Abstract of the Article „Theorie und Praxis der Hullzelle"

by Thomas Allmendinger, *Galvanotechnik 101* (10/2010), 2237-2251

First of all, for the standard Hull-Cell the so called *primary current distribution* has been calculated due to different basic models, the results being compared with literature values. While a *parallel-current-model* seeming the obvious one leads to deviant results, a *cross-current-model* yielded a quite good accordance. By means of the deduced formula, it is feasible studying the *influence of the cell parameters* onto the primary current distribution, that which is demonstrated using the example of a modified cell being extended in the longitudinal dimension but exhibiting equal dimensions besides. As expected, then the primary current distribution gets flatter.

The empirical validation of this formula by means of *layer thickness measurements* at real galvanic depositions is insofar difficult since, on the one hand, no electrolyte exists yielding an ideally linear increase of the over-potential as a function of the current density, and, on the other hand, since the convection distribution and thus the mass transport within the electrolyte chamber of a normal Hull-Cell is inhomogeneous. A homogeneous convection distribution is solely possible in a – here also regarded – equipment resembling to the Hull-Cell but exhibiting a rotating cylinder electrode ("Rotating Hull-Cell"), but even then only approximately. For such a validation, a bright-nickel bath was used as a reference electrolyte. Using the "Rotating Hull-Cell", the accordance between the theoretical and the measured curves was perfect, whilst slight deviations occurred using the normal Hull-Cell, particularly at very low current densities. For getting a more distinct perception of the convection within the normal Hull-Cell, the temporal rate course of a *paddle* was theoretically calculated for a commercially available move device, yielding a quite *asymmetric course*.

The subsequent comparison between different galvanic baths such as *cyanidic copper*, *bright silver* and *cobalt-gold alloy baths* reveals the feasibilities how layer thickness distributions let imply their levelling properties. Further qualitative information is got by the optical assessment of the layer or of particular layer areas, respectively. Indeed, the distance/thickness curves don't always match the theoretical primary current distribution, that which may be ascribed to additional effects such as the variability of the polarisation potential and/or the influence of the mass transfer. Thereby, the statement is of particular importance that *the curve shape expressing the levelling capability of a galvanic bath mostly depends on the middle current density being chosen*. This means that for determining the bath characteristics *various* Hull-Cell depositions are necessary, at least varying the medium current density. Moreover, the influence of the convection may solely be determined by means of a "Rotating Hull-Cell".

Finally, as a basic quantitative measure for galvanic baths the *"Hull-Cell-throwing-power"* is proposed, being defined as *the per cent amount of the layer thickness on a Hull-Cell plate at a low current density compared to that one at a high current density, preferably each being measured at the distance of 1 cm from the edge and averaged over three values with the distance of 1.2 cm (from below)*. E.g., a Hull-Cell-throwing-power of 50 % means that the layer measured 1 cm from the left edge of the plate is half as thick than the layer 1 cm from the right edge of the plate. By this method, different baths may be compared quantitatively considering different parameters such as concentration, bath ingredients or temperature.