

# Universal Regulating Function

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In this lecture, I would like to share one interesting finding that I made when studying regulating functions a decade ago. It is a generalization of the Kohlrausch regulating function for the capillary electrophoresis setup in aqueous solutions considering only electromigration and acid-base equilibria as a basis for calculations. The final formula, that contains all known and unknown regulating functions for the most common case where the electrophoretic system has exactly one stationary zone, is then boldly called the *Universal Regulating Function*.

In [1] we reviewed regulating functions and their connection to the stationary system zones. The stationary zone (a.k.a. injection zone, stagnant zone, water zone or solvent dip) is a system zone that has a zero mobility. But note that even under idealized conditions, the existence of the stationary zone and its eigenmobility identical to zero is always an approximation, therefore, its real existence have to be related to the time interval, in which the given electrophoretic system is studied. The existence of the stationary zone brings a certain conserved property to the system that is constant in time. The mathematical description of this property is then the regulating function.

Mathematically speaking, the governing equations can be rearranged into a system matrix [2, 3], whose eigenvalues are mobilities of all zones in the system and eigenvectors provides a characteristic function for each zone. For the stationary zone, this function can be expressed as a linear combination of concentration profiles over all constituents:  $w(x) = \sum_{i=1}^N a_i * c_i(x, t)$ , and as already mentioned this is the formula of the regulating function of the given system [1]. In this context, the Kohlrausch regulating function, which is valid for strong electrolytes of any valency, has coefficients  $a_i$  equal to the ratio of the charge number  $z_i$  and respective mobility  $u_i$  in absolute value:  $a_i = |z_i/u_i|$ .

The aim of my talk, the universal regulating function, provides coefficients  $a_i$  under no additional approximations to the system depicted above, meaning that it inherently contains all special forms of regulating functions as long as the given electrophoretic system contains one and only one stationary zone. We used that in [1] to formulate a completely new (ad hoc) regulation function for a special case of a divalent electrolyte. But the general formula of the universal regulating function was never published.

[1] V. Hruska and B. Gas, *Electrophoresis* 2007, 28, 3–14.

[2] M. Stedry, M. Jaros, V. Hruska and B. Gas, *Electrophoresis* 2004, 25, 3071–3079.

[3] V. Hruska, M. Riesova and B. Gas, *Electrophoresis* 2012, 33, 923–930.