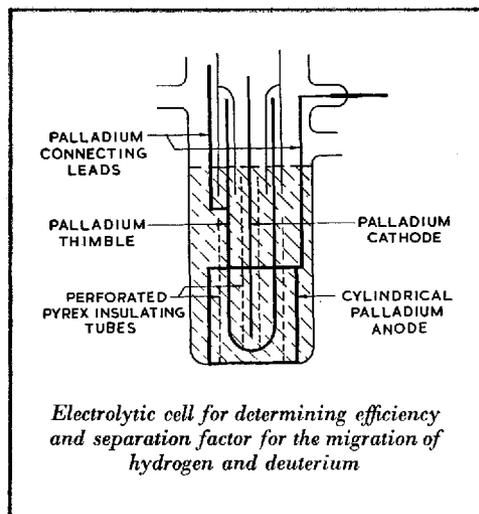


Separation of Hydrogen Isotopes

ELECTROLYTIC MIGRATION THROUGH A PALLADIUM MEMBRANE

With the increasing importance of "heavy water" as a moderator in nuclear reactors there arises a pressing need for a more efficient method of separating hydrogen isotopes. In a report by O. N. Salmon to the U.S. Atomic Energy Commission (AEC Research and Development Report KAPL 1272) a process is described which aims to improve the method of separation by the electrolysis of water. This process is based on the hypothesis that if a voltage drop is maintained across a palladium membrane in aqueous solution hydrogen ions will be discharged into the palladium at the negative surface and will diffuse through the membrane to the positive surface. There they will combine with oxygen ions and re-enter the electrolyte as water. If the current density is sufficiently low a steady state will be reached where no hydrogen is evolved at the negative surface and no oxygen at the positive surface. Furthermore it is reasonable to expect that if hydrogen isotopes are present in the solution fractionation will occur at the palladium membrane with the lighter isotope being discharged preferentially at the negative surface. It was estimated that the separation factor would be equal to or slightly greater than that achieved by conventional electrolysis.

To test these hypotheses and find the value of the separation factor, the cell shown here diagrammatically was found to be the most satisfactory. The palladium membrane, in the form of a thimble, and the two palladium electrodes were made from commercial palladium of 99.9 per cent purity. In saturating the palladium thimble with hydrogen expansion occurs due to an increase in the cubic lattice parameter on passing from α -phase palladium to β -phase palladium



hydride. Consequently it was found preferable to saturate the thimble with hydrogen before assembling the electrolysis cell.

The palladium membrane, the wire cathode and the cylindrical anode dip into an electrolyte of 0.36N. H_2SO_4 solution. Glass tubes, perforated to allow the free passage of ions, insulate the palladium thimble from the cathode and anode respectively.

A potential difference of 0.6 volts was required across the palladium thimble to maintain the current density of protons and deuterons at 0.005 amp./ cm^2 , whereas a voltage drop of about 2 volts is necessary to decompose water at the same rate. In a run of 372 hours, at 25°C, 1.38 Faradays of electricity were passed through the cell and 0.064 cc of D_2O and 12.40 cc of H_2O were decomposed by electrolysis. Initially the anode compartment contained 4.15 cc of D_2O and 33.81 cc of H_2O in the H_2SO_4 solution, whereas at the end of the run

there were 3.74 cc of D₂O and 21.76 cc of H₂O. Hence the separation factor, α , is given by:

$$\alpha = \log \frac{33.81}{21.76} / \log \frac{4.15}{3.74} = 4.26$$

This value is about the same as that achieved in electrolytic separation, but it should be possible to increase it further when the optimum conditions for the process are known.

These investigations indicate that a palladium membrane can be used for months, or even years, in the separation of hydrogen isotopes by electrolytic migration without any appreciable deterioration or poisoning. A cascade process utilising these membranes has yet to be tested experimentally, but if successful it may well provide a basis for a more efficient separation of hydrogen isotopes than has hitherto been possible.

Fume Elimination in Enamelling Ovens

Processes for the catalytic combustion of fumes from enamelling ovens have been successfully developed during the past three or four years, and are in active use in several types of manufacturing operations. The advantages of this method of dealing with oven effluents and preventing condensation in wire enamelling ovens were described by Mr. R. J. Ruff, President of the Catalytic Combustion Corporation, Detroit, in a paper given before the Wire and Cable Section of the National Electrical Manufacturers Association at its annual convention in Atlantic City. The paper, published in *Wire and Wire Products* (1957, 32, (1), Jan., 62-64), reviews first the conventional methods of fume elimination by dispersion, water scrubbing and direct flame incineration, and then deals more particularly with the use of a platinum catalyst to achieve oxidation and burning.

The catalyst unit resembles an air filter element in appearance, and consists of thin ribbons of nickel alloy on which platinum has been deposited. The ribbons are crimped into the form of a mat, and conditioned for activity. A typical mounting arrangement for a catalytic combustion system is shown in the diagram. The basic difference between the latter process and direct flame incineration is that the catalyst accelerates fume combustion, permitting the oxidation reaction to proceed at about 500° F. As the fume burning

temperature now approaches the oven exhaust temperature, little pre-heating is required and this frequently during starting operations only.

More than 500 wire enamelling ovens are now equipped with this system, and many are exceeding 15,000 hours of operation without the need for servicing. Other oven operations in the electrical manufacturing industry where the catalytic combustion system have been successfully employed include coil-baking, core-plate enamelling and fabric and paper impregnation.

