ISSN 1070-4272, Russian Journal of Applied Chemistry, 2007, Vol. 80, No. 9, pp. 1604–1605. © Pleiades Publishing, Ltd., 2007.
Original Russian Text © V.V. Marakov, 2007, published in Zhurnal Prikladnoi Khimii, 2007, Vol. 80, No. 9, pp. 1571–1572.

BRIEF COMMUNICATIONS

Electromagnetic Method for Softening Natural Water

V. V. Marakov

Berezniki Branch, Perm State Technical University, State Educational Institution for Higher Professional Education, Berezniki, Perm krai, Russia

Received: October 9, 2006; in final form, March 2007

Abstract—A water softening method was saggested. The optimal parameters of the external electric field were determined and apparatus for the implementation of the suggested method was described. The mechanism of the coagulation of hardness salts was studied.

DOI: 10.1134/S1070427207090315

The hardness determined by the concentration of dissolved calcium and magnesium salts is one of important quantitative characteristics of quality of natural water. Thermal, chemical, and ion-exchange methods are used for water softening, i.e., for removal of hardness salts from it [1]. The thermal method of water softening does not remove magnesium salts and converts a half of dissolved calcium salts into insoluble compounds. The chemical and ion-exchange methods involve ion-exchange processes to substitute cations of dissolved calcium and magnesium salts by the cations of chemical reagents used for water softening. The above methods of water softening lead to secondary chemical contamination of water.

The known methods of electromagnetic softening do not provide the necessary technical result and require considerable energy expenditure per unit volume of treated water.

A softening method involving treatment of water with a pulsed electric field was developed [2]. In this method the energy expenditure per unit volume of treated water is minimal, with no chemical contamination of water.

In this study, the optimal parameters of the external electric field ensuring the necessary degree of softening of natural water were determined.

EXPERIMENTAL

It was found that the exposure of water, irrespective of its volume, to a low-frequency electric field causes hardness salts to convert into insoluble compounds which form a precipitate containing 75% calcium salts and 25% magnesium salts on the average. The necessary degree of water softening is obtained at a frequency of ac electric field varying from 1 to 5 Hz, intensity of the external electric field in the treatment zone of 2–2.5 units, and a treatment time of 10–15 s. As a result of this exposure, the hardness of natural water is half as large on the average. The second stage of the treatment performed under the same conditions (i.e., time and parameters of the external electric field are the same) causes the content of calcium and magnesium salts to decrease by 25% of their initial content on the average. The necessary content of hardness salts is obtained after multistage treatment. The choice of the parameters of the external electric field is determined by the technical result. When treatment is performed at a frequency of less than 0.5 Hz or more than 5 Hz, the hardness of natural water decreases by 10% on the average and the chemical contamination of water owing to the electrolysis takes place. The water softening method that we developed provides water treatment in both closed- and flow-type cells.

The developed method uses two flow-through electrolytic cells connected in series to decrease the energy expenditure per unit volume of treated water. Each cell has alternating ground and feeding electrodes. The number of the electrodes in the cells is determined by a water flow (average flow velocity in the interelectrode space $v \leq 0.1$ m s^{-1}). This value of the flow velocity provides the necessary technical result on water softening. To the feeding electrodes of each cell, connected in a series, ac electric field with a frequency varying from 1 to 5 Hz was applied from one source.

The voltage diagram measured across the resistor ($R = 5.86$ Ω) connected in a series with the cell and used for the determination of the current strength passed through the treatment circuit was obtained for the natural water treated in a 13.5 cm^3 cell by ac elec-

