Modelling of the Process of Sewage Treatment by Electrocoagulation Method in the Temperature Conditions

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***Abstract*— The paper suggests an approach to modelling the electrocoagulation process taking into account the ratio between the values of the parameters which characterize the domination of convective and mass-exchange components of the process over diffusion. Computer simulation of the distribution of iron concentration inside the electrocoagulator that allows predicting various hydrodynamic phenomena such as internal recirculation that affects the formation of a coagulant was conducted.**

Keywords—mathematical modelling, electrocoagulation, electroflotation, water treatment technology

I. INTRODUCTION

Reducing the volume of discharges of pollutants to the water reservoirs and transition of enterprises to work according to the scheme of closed cycle of water use is the main direction of protection of the water environment. It requires the use of a significant amount of additional chemicals, one of which is divalent iron. Different technologies are used for its receipt, but the most resource-saving is electrocoagulation. Therefore, the purpose of this work is to develop a mathematical model of electrocoagulation processing which takes into account the process of formation of divalent iron from a solution of electrolyte the influence of technical characteristics (current strength, flow rate, temperature) on the kinetics of the process of mass and heat transfer in the electrocoagulator, and also the study of the influence of these parameters on the efficiency of the formation of a coagulant.

II. THE MAIN MATERIAL OF THE ARTICLE

The change in concentration of divalent iron C is described by means of the scalar transport equation with the contributions of turbulent [1, 5]:

$$\frac{\partial C}{\partial t} = -v\nabla C + \nabla\left(D\nabla C\right) + S_C\,, \tag{1}$$

where $D = \overline{D} + D_{turb}$ – total diffusion coefficient, $\overline{D}$ – coefficient of molecular diffusion, D_{turb} is the coefficient of turbulent diffusion, which depends on and the Schmidt turbulent number Sc_T (according to the Kays-Crawford model [2]). Equations are supplemented by boundary conditions.

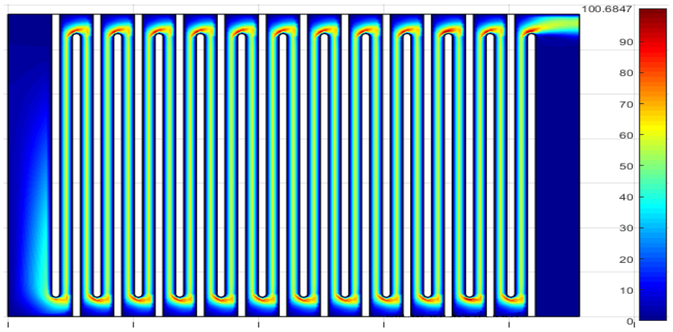
In a nonisothermal turbulent flow for the case $\rho = const$ i $k = const$, applying the averaging rule to the heat equation, we obtain:

$$\frac{\partial T}{\partial t} + (v\cdot\nabla)T = a\nabla^2 T + \frac{q_V}{\rho c_\rho} \tag{2}$$

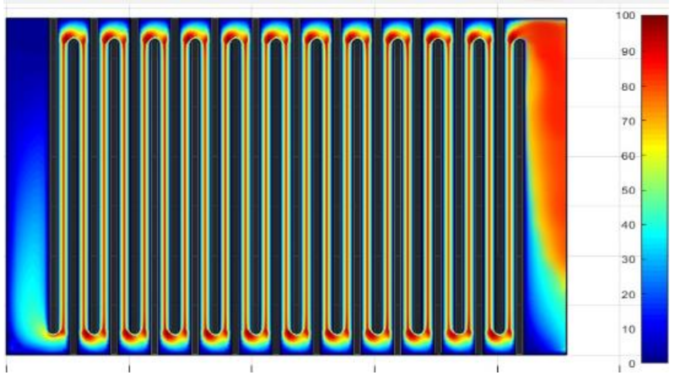
where $a = k/\rho c_\rho$ thermal diffusivity, k is thermal conductivity, c_ρ is specific heat capacity ρ is density, q_V – the intensity of internal heat sources. The amount of heat released during the electrode heating of the liquid is proportional to the current strength, its time of passage and the voltage drop $q_v = I\cdot U\cdot t$, where U is applied voltage, I is current.

The solution of the corresponding model problem with the use of the asymptotic approximation [3, 4, 6] of the solution of the boundary value problem is found, and the results of calculations of the distribution of the concentration of iron and water temperature in the electrocoagulator and the output of the coagulator depending on the current strength are given.

The distribution of the concentration of iron and water temperature in the electrocoagulator at the initial time and after 240 min is shown in Fig. 1 and Fig 2. Analysis of the distribution of iron concentration inside the rector allows predicting various hydrodynamic phenomena such as internal recirculation and dead zones that affect the formation of a coagulant.

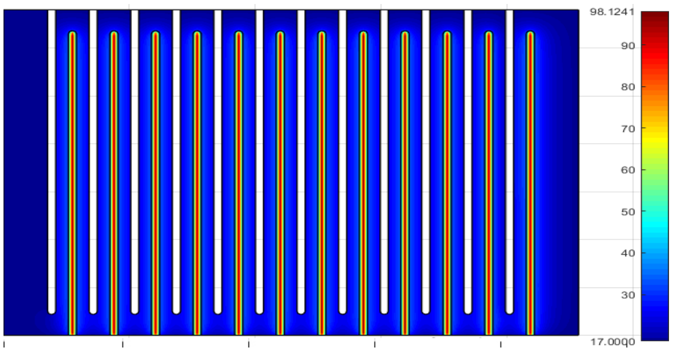


a)



b)

Figure 1. The distribution of the concentration of iron at the initial time (a) and after 240min (b)



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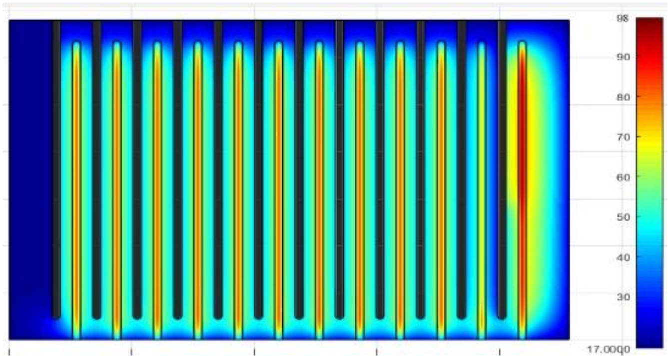

b)

Figure 2. The distribution of the water temperature at the initial time (a) and after 240min (b)

V. CONCLUSION

The proposed methodology for calculating the concentration distribution can be used to analyze the influence of heat and mass transfer in the electrolyte and the kinetics of the reaction on the electrodes, as well as the basis for experimental and theoretical studies of optimization and automation of the process of formation of coagulant by the method of electrocoagulation.

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