

Mobilities of methanesulfonate, needed for liquid junction potential corrections, and of two related anions, and a mystery solved

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Liquid junction potentials (LJP) corrections are especially important in patch-clamp measurements of membrane potentials and the absence, or incorrect application of LJP corrections, can radically affect ion selectivity measurements and lead to totally incorrect selectivity conclusions (Barry & Lynch, 1991). The LJP corrections can be readily and reliably calculated, particularly for monovalent ion salts, provided the mobilities of the significant ions in the appropriate solutions are known (Barry *et al.*, 2013). The anion methanesulfonate is often used as a substitute for chloride (Cl^-) ions as it is not transported through Cl^- channels and, for example, cesium methanesulfonate is often used as a component of the intracellular patch pipette. Mobilities of ions, relative to K^+ ions, can be readily calculated from the measurement of the limiting equivalent conductivity (λ^0) of the ions relative to the value for K^+ and for many this is available in published literature tables. Methanesulfonate is not listed in such tables, though two other somewhat related ions, methylsulfate (Dean, 1999) and methylsulfate (Vanysek, 2002) are, and their values are given as having an identical limiting equivalent conductance of $48.8 \text{ S.cm}^2\text{equiv}^{-1}$, which would give each of them a mobility, u , relative to u_{K} of **0.66**. In addition, methanesulfonate is sometimes assumed to be either the same as methylsulfate or methylsulfonate or at least having a similar ionic mobility to them. However, NaMethanesulfonate (MW = 118.09; $\text{CH}_3\text{NaO}_3\text{S}$), NaMethylsulfate (MW = 134.09; $\text{CH}_3\text{NaO}_4\text{S}$) and NaMethylsulfonate (MW = 158.156; $\text{CH}_2\text{C}(\text{CH}_3)\text{CH}_2\text{SO}_3\text{Na}$) are clearly different salts of different structure and size and would be expected to have different mobilities.

The aim has therefore been to directly determine the mobilities of these three anions, by measuring their LJPs (*e.g.* Barry *et al.*, 2013) for biionic solution junctions for each 100 mM Na salt *versus* 100 mM NaCl. The results showed that for NaMethanesulfonate, the corrected measured LJP was -7.4 mV, which corresponded to a methanesulfonate mobility value (relative to K^+) of **0.60**. For NaMethylsulfate, the corrected measured LJP was -7.7 mV, which implied a relative methylsulfate mobility value of **0.59** and for NaMethylsulfonate, the corrected measured LJP was -10.6 mV, which implied a relative methylsulfonate mobility value of **0.45**. The last two values are very different from the values determined from the literature of 0.66, implying that the values in the literature for methylsulfate and methylsulfonate values are incorrect.

To confirm these results, we have measured the limiting equivalent conductance (Λ^0) of the NaMethanesulfonate salt in a range of solutions from 10 mM to 1 mM using a Radiometer 210 Conductivity Meter (see *e.g.* Ng & Barry, 1995) and obtained an initial Λ^0 value of $96 \pm 1 \text{ S.cm}^2\text{equiv}^{-1}$, which when corrected for the λ_{Na}^0 value of $50.1 \text{ S.cm}^2\text{equiv}^{-1}$ for the Na^+ , gave a value for methanesulfonate $^-$ of $45.9 \pm 1.0 \text{ S.cm}^2\text{equiv}^{-1}$, implying a mobility relative to K^+ of 0.62 ± 0.02 , not very different from the value more directly measured using LJPs.

Further experiments will confirm more precise λ^0 values for methanesulfonate and measure λ^0 values for the methylsulfate and methylsulfonate anions.

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