Effect of Ultrasonic Treatment On Conductivity And pH Indicator Solutions of Organic Acids.

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Abstract **- The article presents the results of laboratory studies on the effect of ultrasonic treatment at 30 kHz solutions of organic acids in a wide range of concentrations to changes in pH and conductivity. Ultrasonic treatment in the concentration range 10^{-1} - 10^{-15} does not lead to a significant change in electrical conductivity, and in the range of 10^{-6}-10^{-15} led to a significant decrease in electrical conductivity almost all embodiments. It was established two local maxima electrical conductivity may be indicative of the formation of charged clusters in the solution at 10^{-12} and 10^{-15} M under the influence of ultrasonic irradiation.**

Index Terms **- Organic acids, ultrasonic exposure, conductivity.**

I. INTRODUCTION

ULTRASONIC EXPOSURE - elastic mechanical oscillations with a frequency greater than 20 kHz, propagating in different physical environments.

In the frequency range of 5-10 kHz are marked physic-chemical phenomena such as separation of molecules and ions with different masses, waveform distortion, the appearance of the alternating electric field, capillary-acoustic and thermal effect, the activation of diffusion. Manifest spillovers affecting the processes of extraction of medicinal plant and animal materials, there has been increasing reverse osmosis process, the permeability of cell membranes, are made possible sterilization of heat-sensitive substances, phonophoresis, produce concentrated inhaled aerosols.

II. PROBLEM DETERMINATION

The aim of this work is to study the influence of ultrasonic exposure on the change in pH and electrical conductivity of aqueous solutions of organic acids in concentrations ranging from 10^{-1} to 10^{-15} M.

III. THEORY

Previously, we conducted laboratory studies on the combined use of herbicide on the basis of N-(phosphonomethyl)-glycine, a mixture of organic acids in very small concentrations (VSC) and the ultrasonic dispersion. [2] Using ultrasonic atomizer of model USS-0.15/44-EM (see Fig.1) (working frequency of 22 kHz, the average diameter of the particles sputtered 40-50 mm) resulted in an increase in the phytotoxicity of the herbicide of about two times compared to the embodiment herbicide in water.

Fig. 1. An ultrasonic atomizer of model USS-0.15/44-EM

We therefore undertook a study on the effect of ultrasonic exposure change of pH and conductivity of the drug upon dilution with organic acids.

IV. APPLICATION OF ULTRASOUND

It is now widely used feature of ultrasonic exposure speed up processes in liquids.

High-intensity ultrasound technology in liquid media due to [3]:

- Specific liquids impedance significantly greater than that of gas, however, more power is emitted from the liquid in the oscillating system when the same tool oscillation amplitude oscillatory system. Therefore the conditions for entering the ultrasonic waves in the liquid is more favorable than in other environments.
- Ultrasonic cavitation, which runs only in liquid media provides maximum energy treatment of liquids and solids in a liquid. Ultrasonic cavitation generates a large amount of second order effects, which, in turn, provide the intensification of technological processes occurring.

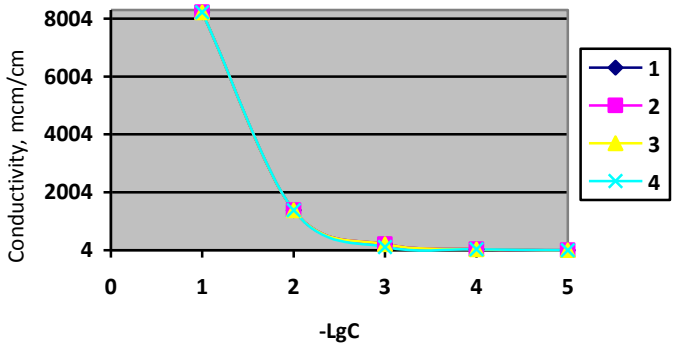
V. RESULTS OF EXPERIMENTS

For the study was used a solution of organic acids comprising citric acid, succinic acid, oxalic acid, malic acid, and α-ketoglutaric acid in a specific ratio. The range of acid concentration was 10^{-1}-10^{-15} M.

