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APPLICATION OF THE ELECTROACTIVATION METHOD FOR THE DISINFECTION AND THE INCREASING OF TRANSPARENCE OF WASTE WATER OF FARMING PRODUCTION ORIGIN

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A b s t r a c t. The complex of theoretical, experimental and applied investigations connected with the application of the electroactivation method for correction of natural and waste water properties has been carried out. Principle of operation of electroactivation is concluded in following scheme: influence of electric current on liquid properties while it flows in electrochemical systems, divided by semi-permeable membranes.

Investigations carried out in this area revealed the possibility of nonreagent changing the natural waters properties, e.g. by varying pH from 1.5 to 14. Thus, full disinfection and purification from heavy metal ion may be achieved. On base of the research work the approach was elaborated which specified the complete cycle of disinfection treatment regard to waste waters and slurry in conditions of stock-farming and poultry production. The above method was tested in corresponding conditions and confirmed its efficiency.

K e y w o r d s: electroactivation, natural and waste waters, disinfection, clarification, stock-farming

INTRODUCTION

Waste water in the farming production complex and, particularly, in stock-farming may be considered as the most contaminated and infected [1-3,7,8]. Various methods of water disinfection and clarification usually require use of chemical reagents, whereas applying of such physical factors as exposing of water run-off to ionizing radiation, neutron stream or ultra-violet radiation, appeares rather expensive, and sometimes non-effective in conditions of real production, where it is necessary to treat appr. 600-1500 t/day [3]. Additionally, opportunity of full automatization, as well as refusal from chemical reagents attracts more and more attention to study of electrochemical methods of disinfection and clarification. Even among methods recently being proposed by researchers (e.g., electrolysis, electrocoagulation, electrofluetation), the most important one is lacking, namely, one which could provide simultaneously full disinfection and clarification in production conditions.

By our opinion, one of the most progressive electrochemical approaches is electrochemical activation. Figure 1 illustrates the basic arrangement which is used in all known experimental set ups designed to treat natural waters or solutions [1,2,4,10]. As can be seen from Fig. 1, the liquid under treatment flows into lower part of structure, then runs upwards against gradient of gravitational force, passes cathode and anode chambers and exits the system. In this case catalyte acquires acidic properties, whereas analyte - alkaline ones.

Note, that atomic and molecular oxygen and chlorine will release in analyte, whereas hydrogen peroxide, accordingly, in cataline. It will be followed by drastically change of redox-potentials. During exploitation of such arrangement in farming industry, some problems, however, have been revealed, e.g., the lack of data on fractions properties storing, relaxation, relation between initial and current (after treatment) parameters and composition, as well. Among the most serious problems to solve is physical and chemical mechanism of receiving the solutions with desired properties. Besides, known reports on disinfection

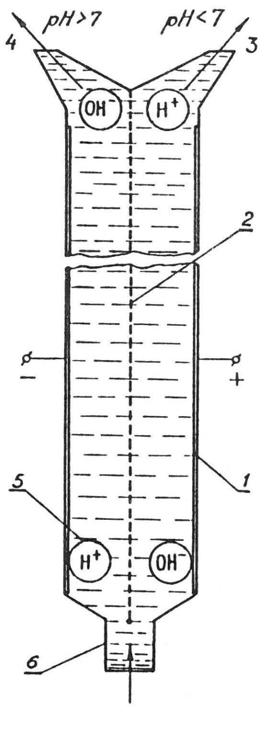

Fig. 1. Diagram of flowing electrochemical system for electroactivation of liquids. 1 - electrodes, 2 - membrane, 3 - exit for acid fraction, 4 - exit for alkaline fraction, 5 - discharge of ions H^+, OH^-, 6 - inlet pipe for liquid be treated.

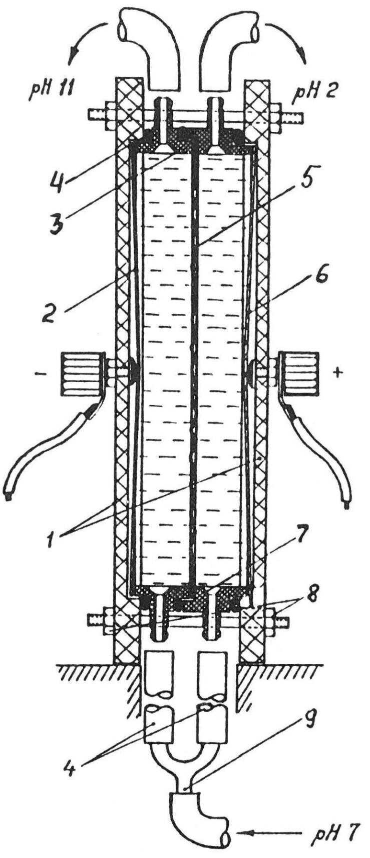

Fig. 2. Activator designed to treat liquids or running waters. Chamber volume: 1 l. 1 - side walls; 2,6 - electrodes; 3, 7 - plates (acrylic plastic) supporting cathode and anode chambers and inlet pipes; 4 - hydroisolation gasket; 5 - membrane; 6 - coupling bolt; 8 - boltes; 9 - T-joint.

and clarification are limited mainly by low levels of infection and pollution [1,2,10]. Similar reasons gave the beginning of comprehensive investigations in laboratory of hydrophysics, Agrophysical Research Institute.

