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COMMENT

Comment on "Numerical model for predicting the efficiency behaviour during pulsed electrochemical machining of steel in $NaNO_3$" [Van Damme S. et al. (2006) J Appl Electrochem 36(1):1]

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A flaw in the numerical implementation of the study in [2] has been noticed. This mistake has been remedied. In order to refit the model to the experimental data, a corrected set of optimal parameters was obtained, which is presented in this comment.

The corrected optimized values for the adjustable model parameters can be read in Table 1. The polarization parameters can be found in Table 2.

The experimental and simulated efficiencies are shown for concentrations 70, 130 and 250 g $NaNO_3$ L^{-1}, respectively, in Figs. 1, 2 and 3.

The root mean square deviations between the simulated and the experimental average efficiency in the interval between 0.3 and 1.1 A mm^{-2} are listed in Table 3. They are roughly equal to 7%.

The changes in Q_a, r and q are not very major. The parameters r and q where chosen in such a way that the efficiencies at low current densities matched the experimental results. This is the zone where no water depletion occurs, because the concentrations do not reach high enough values, and the efficiency is only determined by the polarization behaviour. The polarization parameter Q_a is slightly changed compared to [2] to agree better with the overpotential measurements from [1].

The change in $[c^{\text{begin}}_{\text{Me}^{z+}}, c^{\text{end}}_{\text{Me}^{z+}}]$, however, is major. The implementation flaw caused the mass diffusion layer δ to be too thin, and hence the surface concentration c^* to be too low ($\frac{c^*}{\delta} = \frac{J}{nFD}$ remains the same). When correcting the flaw, the model parameters from [2] are no longer useful, because the water depletion sets in too early. This is countered by sliding the depletion interval $[c^{\text{begin}}_{\text{Me}^{z+}}, c^{\text{end}}_{\text{Me}^{z+}}]$ higher. The width of the depletion interval was kept at 1.25 mol L^{-1}, as was done in [2].

References

1. Altena H (2000) Precision ECM by process characteristic modelling. Ph.D. thesis, Glasgow Caledonian University
2. Van Damme S, Nelissen G, Van Den Bossche B, Deconinck J (2006) Numerical model for predicting the efficiency behaviour during pulsed electrochemical machining of steel in $NaNO_3$. J Appl Electrochem 36(1):1–10

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Table 1 Optimized values of the adjustable model parameters

$[c_{Me^{z+}}^{begin}, c_{Me^{z+}}^{end}]$	[0.840 mol L^{-1}, 2.090 mol L^{-1}]
r	1.4
q	0.7 V

Table 2 Polarization parameters

R_{H_2}	0.1 Ω mm^2
Q_{H_2}	−1 V
R_a	3.0 Ω mm^2
Q_a	2.2 V

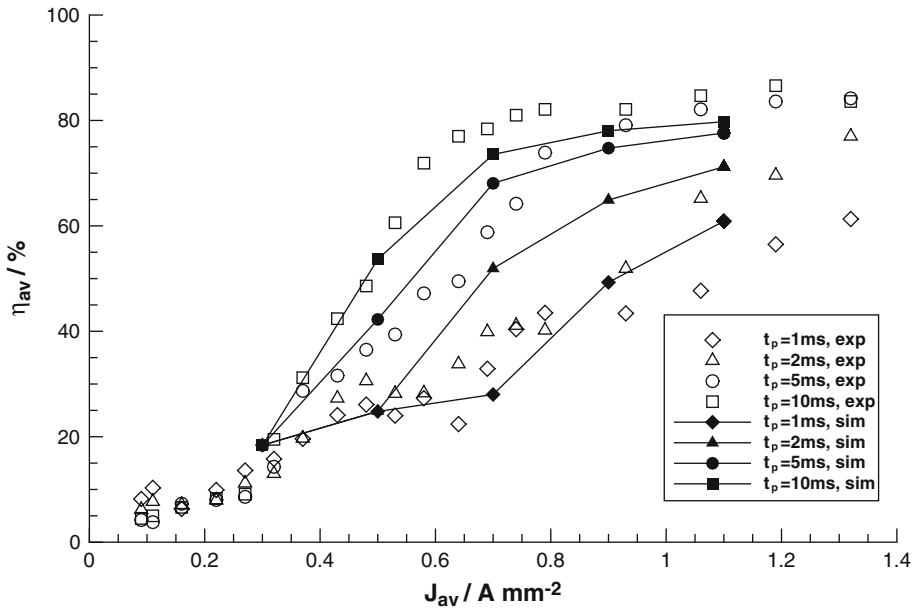

Fig. 1 Comparison of experimental and simulated efficiency curves for different pulse durations t_p at 70 g $NaNO_3$ L^{-1}

