prepare a hydrogen-exchanged ferrierite for sorption experiments.

Since this work began, an incomplete description of a structure for ferrierite has been published⁵. While some features are similar to those described here, there are also marked differences, so that until more details of this other structure are made available, a measure of doubt will exist as to whether the two frameworks are identical or not. As part of the investigation the unit cell of our specimen was determined as orthorhombic I with $a = 19.15 \text{ \AA}$, $b = 14.12 \text{ \AA}$ and $c = 7.47 \text{ \AA}$. This differs from the heulandite cell by a small amount. It is, however, unlikely that there is a close connexion between the two structures, since the symmetry of heulandite is lower.

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CHEMISTRY

Electrical Conductivity and Photoconductivity of Pure Benzene

In addition to reporting some results of measurements of electrical conductivity and photoconductivity of benzene, we wish to direct attention to the effect of conventional out-gassing and other techniques on the purity of solutions. The effect of contamination introduced by such procedures is of considerable practical importance and has also been noted by Dubois and Wilkinson¹ in another connexion. The conductivity measurements were incidental to a study which we undertook of photoconduction in organic solutions.

Recently, Forster² has published results of measurements of electrical conductivity of purified benzene. Typical values after polarization for 24 h at 25° C in a cell with fields up to a few hundred V/cm were $0.61 \times 10^{-15} (\Omega \text{ cm})^{-1}$, or $6.9 \times 10^{-15} (\Omega \text{ cm})^{-1}$ when the benzene was saturated with dry air. He found that close to the electrodes there was a rapid fall in potential, so that the effective field in the bulk of the solution was reduced. After correcting for this, the resulting conductivity was $1.1 \times 10^{-14} (\Omega \text{ cm})^{-1}$. Forster also quotes work by Kraus and Fuoss³ and Kortüm and Bockris⁴ in which values of about 3×10^{-15} and $5 \times 10^{-17} (\Omega \text{ cm})^{-1}$ respectively are stated. A recent paper by Sano and Akamatsu⁵ gives a value of $6.4 \times 10^{-14} (\Omega \text{ cm})^{-1}$.

Among these values, those given by Kortüm and Bockris, which are from experiments by Jaffé, in 1908, are outstandingly low. Our work fully supports this value as the following account will show.

At first our experiments were carried out in a cell with platinum electrodes about 1 cm² in area with a 1 cm separation. Electrical measurements were made by means of a vibrating reed electrometer (E. K. Cole, Ltd., type 1341A).

After vacuum distillation and transfer of the benzene under dry oxygen-free nitrogen in a closed system to the conductivity cell, and polarization for 24 h, the conductivity was found to be $0.33 \times 10^{-14} (\Omega \text{ cm})^{-1}$ in a field of roughly 240 cm⁻¹, which agrees with Forster's values. The measurements were then repeated in a special cell with a 0.0125 cm gap between transparent conducting quartz electrodes coated with stannic oxide, so that field strengths of 15,000 V/cm were readily attainable. After polarization for 15 min, the current was steady and the conductivity was $0.7 \times 10^{-14} (\Omega \text{ cm})^{-1}$, which agreed with

the earlier determination within the variation expected from different batches of vacuum-distilled benzene. If Forster's potential variation had applied to our system we should have expected the narrow gap cell to give considerably lower conductivity values (see a discussion of Forster's results by Silver⁶, who has applied the classical Thomson treatment of conductivity in gases).

We then abandoned the conventional purification techniques, and used benzene which had first been crudely distilled, then very carefully distilled by means of a 25-stage bubble-cap fractionating column, with transfer to the conductivity cell by syringe. After 15 min polarization in the cell, conductivity values for different batches varied between 2×10^{-18} and $1 \times 10^{-17} (\Omega \text{ cm})^{-1}$, similar to the values found by Jaffé. The success of this distillation procedure depends on careful control of conditions in the distillation column. Starting with 4 l. of sulphur-free benzene (May and Baker, Ltd.) about 400 ml. of purified benzene were obtained after distillation for 24 h. The purified benzene was stored before use in glass containers from which moisture was excluded by means of 3/16 in. 'Hi-drite' granules (Hi-drite, Ltd.) held in the hollow glass stoppers. Other than this, no special storage precautions were taken.

These observations suggested a further investigation of the effects of vacuum distillation. This was carried out in a system constructed of glass with 'Teflon' seals and 'Teflon' vacuum taps, using a glass freeze trap and an Edwards rotary pump containing type 8A oil. Degassing a sample of purified benzene with solid carbon dioxide in the trap caused a three-fold increase in conductivity. A complete vacuum transfer under the same conditions caused a hundred-fold increase in conductivity, which represents a return to values similar to those reported by Forster and others. Very similar results were obtained after thorough cleaning of the apparatus and use of a liquid nitrogen trap. Evidently such contamination is of major importance in conductivity work and may also be important in any other work where degassing cycles are used.

It is of interest to note the effect of oxygen on the electrical conductivity and photoconductivity of the very pure benzene. The conductivity of a control sample in a typical experiment was $4 \times 10^{-18} (\Omega \text{ cm})^{-1}$ after 15 min polarization. After 5 sec exposure to a high-pressure mercury arc (Philips 125W) through a Corning 0-53 filter (less than 5 per cent transmission at 290 mμ; negligible at 280 mμ) the conductivity rose to $60 \times 10^{-18} (\Omega \text{ cm})^{-1}$, and fell quickly to the original value when the radiation was cut off. When the sample was saturated with dry oxygen by bubbling for 30 min the initial conductivity was $14 \times 10^{-18} (\Omega \text{ cm})^{-1}$ after 15 min polarization, which after the same 5 sec exposure rose to $100 \times 10^{-18} (\Omega \text{ cm})^{-1}$. In both cases, prolonging the exposure beyond 5 sec caused a reduction in the photocurrent.

The results are qualitatively similar to Forster's, except that all processes are faster, presumably because the path lengths between the electrodes are shorter and the field strengths much higher. It will be seen that the conductivities in our experiments are more than two orders of magnitude less.

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