EXPERIMENTAL TECHNIQUE

Before beginning of the work directed on development methods of sewage water disinfection, clarification and purifying from heavy metals, we have fulfilled a cycle of laboratory experiments on natural water and solutions, on waste water in the electrochemical and machine-building complex, and then at breeding-stock farm.

To provide investigations we prepared a number of electroactivators of various volumes and capabilities. Figure 2 shows one of the modified structures, due to advanced insert, made from dielectric rings, we enlarged the efficiency. Figure 3 presents photo of above arrangement. Activator ensured the treatment process in static conditions or in running water. To provide an uniform income of liquid and to ensure steady operation, we used perestaltic pumps of different structures and efficiencies from 5 l/h to 150 l/h. The D.C. sources have been used with different power capacities.

Experiments included measurement of pH and redox-potential as well as conductivity for solutions had duration appr. 2-3 weeks. Kinetics of waste water clarification for different compositions has been also studied.

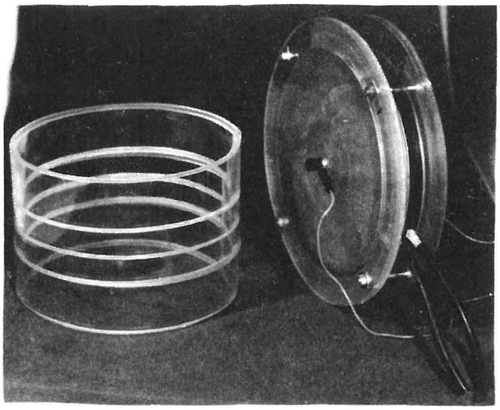

Fig. 3. View of electroactivator of varying volume.

The problem of disinfection and clarification of such specific farming product as manure attracted our attention in full volume, including removal of slurry at stock farming and poultry plants.

We investigated bacteriological impurity and some physical and chemical parameters of stock-breeding sewage waters with assistance of personnel of special epidemiological laboratory of Cherepovetz (Vologda Region), where large live-farming production complex is located. Kinetics of clarification was analysed using 500-ml measuring cylinder, which permitted to measure moments of appearance of clear boundary line between transparent liquid and non-transparent precipitate. The treatment was ensured for non-dilute sewage and for sewage with several different dilution rates by adding the drinking water, in accordance with different conditions of hydro-wash-off.

RESULTS AND DISCUSSION

Presented data confirm that treatment of water having low mineralization level (distillate, pipe-water), is not able to provide steady-in-time fractions of the solutions. But in the same time, raising the concentration of the solutions, as seen in Fig. 4, reveals the opportunity to receive and to store the parameters, significanly different from initial ones. Unfortunately, it is not justified for catalyte. The redox-potential rapidly reduces to its initial value in 24 hours (Fig. 4b). This method is of the most interest for clearing and de-

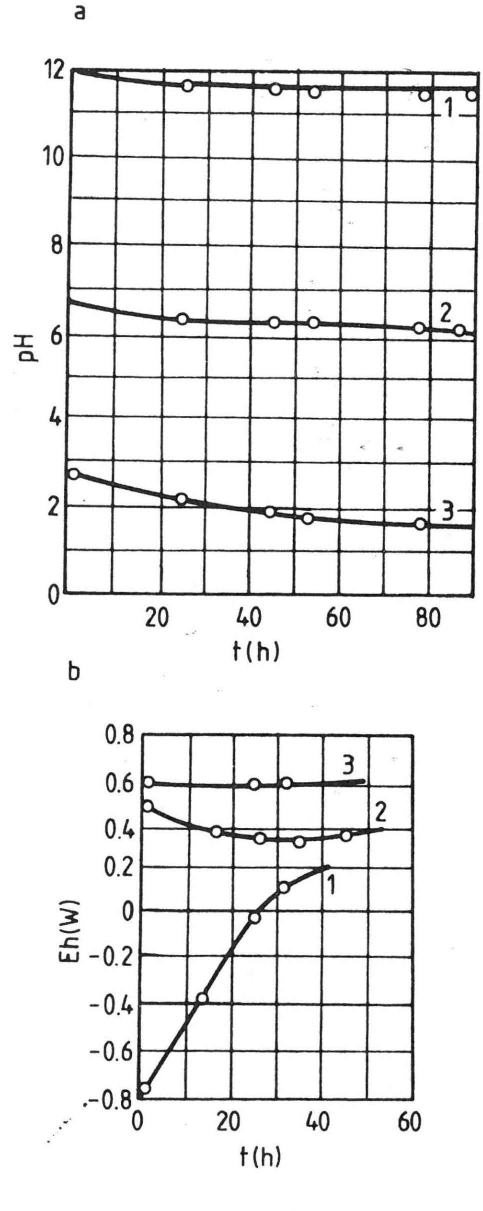

Fig. 4. Results of tretment for 15 % aqueous solution Na_2SO_4. Time of treatment in static conditions 8 min. Specifications: I = 2 A; U = 36 V. Measurements begin in 15-20 min after treatment completed. Kinetics of pH values (a) and redox-potential Eh (b) for two fractions of liquid and reference solution. 1 - alkaline fraction; 2-15 % solution of Na_2SO_4; 3 - acidic fraction.

