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ELECTROMAGNETIC CLEANING OF HOUSEHOLD WASTE FILTRATE

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***Анотація.** Стаття присвячена фізичному методу очищення стічних вод побутових відходів. Для очищення потоку рідини використовується соленоїдний блок управління. Зниження агресивності фільтрату забезпечено видаленням домішок з основного потоку. З урахуванням властивостей матриці планування експерименту обчислені коефіцієнти регресійного рівняння. Вони адекватно відображають процеси управління траєкторією очищення рідини при її виведенні з основного потоку.*

***Ключові слова.** Очищення, фільтрат, фізичні способи очищення, фокусування іонів забруднення, управління траєкторією руху домішок, прецесія Лармора, планування експерименту*

***Annotation.** The article is devoted to the physical method of wastewater treatment from household waste. A solenoid control unit is used to clean the fluid flow. Reducing the aggressiveness of the filtrate is provided by the removal of impurities from the mainstream. Taking into account the properties of the experiment planning matrix, the coefficients of the regression equation are calculated. They adequately reflect the processes of controlling the trajectory of cleaning the liquid when it is removed from the mainstream.*

***Keywords.** Cleaning, filtrate, physical ways of cleaning, focusing of ions of pollution, management of a trajectory of the movement of impurity, The Larmor precession, planning of the experiment.*

Introduction. The concept of “cleaner production” according to the UNIDO methodology (United Nations Industrial Development Organization) is to improve industrial processes with lower levels of waste and pollution to preserve natural resources [1].

In the human environment, the need for water is growing. To prevent pollution of water bodies and rational use of water resources, mining enterprises use recycled water systems. However, today it is impossible to choose a system of post-treatment of water, which provided the necessary degree of purification for various conditions [2]. An urgent problem is the development of innovative methods for treating recycled water in mining enterprises. Therefore, it is important to develop effective, resource-saving, environmentally sound ways of post-treatment of water with the ability to adjust the parameters of post-treatment for changing conditions.

Today, the main methods of water purification are physical, chemical and biological [3].

Disposal of municipal solid waste becomes an urgent task as megacities develop. An important problem associated with the accumulation of household waste is the disinfection of wastewater. The discharge of wastewater into natural surface sources is possible when developing integrated disinfection methods, a combination of biological, chemical, physical and membrane methods.

Analysis of literary sources. In [4], the disinfection of wastewater accumulated during storage or landfill had reviewed. Known methods for disinfecting wastewater, such as chemical processing, biological treatment (aerobic and anaerobic) have both advantages and disadvantages. Chemical and physical disinfection (coagulation / lumping, chemical precipitation, adsorption, ammonia removal, chemical oxidation, ion exchange, and electrochemical treatment), membrane filtration (microfiltration, ultrafiltration, Nano filtration and reverse osmosis) also have drawbacks.



Today, the use of membrane technology, especially Reverse Osmosis (RO), is central to the sewage disinfection chain from accumulated household waste.

Various methods have used for water purification such as ultraviolet irradiation, heat treatment, the addition of disinfectants, for example, chlorine, etc. The use of these methods of water purifications. A study [5] evaluates water treatment using *Phyllanthus Embolic* wood. As a result, color, aroma, turbidity, conductivity, solids, alkalinity, calcium, iron, chloride and nitrate levels had increased in the test container. Total hardness, sulfate, magnesium, and pH levels have reduced. The level of *Escherichia coli*, complete coliforms, and fecal coliforms have reduced. It is established that the wooden pieces of the forest *Phyllanthus Embolic* improve the purity of the water on reduces, turbidity, increasing taste and removing germs.

The study [6] provides information on wastewater treatment by the magnetization method. It examined and disclosed the positive aspects of magnetism and magnetic materials for water purification. Water is the main source of survival on this planet. Its preservation takes precedence. An increase in the supply of water in demand must comply with current standards. Several cleaning methods can ensure that water meets standards. Magnetic separation is one of these cleaning methods. It has used in the mining industry. It provides not only water purification but also pipe cleaning from adhering to impurities on the inner wall of the pipes.

The purpose of the work, tasks, and essence of the work. This work had carried out by following the Law of Ukraine on state programs. (Sheets of the Supreme Council Ukraine, No 2354-VIII from the 03/20/2018 and the General program "Drinking water Ukraine" for 2011-2020, the Law of Ukraine from the 20.10.2011 №3933-VI 2011-2020.

Purpose - Purification of water from contaminants by focusing them with an electromagnetic field at the drainpipe.

Tasks - scientific planning of the experiment to determine the factors under study; the compilation of planning matrices for a complete factorial experiment; calculation of regression coefficients, the use of statistical criteria to assess the homogeneity, normality of experimental data, the significance of the coefficients and the adequacy of the obtained mathematical model.

Statement of the problem in general. As the field strength increases, the circular radius of the contaminated particles (Larimore's radius) decreases and concentrates the pollution in the zone of removal from the total flow. Larimore's radius means the radius of the circular motion of a charged particle in a uniform magnetic field, named after the Irish physicist Joseph Larmor.

