

BLANKET REPRESENTATION AND EXPEDIENT OF DISINFECTING WATER USING PULSING ELECTROMAGNETIC FIELD

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ABSTRACT: The paper deals with comparative analysis of existing expedients and devices of disinfecting water, spots ways of the solution and a new method of water purification using electromagnetic field applied in a crosswise direction. Using the parameter description and theory, the paper draws a model of the installation and conduct a finite element analysis. Finally, the article offers a few additional applications of the pulse electromagnetic device for disinfecting and treating water.

ABSTRAK: Dalam operasi, analisis perbandingan dijalankan bagi menentukan kesesuaian yang sedia ada dan alatan untuk menyahjangkit air. Dengan mengaplikasikan medan magnet lintang, penyelesaian masalah dikenal pasti dengan meningkatkan kemagnetan terhadap medan elektromagnet ke atas air.

KEYWORDS: *Water Disinfection; Electromagnetic Field; Cross Magnetic Field.*

1. INTRODUCTION

In Uzbekistan there are many existing and newly constructed railways passing over the deserted and semidesertic regions. In this connection there is a problem of the population potable water. The railway transportation also is the consumer of water, in particular water is used in many productions, such as cooling of compressors of diesel engines, of diesel locomotives and other inventory, reception a pair, refueling of carriages, rheostat tests of diesel locomotives, etc. Hence, it needs preparation of technical water for a locomotive facility and other services. In this connection special interest represents a question of disinfecting and water treating [1].

The expedient of processing of fluids and the yields including processing of water by a pulsing electromagnetic field with a pulse length 10^{-5} - 10^{-7} of micro seconds and an instantaneous power of a pulse 50 - 1000 mW [2]. Deficiencies of this expedient are a low degree of disinfecting of water, small productivity, major specific rates of flux of the electric power.

The second analog, the close by technical opportunities is the expedient of disinfecting of water the electromagnetic pulse, based on processing of water by an electromagnetic field with induction 7-8 Tl, frequency of following of pulses 10 - 15 Hz, a pulse length 10-15 ms and power consumption 4.0 - 4.5 kW. A deficiency of this expedient is difficulty of arrival of necessary meanings of induction of a magnetic field and major power consumptions.

In operation expedients of sewage treatment with high concentration of organic pollutant a method of methane fermentation and plasma discharges which device is very much the composite surveyed.

The existing methods of sewage treatment by an electromagnetic field using a special generator working in a frequency span from 10 up to 20 kHz [3] is not very effective and the device is very complex.

In operation the technology of water-preparation in rural areas with use complex electrical and a magnetic action on underground potable water is surveyed. Installation for electro pulsing magnetic processing will consist of the generator of electromagnetic pulses and a working body [4]. The generator of electromagnetic pulses includes three functional parts in the composition: a charger, the energy storage unit and the discharge device. In impulse generator the charging and discharge devices function on a various time interval and feebly interact among themselves. However, to the present time, concrete recommendations to the choice of generators and to a substantiation of the parameters, with reference to systems of disinfection of potable water is missing.

Most close technical solution to disinfecting water is using the electromagnetic pulse, is by an electromagnetic field with induction of 7-8 mTl, frequency of pulses in the range of 10-15 Hz, with pulse length of 10-15 ms and with a pulse current amplitude of 200-300 A. However, a deficiency of the given expedient being a small influence the electromagnetic field on molecules of water when lines of flux of a field are guided along fluxion of water, instead of their being perpendicular to fluxion of water in the form of a low degree of disinfection of water.

The device includes a housing, inside which there is a high-voltage electrode, isolated from the housing with the help of the bush sets [8]. The high-voltage electrode is executed as the volumetric lattice which is anchored on shunt. The high-voltage electrode is located between the earthed electrodes which are executed as volumetric lattices and are connected to a housing. In a top hamper of the device for water delivery which acts as a collector with distributive punch sets. On the switching centre the branch pipe bringing stripped water is connected to a target branch pipe ejector, through which in the stripped water moves. Below the electrode system the running nozzle which acts as riffle is located. The branch pipe draining out the processed water is placed in a bottom of a housing and is connected to the intermediate capacity. Below the branch pipe below the hurdle nozzles on a housing is intended for tap unreacted ozone - to an air mix sets. The branch pipe is connected to the pump to ensures delivery from the intermediate capacity. The application of free air in the device is carried out through a branch pipe.

