

Influence of the shear flow rate on the effect of water purification during the process of its deferrization in a rotor-pulsating apparatus

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Abstract – This paper presents the results of studies to determine the purification effect in the process of water deferrization in an aerator-oxidizer at different shear flow rates over a certain number of processing cycles.

Keywords – deferrization, aerator-oxidizer, ejector, purification effect, shear flow rate

Introduction

Aeration remains the most common method of natural waters deferrization. In addition, under the condition of intense aeration, the efficiency of other methods increases [1].

At the Institute of Engineering Thermophysics of the National Academy of Sciences of Ukraine, studies were conducted to the use of the rotor-pulsating apparatus as an aerators [2,3].

In the work [4] the results of research on the oxygen absorption rate in water solutions in the setup, consisting of an ejector unit and a disperser-mixer which is a rotor-pulsating apparatus are presented. The aim of the work was to evaluate the efficiency of the rotor-pulsating apparatus in the aeration of aqueous solutions by the method of chemical oxidation by air's oxygen of sodium sulfide, which was a part of the model solution.

By comparing the efficiency of aeration of some setups with the studied sulfite method under the generalized criterion, it was determined that, with the disperser-mixer proposed in this study, the specific energy consumption per unit of dissolved oxygen was an order of magnitude higher than the pneumatic and mechanical aeration types found in the literature.

Materials and methods.

Studies to determine the purifying effect in the process of water deferrization were carried out on an aeration and oxidation setup with a rotor-pulsating apparatus as an aerator-oxidizer and an ejector installed in the suction nozzle of the rotor-pulsating apparatus. The scheme and principle of the setup is given in [5]. Table 1 shows energy and hydraulic characteristics of the setup.

Table 1

Energy and hydraulic characteristics of the setup

Shear flow rate, s^{-1}	$106 \cdot 10^3 s^{-1}$	$132 \cdot 10^3 s^{-1}$
Air water mixture flow, m^3/h	3.38	3.56
Air flow rate m^3/h	0.98	1.31
Pump head, MPa	0.04	0.07
Power consumption, kWh	1.62	2.35

Studies were carried out on model solutions at an initial iron (II) concentration of 3.5 mg/L during a certain number of processing cycles followed by filtration.

Results and discussion.

During the experiment, in the aerator-oxidizer, the shear flow rate, which is the product of the angular velocity of the rotor-pulsating unit on the inner diameter of the large rotor divided by the gap between the rotor and the stator, was changed.

To analyze the efficiency of the process, we selected the effect of water purification for one processing cycle, the value of which was calculated by the following equation:

$$E_{def} = \frac{C_0 - C}{C_0} \cdot 100\% \quad (1)$$

where C_0 - initial total iron concentration total iron, mg/dm³; C - total iron concentration after one processing cycle, mg/L.

Tables 2 and 3 show the purification effect during water processing in the aerator-oxidizer at a shear flow rate of $106 \cdot 10^3 \text{ s}^{-1}$ and $132 \cdot 10^3 \text{ s}^{-1}$.

Table 2

The effect of water purification at the shear flow rate of $106 \cdot 10^3 \text{ s}^{-1}$.

Number of processing cycles	Iron concentration, mg/L	Purification effect, %
0	3.50	67.14
1	1.15	47.82
2	0.60	48.30
3	0.37	30.00
4	0.30	24.00

Table 2

The effect of water purification at the shear flow rate of $132 \cdot 10^3 \text{ s}^{-1}$.

Number of processing cycles	Iron concentration, mg/L	Purification effect, %
0	3.50	87.50
1	1.80	80.00
2	0.50	60.00
3	0.20	40.00
4	0.11	14.00

The data presented in tables 2 and 3 indicate that during the first processing cycle, the purification effect of in both cases is the highest compared to the subsequent cycles. So, with the shear flow rate of $106 \cdot 10^3 \text{ s}^{-1}$, the purification effect is almost 70% at a concentration of Fe (II) ions of 3.5 mg/L and about 30% at a concentration of Fe(II) 0.5 mg/L. Increasing the shear flow rate of $132 \cdot 10^3 \text{ s}^{-1}$ leads to an increase in the purification effect of the first processing cycle up to 85% at the concentration of Fe (II) ions of 3.5 mg/L. During subsequent processing cycles, the concentration of Fe (II) ions decreases to 0.5 mg/L and the purification effect is reduced to 60%.

Conclusion

It is determined that the greatest effect of water purification in the aerator-oxidizer is observed after the first processing cycle and its value increases with increasing shear flow rate.

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