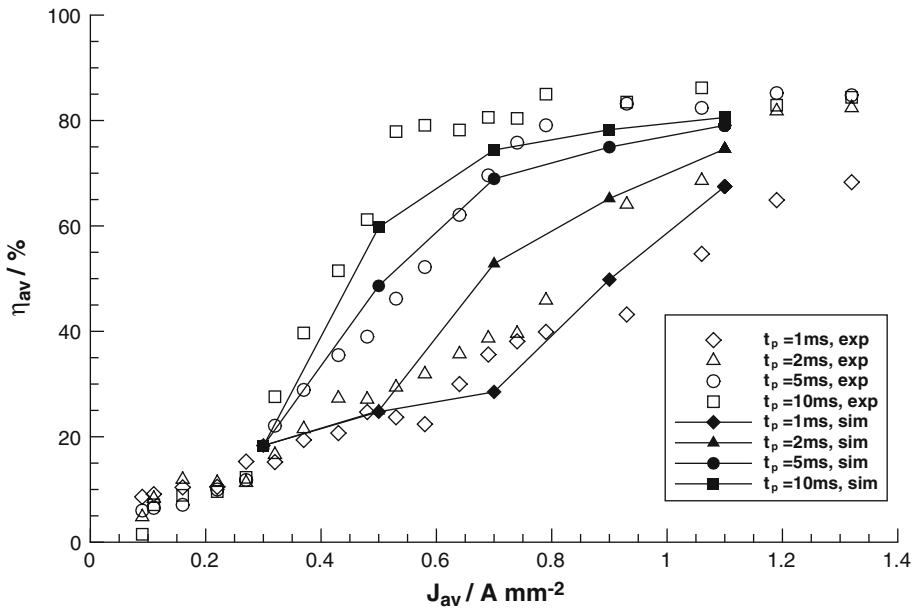

Fig. 2 Comparison of experimental and simulated efficiency curves for different pulse durations t_p at 130 g $NaNO_3$ L^{-1}

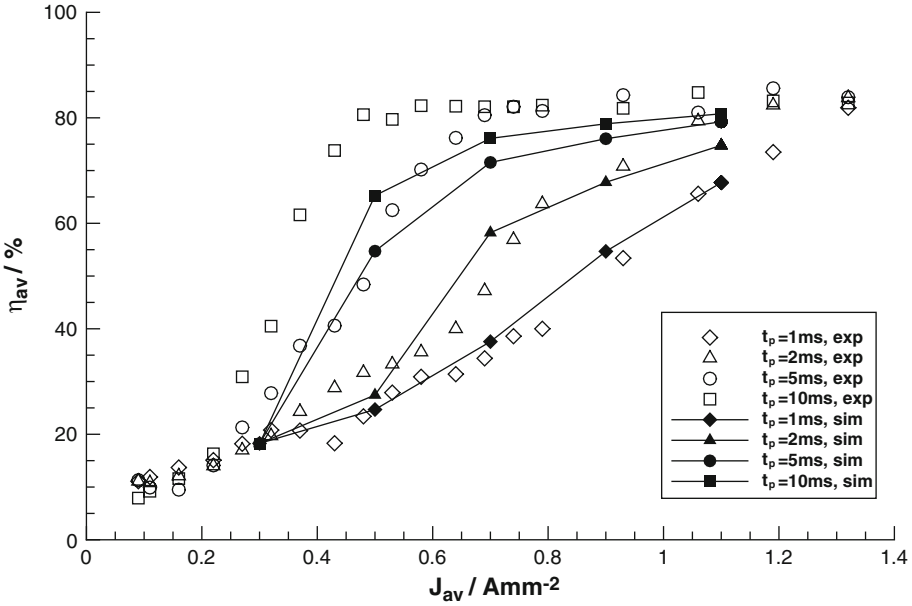

Fig. 3 Comparison of experimental and simulated efficiency curves for different pulse durations t_p at 250 g $NaNO_3$ L^{-1}

Table 3 RMS deviations between the simulated and the experimental average efficiency curves for different concentrations and pulse durations

c_{NaNO_3} (g L^{-1})	$t_p = 1$ ms (%)	$t_p = 2$ ms (%)	$t_p = 5$ ms (%)	$t_p = 10$ ms (%)
70	5.6	10.3	5.2	5.4
130	5.5	7.3	5.1	7.8
250	2.6	4.6	6.8	13.0