Electrocoagulation efficiency and energy consumption probing by artificial intelligent approaches

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ABSTRACT

Color removal efficiency (CR%) and energy consumption (EnC) of Electrocoagulation (EC) were investigated using synthetic wastewater, containing disperses like orange 25 dye (DO25). Five operational parameters including initial pH (pH0) (2, 5.5, and 9), initial dye concentration (C0) (20, 60, and 100 mg L⁻¹), applied voltage (VEC) (10, 20, and 30 V), initial electrolyte concentration (CS) (0, 1.5, and 3 g L⁻¹), and treatment time (tEC) (0, 0.5, 5, 10, 15, 25, 35, and 50 min) were probed as more effective operational parameters of EC. Combined design of experiments (DOE) was designed and experiments were conducted in accordance with it. The experimental data were obtained in a laboratory through a handmade batch reactor. The achieved CR% (0–99.9) and EnC (0–69.4 wh) were gained under experimental conditions. The optimum value of C0 was almost 20 ppm (minimum range). Two optimum clusters could be discriminated for other four parameters. First group was corresponded to conditions with pH0 = 9 (maximum value of range), CS = 0.7–1.1 (g/lit), VEC = 10 V (minimum of range), and tEC = 1 min. Second group was corresponded to the conditions with pH0 = 6.8 (except two cases), CS = 1.1–2 (g/lit), VEC = 10–15.2 V, and tEC = 49.4–50 min. The data was used for model building by employing two more popular models in this study: reduced quadratic multiple regression model (SMLR) and artificial neural network (ANN). Further statistical tests were applied to exhibit models’ goodness and to compare the models. Based on statistical comparison, ANN models obviously outperformed SMLR models. Finally, multi objective optimization of CR% and EnC was carried out using genetic algorithm (GA) over the outperformed ANN models. The optimization procedure causes nondominated optimal points, which gave an insight into optimal operating conditions of the EC.

Keywords: Design of experiments (DOE); Artificial neural networks (ANNs); Genetic algorithm multi-objective optimization; Color removal; Electrocoagulation (EC)