Modelling of Electrochemically Enhanced Leather Tanning

Marco Marinsalta [a], Omar Salmi [a], Luca Zola [a], Fabio Pastori [a] & Maurizio Masi [a]

[a] Department of Chemistry, Materials and Chemical Engineering "Giulio Natta", Politecnico di Milano, Milan, Italy

E-mail: marco.marinsalta@polimi.it

This work focuses on the optimization of the leather tanning phase, the crucial part of the process that transforms the raw material into the finished product, bringing in the leather substances that can attach themselves to the collagen fibres and make the material durable. Today, the most used tanning agent is basic chrome sulphate due to its affinity with the carboxyl groups of the collagen chains. Just before tanning the skin is immersed in an acid solution, this facilitates the entry of chromium into the hide. This phase is known as pickling. The pH value is then restored to the starting one to ensure proper fixation of the tanning agent. This step before tanning is necessary because it makes the adsorption of chromium onto the collagen fibres thermodynamically disadvantaged. Consequently, the tanning agent can move freely in the leather. To optimise the process, the entry of chromium into the leather must be improved. This is done by exploiting the electrical charge of the chromium ions and facilitating its entry by applying an electric field. In this work, modelling of the phenomenon was conducted. The adsorption of chromium on the skin is a phenomenon that has received little attention in the literature, so it was necessary to conduct an experimental campaign to find the parameters of the adsorption isotherm. This made the modelling results closer to the real ones. The model develops the Nernst-Planck equation and considers the change in diffusivity as the chromium concentration changes. Given the high responsivity of acid in the case of electric field application, the possibility of combining pickling, tanning and basification in a single step is explored. The system consists of two partial differential equations (PDE). Their resolution allows the behaviour of chromium over time and its local distribution within the leather to be known. The results are very satisfactory and show the high rate of entry of the tanning agent and the precision with which the concentration profile in the skin can be controlled. Comparing the numerical value of the members that make up the equation governing the phenomenon reveals the total prevalence of the input due to the applied electric field. In conclusion, the results obtained are compared with experimental data from research conducted in parallel to this study within the same research group and a great agreement between them is noted.

Keywords: *leather, chromium tanning, electrochemical tanning, tanning process simulation*