HLOROGEN - In-situ electrochemical process for active chlorine production: Specificity and optimization

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Active chlorine, obtained by the process of non-membrane electrolysis from a dilute aqueous sodium chloride solution, has found wide application in the areas of water disinfection, disinfection in medicine and veterinary medicine, as well as for general use [1-3]. The quality and efficiency of the products obtained in this way depend on many parameters, which makes the process of optimizing the quality of the final product difficult, and often impossible.

SIGMA doo has conducted a series of experiments, focusing on monitoring the influence of the following input parameters on the quality and efficiency of electrochemically obtained active chlorine: Concentration of the dilute aqueous salt solution entering the electrolyser; pH of the dilute salt solution entering the electrolyser; Nature of the anode used for the electrolysis process, from different manufacturers.

Part of the analysis was carried out in the internal laboratory of Sigma Crvenka doo, while the remaining data were acquired in cooperation with faculties, institutes and laboratories in the Republic of Serbia and the European Union. The capacity of the equipment used for the tests is 2.5 l/h of the solution, with a maximum concentration of 10 g/l of active chlorine.

The obtained experimental data, together with a 30-year data set collected from more than 200 locations where HLOROGEN technology equipment is installed in Serbia and abroad [4], resulted in the development of a mathematical model for the non-membrane electrolysis process. Under certain initial assumptions, the stationary material balance of the non-membrane electrolysis process showed that the yield of active chlorine can be represented by the following dependence:

$$C_{\mathrm{Cl_2}} = f\,(F_{\mathrm{v}}, x, y, z, \mathrm{U}, \chi(C_{\mathrm{Cl_2}}), \xi)$$

where:

$C_{\mathrm{Cl_2}}$ - Yield of active chlorine
F_{v} - Volume flow of the solution through the electrolyser
x, y, z - Electrode geometry
U - Electrolysis voltage
$\chi(C_{\mathrm{Cl_2}})$ - Electroconductivity of the electrolytic solution as a function of active chlorine concentration
ξ - Degree of electricity utilization

The complex dependence of these parameters and a large number of experimental data make it difficult to optimize the non-membrane electrolysis process. Therefore, a fully connected PINN neural network (physics-informed neural network) with supervised learning was applied in this work [5,6]. The work does not focus on optimizing the hyperparameters of the network itself, but on the interpretation of the application of the neural network to a specific example.

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