

## NOTE ON THE TRANSFERENCE NUMBER OF HYDROGEN

---

BY WILDER D. BANCROFT

In the paper by Mr. McIntosh<sup>1</sup> reference should have been made to the work of Hopfgartner.<sup>2</sup> Hopfgartner determined the transference number of chlorin in hydrochloric acid by Hittorf's method. The mean of his values is  $n_{Cl} = 0.163$ , while McIntosh found  $n_{Cl} = 0.159$  by the electrometric method. These two numbers agree so well that one would be inclined to take the mean as the true value, were it not that some recently published work does not confirm this result. Bein<sup>3</sup> has determined the transference number for chlorin in hydrochloric acid by Hittorf's method. He finds that the value varies enormously with the temperature. From his experiments the most probable value at  $18^{\circ}$  is  $n_{Cl} = 0.167$ , a trifle higher than that of Hopfgartner and quite a bit higher than that of McIntosh. Even this highest value does not agree well with the results of Kohlrausch.<sup>4</sup> The latter considers 353 as the most probable value for the molecular conductivity of  $18^{\circ}$  of hydrochloric acid at infinite dilution. The migration velocity of chlorin as ion being taken as 63, the corresponding value for hydrogen as ion becomes 290. According to these data the transference number of chlorin in hydrochloric acid should be  $\frac{63}{290 - 63} = 0.178$ , a value that is much higher than that of Bein, differing from it by more than Bein's value differs from that of McIntosh. Under these circumstances it would seem best to waive for a time the conclusion that "the

---

<sup>1</sup> Jour. Phys. Chem. **2**, 273 (1898).

<sup>2</sup> Zeit. phys. Chem. **25**, 115 (1898).

<sup>3</sup> Ibid. **27**, 1 (1898).

<sup>4</sup> Wied. Ann. **50**, 406 (1893).

Helmholtz method of determining transference numbers is not applicable to gas cells."

If we take 63 as the migration velocity of chlorin as ion, the migration velocity of hydrogen as ion becomes 314 (Bein), 324 (Hopfgartner), or 333 (McIntosh). Professor Jahn has called my attention to the fact that by throwing part of the error into the value for chlorin as ion, we can calculate the values of hydrogen as ion as 294, 295 and 297 respectively by means of the formula  $n_H = \frac{u}{353}$ . These values may be considered as identical with the 290 of Kohlrausch. These values, however, give us for the migration velocity of chlorin the numbers 59 (Bein), 58 (Hopfgartner), and 56 (McIntosh) instead of 63 (Kohlrausch). The percentage discrepancy is as serious as ever and there seems to be quite as much difficulty in assuming an error of four to seven units in the value for chlorin as there is in assuming an error of twenty-five to thirty-five units for the value of hydrogen. The sum total of our knowledge is then that the values for the transference numbers as determined by the two methods agree better than they do with the values calculated from the conductivity. It is interesting to note that Bein, Hopfgartner and McIntosh are agreed that the transference number does not vary with the dilution and also to note that McIntosh's value for the anion in sulfuric acid (0.174) is identical with that obtained by Bein. The paper by Kummell,<sup>1</sup> in which Helmholtz's method is used, was not received in this country until after Mr. McIntosh's paper had been sent to the printer or reference would have been made to it.

*Cornell University*

---

<sup>1</sup> Wied. Ann. **64**, 655 (1898).