150,000 ohms and increases the rate of flashing to about 60 per minute, is fitted. R_{2c} , the testing resistance, is about 200,000 ohms.

REFERENCE

Knowles, G., Briggs, R., and Scragg, L. J. (1951). *Chem. and Industry*, p. 700.