The main research material. An electromagnetic control unit (ECU) has proposed for cleaning liquids. The winding of the ECU has arranged so that the induction increases in the range from 10 mTl to 50 mTl in the direction of flow exit from the ECU. Moreover, the vertex of the paraboloid of rotation has sharpened, that is, its cross-section decreases.

The motion of charged impurity particles has modeled by the equation of the canonical circular paraboloid of revolution. The volume of the body, which is cut off with an area $z = c$ from the paraboloid of revolution [7].

Discussion of research results. The calculation of the volume of contaminants focused on the paraboloid of rotation and prepared for removal from the mainstream has carried out using the LabVIEW shell. A linearly increasing dependence of the number of contaminants focused on the rotation paraboloid on the inner diameter of the pipe along which the flow is moving has obtained

Parameter a is determining the inner diameter of the pipe. Therefore, a pipe of 273x16 mm, a wall thickness of 16.0 mm, unmeasured length, and increased accuracy of manufacturing from structural cryogenic steel grade 12X18H10T GOST 9941-81, Hardness HB 10 -1 = 179 MPa was selected.

Contaminants focused on the rotation paraboloid on the pipe section, which has covered by the coil of the electromagnetic control unit, will occupy 21 % of the pipe section volume under the focusing coil.

The results of chemical studies of the filtrate recorded:



- the maximum content of aggressive components of the filtrate before processing it with ultrasonic and electromagnetic flows;
- the maximum permissible concentrations of the same impurities according to the recommendations of SanPIN № 4630-88.

To determine the content of impurities in the filtrate after processing it with ultrasonic and electromagnetic flows, scientific planning of the experiment is necessary. Using a full factorial experiment allows us to refine the mathematical model of the process with a reduction in time and material costs for its implementation [8].

To construct the experimental design matrix, the following impurities had identified as the main factors: ammonium nitrogen NH_4 - φ_1 ; nitrates NO_3 - φ_2 ; phosphates PO_4 - φ_3 .

In the corresponding columns, table 1, the values of the maximum and defined by the sanitary norms allowable content of the corresponding chemicals have listed. The initial parameter " φ " is the total content of chemicals after loading it with ultrasonic and electromagnetic flows, mg / dm³:

According to the results of the experiment, the values of unknown model coefficients have found. The mathematical model should be adequate to real processes. The accuracy and reliability of the model depend on the correct determination of its coefficients.

Taking into account the properties of the experiment-planning matrix, the coefficients of the regression equation are calculated. The calculation had carried out based on average values \bar{F} , which ensures high accuracy of their assessment.

Table 1 - Experiment planning matrix for three factors with a dummy variable $x_0 = 1$

№ experience	Factors on a natural scale			Input parameter g / dm ³ , F	Factors in a dimensionless coordinate system			Average arithmetic factors in kind scale, \bar{F}	
	Ammonium nitrogen NH_4 , mg / dm ³ , NH_4 , мг/дм ³ , φ_1	Нитраты NO_3 , mg/dm ³ , φ_2	Phosphates PO_4 , mg / dm ³ , φ_3		Dummy variable $x_0=+1$	x	y		z
1	2,0	45	3,5	50,5	+1	-1	-1	-1	16,83
2	640	45	3,5	688,5	+1	+1	-1	-1	229,50
3	2,0	52	3,5	57,5	+1	-1	+1	-1	19,17
4	640	52	3,5	695,5	+1	+1	+1	-1	231,83
5	2,0	45	60	107,0	+1	-1	-1	+1	35,67
6	640	45	60	745,0	+1	+1	-1	+1	248,33
7	2,0	52	60	114,0	+1	-1	+1	+1	38,00
8	640	52	60	752,0	+1	+1	+1	+1	250,67

Further statistical analysis of the resulting mathematical model verified the hypothesis of homogeneity of variances by the Cochran's criterion. The normal law of the distribution of errors of individual experiments has confirmed. Then, using the Fisher criterion, the hypothesis of the adequacy of the model has tested, and finally, for each calculated coefficient of the equation, its



significance has checked by the Student criterion. This set of criteria allowed us to evaluate the reliability of the obtained experimental results. Uniformity checks with the same number parallel experiments had carried out using the Cochran. The ratio of the maximum variance to the sum of all variances (Cochran's criterion): (G- criterion). For this, the variance of parallel experiments is determined.

The homogeneity of the average variances allows us to find the value of the random error common to all values of the influencing or measured quantity. [9]. It confirms the adequacy of the equation for the experiment.

Conclusion. 1. An electromagnetic control unit (ECU) of impurities in the filtrate has been developing for their subsequent removal from the mainstream.

2. The proposed ECU differs from the known ones in that it takes into account the functional dependence of the Larimore's radius on the mass of a charged particle and can use for variable conditions.

3. Taking into account the properties of the experimental planning matrix, the coefficients of the regression equation had calculated that adequately reflect the processes of liquid purification during its magnetization.

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