To investigate the effect of ultrasound on the conductivity and pH of the solutions of organic acids used ultrasonic bath UM-4 (operating frequency 30 kHz). The treatment was performed for 5, 15 and 30 minutes, immersing the flask in a bath solution.

The pH of the feed solution and the solution was measured after ultrasonic exposure in pH-meter EXPERT 001. The results showed no significant change in pH.

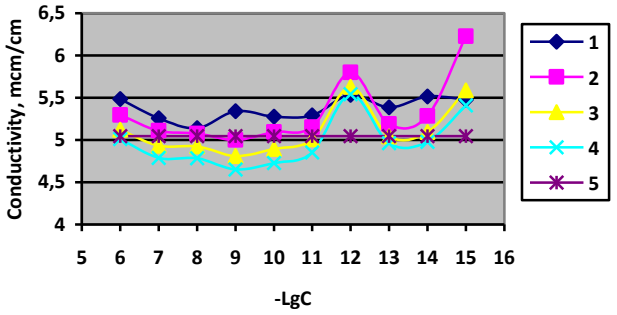
Conductivity was measured in EXPERT 002 - conductivity without ultrasonic exposure (1), the electric conductivity by ultrasonic exposure for 5 minutes (2) for 15 minutes (3) and 30 minutes (4). Instrument error was 0.078 mcm/cm. The results are shown in Fig.2 and Fig.3.



1- untreated; 2- ultrasonic exposure 5'; 3- ultrasonic exposure 15'; 4- ultrasonic exposure 30'.

Fig. 2. The dependence of the electrical conductivity of the solution of the organic acid concentration in the range from 10^{-1} to 10^{-5} M.

According to Fig.2 shows that the use of ultrasonic exposure has no significant effect on the change of electric organic acid solution in the range from 10^{-1} to 10^{-5} M.



1- untreated; 2- ultrasonic exposure 5'; 3- ultrasonic exposure 15'; 4- ultrasonic exposure 30', 5 – H_2O.

Fig. 3. The dependence of the electrical conductivity of the solution of the organic acid concentration in the range from 10^{-6} to 10^{-15} M.

According to the results it can be concluded that the ultrasonic treatment of the solution of organic acids in the range from 10^{-6} to 10^{-15} M reduces electric conductivity in virtually all embodiments. The presence of two local maxima may indicate the presence of associates in solution at a concentration of 10^{-12} and 10^{-15} M.

VI. DISCUSSION OF RESULTS

The use of ultrasonic treatment of a solution of organic acids with a frequency of 30 kHz in the range from 10^{-1} to 10^{-15} M did not significantly change the pH of the solution and measure the electrical conductivity in the range of 10^{-1}-10^{-5} M.

The use of ultrasonic treatment and then measuring the electrical conductivity of the indicator on the Conductivity meter in the concentration range of 10^{-6}-10^{-15} M reduced the electrical conductivity of solutions, and the peaks at concentrations of 10^{-12} and 10^{-15} M can be attributed to the formation of charged water clusters.

Thus, it can be concluded that the application of ultrasound alters the activity of the ions in the solution of organic acid and nano- and femtoconcentrations that may cause changes in the phytotoxicity of herbicides when combined herbicide organic acid concentrations and ultrasonic exposure.

REFERENCES

[1] Vereshchagin, A.L. Influence of an ultrasonic irradiation and growth regulators on rizogennaya activity of vegetative objects / A.L. Vereschagin, A.N. Khmeleva. - Biysk: Publishing house AltSTU it I.I. Polzunova, 2010. – p. 73.

[2] Khmelev, V.N. Changing of Phytotoxicity N-(Phosphonomethyl)-Glycine Under the Influence of Frequency of an Ultrasonic Atomizer / V.N. Khmelev, J.I. Zakharieva, A.L. Vereshchagin; XIII International Conference and Seminar of Young Specialists on Micro / Nanotechnologies and Electron Devices EDM 2012, Novosibirsk, NSTU, 02/07/2012.

[3] Khmelev V. N. Application of ultrasound of high intensity in the industry / V.N. Khmelev, A.H Slivin, R.V. Barsukov, C.H. Gipsies, A.B. Rascals; BTI. - Biysk: Publishing house Alt STU, 2010. – 196 p.

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