mineralization of drainage waters in arid regions where the high level of mineralization reflects the conventional conditions [11]; that is stipulated by their fall-out in form of hydroxide in catalyte at pH=10-13.

Besides, it has been shown that sewage waters might be clarified and purified not only by direct treatment but adding the parts of analyte or catalyte. To conform this conclusion, we performed an experiment with non-transparent suspension of iron-hydroxide, thus simulating the above mentioned system (1.6 % Fe^{+3}). Adding 50 % treated solution (catalyte) to suspension results in full clarification and precipitation. In the same time, adding of the acid fraction provides stabilization of suspension. Positive results have been observed while treatment of farming sewage waters, taken directly from the pipe and diluted at different rates as well.

The effect of full clarification and full disinfection had been ensured at specific treatment terms. In fully clarified fraction the content of dry substance attained 1.5-2 g/l, mainly consisting of mineral salts. Figure 5 shows kinetics of clarification of live farming sewage after treatment, whereas Table 1 gives the initial values of biological pollution of sewage and some results of disinfection. Together with full disinfection of sewage waters in clarified fraction, other physical and chemical properties has been improved, refer to Table 2.

However, this approach does not provide full freedom from high concentration of ions of non-organic salts and significant quantity of nitrogen components.

Clarified liquid fraction possesses relatively low viscosity, and represents Newton liquid, moreover limited shear stress forces to attain zero. Dense fraction precipitated is featured by high viscosity, non-Newton type of flow, resembling initial manure as to its reological properties [6,7,9]. Consequently, liquid fraction being wholly disinfected, may be freely used in secondary hydro-run-off, that would ensure the reduction of the water consumption, moreover, it would make the

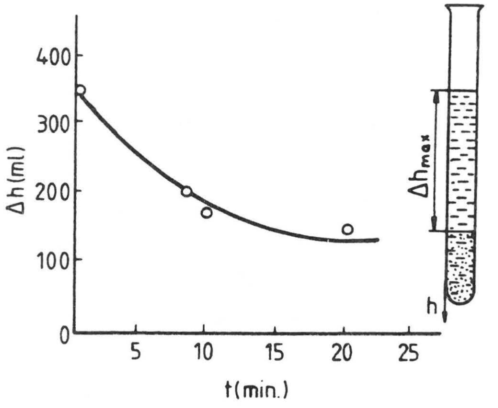

Fig. 5. Kinetics of waste water clarification after electric treatment in live farming complex: h = f(t) - acid fraction; h - height of clarified liquid; anode - titanium; cathode - iron.

Table 1. Results of bacteriological probes for sewage waters, including slurry. Probes had been taken in Cherepovets District, Vologda Region

Microbe number		Coli-Titer		Coli-Index	
Initial (cs/ml)	After treatment (cs/ml)	Initial -	After treatment -	Initial (cs/ml)	After treatment (cs/ml)
$3 \cdot 10^6$	$3 \cdot 10$	$4 \cdot 10^{-5}$	11	$23 \cdot 10^6$	<90

Table 2. Results of analysis of physical and chemical properties of the sewage waters (fraction taken after settlement)

Parameter	Control	After treatment
Smell	Manure	Manure
Threshold of disappearance in dilution	2048	24
Colour	dark-brown	light yellow
Threshold of disappearance in dilution	8092	-
Clarification (drain into measuring cylinders 500 ml)	up to 30 days separation is not observed actually	100 % separation during 30 min into transparent dense fraction
Biological oxygen factor	1920	90
pH	7.1	4.35

approach ecologically safe. Dense fraction may be used for compost, planned to ferlization.

Note that this method, as other electrochemical methods demands additional previous clearing of the sewage waters from large-size suspended particles, which may be also directed to the compost formation. The most effective is the treatment of steady colloidal system including particles of size less than 0.1-0.5 mm, which can not be treated by other methods. This treatment is provided in running conditions.

Currently this approach is under modifications to be more suitable for large volumes of sewage waters.

CONCLUSION

Finally, we would like to note that using of electroactivation method allows to ensure true clarification and disinfection of sewage waters, to receive ready preciptation without adding special reagents. This method gives the opportunity to receive valuable material from the sewage, which are considered currently as harmful by-products, dangerous for ecology. We hope that our study would be useful not only in medicine or veterinary [1,2,5], but for the improvement of ecological state of the soil and the air in environments of farming production facilities.

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