COMPARISION OF MATHEMATICAL MODELS OF REACTIONS KINETICS IN GALVANOCHEMICAL WATER TREATMENT PROCESS

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INTRODUCTION

Combination of unique properties made ferrous and ferric ions the most widely used reagents for wastewater treatment [1].

Ferrous ions can be added as ferrous salt (basically as ferrous sulfate hephtahydrate), or produced by electrocoagulation [2] and peroxi-coagulation [3] processes. A production of ferrous ion by electrocoagulation and peroxi-coagulation has advantages over the reagent method, because byproducts of these processes take place in additional reactions of transformation and removal of admixtures [2,3].

The novel method for producing ferro-ferric ions is galvanochemical (galvanocoagulation [4]) process, which based on using carbon steel's oxygen corrosion. The galvanochemical process in comparison with electrocoagulation and peroxi-coagulation doesn't require external DC power and use of full value steel sheets. Equipment for this process contains a horizontal revolving cylinder with corroding material. This cylinder has inside mixing ribs, which are arranged so-called "waterfall" mixing pattern. For acceleration of oxygen reduction, which is linked to iron ionization, some neutral materials such as coke, titanium or stainless steel may be added to the galvanochemical system.

Kinetics of the steel corrosion, along with its sequence of the hydroxides forming, governs the process of waste water decontamination in its base. The main goal of this work was to create mathematical models of the above-mentioned processes (steel corrosion and hydroxides formation) and investigate their behavior.

EXPERIMENTAL

Experiments were performed on a laboratory model and in more detail with approach to results calculation described in [5, 6]. All calculations were performed by using Microsoft Office Excel software.

RESULTS AND DISCUSSION

Historically, mathematical models, which described rates of iron corrosion and ferric–ferrous hydroxides accumulation, were built in form of logarithm linear equations [5,6].

$$\text{Ln}\,\Pi = A_0 + \text{SUM}\,(A_x * \text{Ln}\,F_x) \qquad (1)$$

Where: Π – parameter of galvanochemical process (corrosion rate or hydroxides accumulation rate); F_x – experimental factors; A – constant.

These models can take in account some nonlinear properties of systems and therefore have advantages in comparison with linear and exponential data fits provided by Excel. By using Inductive Regressive Analysis significance of the experimental parameters and sensitivity of the models were found [6].

Several parameters increased processes rate, some declined one. In this case we can expect extremums in our system. But all linear models by their nature can't give information about extremums.

Extremums of galvanochemical process were studied by the using second order mathematical model [7]:

$$\Pi = A_0 + (A_i * F_x + A_j * F_x^2) \qquad (2)$$

These sort of mathematical models were undergoes Inductive Regressive Analysis too.

Statistical parameters and factors significance of models (2) were close to data of logarithm linear equations of model (1). On the base of these mathematical models data parameters were calculated and compared with experimental data.

REFERENCES

1. R. A. Conway and R. D. Ross, Handbook of Industrial Waste Disposal, p. 234, John Wiley and Sons, New York (1980).
2. T. A. Kharlamova and L. T. Sokolova, *Khim. Tekhnol. Vody*, Vol. 4, 157 (1982).
3. E. Brillas, R. Sauleda and J. Casado, *J. Electrochem. Soc.*, Vol. 144, No 7, p. 2374-2379 (1997).
4. R. V. Vergunova, N. E. Korobchanskaya and E. A. Korotkova, in Creative Technological Processes and Equipment for Circuit Lowwaste Systems Water Treatment Galvanic Processes, p. 52, Kharkov (1989).
5. A. Pikelny and V. Barsky, in Meeting Abstracts, PV 96-1, p. 177, The Electrochemical Society, Los Angeles, CA (1996).
6. A. Pikelny and O. Pikelnaya, in Meeting Abstracts. AESF SUR/FIN'99, p. 129, Section S, Cincinnati, Ohio (1999).
7. O. Pikelnaya and A. Pikelny, in Meeting Abstracts, Volume 2000-1, The Electrochemical Society, Toronto, Ontario, Canada, Abstract No 18 (2000).