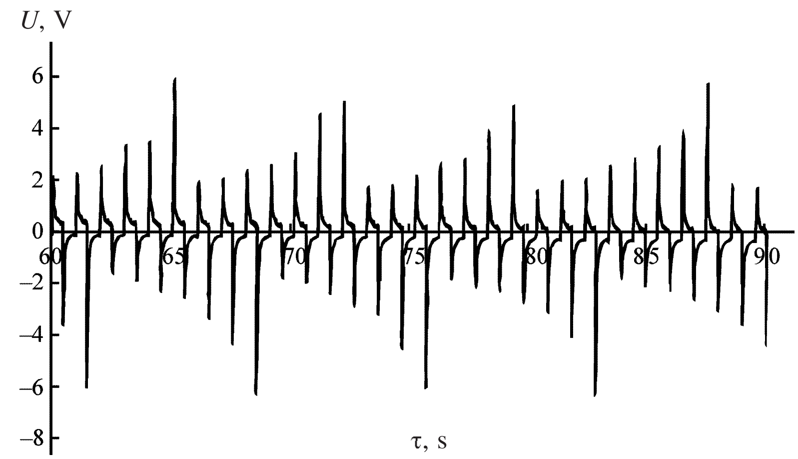

Fig. 1. Voltage U across the resistor measured under the exposure of natural water to ac electric field (frequency 1 Hz, voltage 3 V). (τ) Time; the same for Fig. 2.

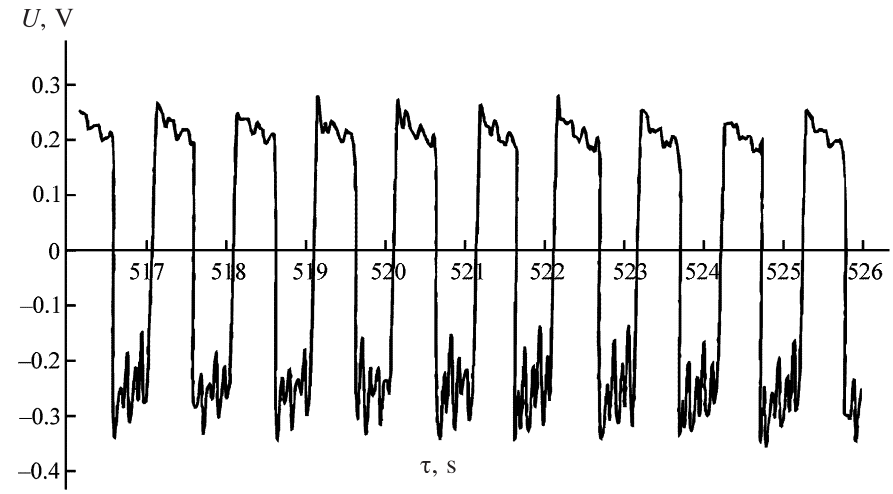

Fig. 2. Voltage U across the resistor measured under the exposure of distilled water to ac electric field.

tric field with a frequency of 1 Hz and a supply voltage of 3 V (Fig. 1). The voltage was measured using a Real Lab system for data collection and control, having an 8-channel analog collection unit with an interval of channel interrogation of 2 ms. A potential drop across the resistor was recorded by one channel of the measuring system. The analysis of the results showed that the potential drop and, consequently, the current passed through the resistor at any time of the measurements depend on the concentration of dissolved salts in the water [3].

We used distilled water to study the effect exerted by dissolved salts on the electrical properties of natural water. The voltage diagram measured across the resistor under the exposure of ac electric field (frequency 1 Hz, supply voltage 4.6 V) to distilled water ($V = 13.5$ cm^2) is presented in Fig. 2. The analysis of the results shows that, when the concentration of dissolved salts in distilled water is minimal, a voltage drop across the resistor remains virtually constant during the exposure time.

CONCLUSIONS

A pulsed method of water softening, causing no chemical contamination of water and ensuring minimum energy expenditure, was suggested.

REFERENCES

1. Kul'skii, L.A., Goronovskii, I.T., Koganovskii, A.M., and Shevchenko, M.A., *Spravochnik po svoistvam, metodam analiza i ochistke vody* (Reference Book on Properties, Analysis, and Treatment of Water), Kiev: Naukova Dumka, 1980.
2. RF Patent 2217384.
3. Sokol'skii, Yu.M., *Omagnichennaya voda: pravda i vymysel* (Magnetically Treated Water: Facts and Fiction), Leningrad: Khimiya, 1990.