The given work has the high-voltage electrode located between earthed electrodes and hurdle a nozzle for dissolution of ozone on water that creates complexity in a design and difficulties in its operation. Use of a high pressure demands creation of additional systems of protection and the raised qualification of the attendants of the device. The device will consist of a reactor for processing water and electrode system [5]. The reactor will consist of the case in which top part the unit of creation of a water-gas mix of the electrode system located under unit producing the water-gas mix and unit of tap of a water-gas mix is placed under the electrode system.

The unit producing the water-gas mix includes aerator, ejector, branch pipes of a supply of water and tap of air and gases, the aerator being connected to a fan. The unit of tap of a water-gas mix includes the chamber response on which output in ejector and a

target branch pipe is established. The generator of high-voltage pulses is connected to the electrode system.

Lacks of the given methods are complexity of the device, a low resource of work of isolation of electrode systems and electrodes, application of high-voltage pulses of equal 1000 pulses/seconds, application of filters with special road-gravel loading for clarification of water.

The task in view is to solve the problem that would provide lower the influence of electromagnetic field on processable water by applying cross magnetic field in which power lines are directed perpendicularly to a liquid, and also by applying vertical electric field created by a core. Under the action of a magnetic field, additional pressure which entails increase in distance between molecules of water is created. Bubbles are formed inside the water by high density of the microbes. When the pulse pressure is terminated the bubble bursts due to change of pressure leading to destruction of the microbes. For branch of pure water separated from the impurity due to the application of vertical electric field under which ions of oxygen in the water are formed which creates a helical trajectory, twisting around a core, and all the impurities settle at the bottom of a pipe. Since the speed of an electromagnetic wave in water is 5×10^5 m/s, that is exceeds many times the speed of a liquid which is 1.5 - 2 m/s, there is a repeated clearing process. With this characteristic of the system it provides the required kolli - an index and necessary number of microbes in gramme to a molecule of water. Time of clearing does not depend on the geometrical sizes of a pipe and speed of movement of a liquid.

The method of disinfecting water by a pulse electromagnetic field, created by inductance, and also a vertical electric field, is developed with the cross power lines directed perpendicularly to a current of water.

Inductance is outside the dielectric pipe, the core is inside (in the middle of) a dielectric pipe. The device (Fig. 1) for disinfecting represents the solenoid with the general length, $l_c = 2$ m, reeled up on top of a nonmetallic pipe (for isolation from water) with diameter, $d = 159$ mm and is placed inside a metal pipe for prevention from external damages. The solenoid should provide an induction within the limits of 7-10 mT. Water, passing through the solenoid with speed $V = 1$ m/s, serves as a natural heat-conducting path for him. Thus, passing through the solenoid in length $l_c = 2$ m, water is processed during time T, equal $T_{return} = l_c / V = 2$ s.

The solenoid is fed from the transformer which include a network of alternating current by a pressure of 220 V through a thyristor. The thyristor itself manages the pulse generator, since thyristor and the transformer represent the pulse generator. For management of the pulse generator pulses frequency of 10 - 15 Hz and 10 - 15 ms duration are required.

For this purpose the power supply having the one-vibrator, a divider of frequency and the amplifier of capacity of rectangular pulses is required. There are no data, allowing to define parameters of the device and working body in view of productivity of a source of water and his initial contamination. At the same time presence of such clear advantages of the electromagnetic device as an opportunity of concentration and distribution of significant energy at small capacities of devices with a control system, compactness, reliability and controllability process, predetermine their use for disinfecting water with wide areas of his application.

It is found that existing devices and ways of disinfecting water by the pulse electromagnetic field, the waters based on processing by an electromagnetic field with set

forth above parameters have rather low efficiency, have small influence of an electromagnetic field on molecules of water as power lines of a field are directed along flow of a liquid, instead of directing them perpendicular to the flow, that gives a low degree of disinfection of water.

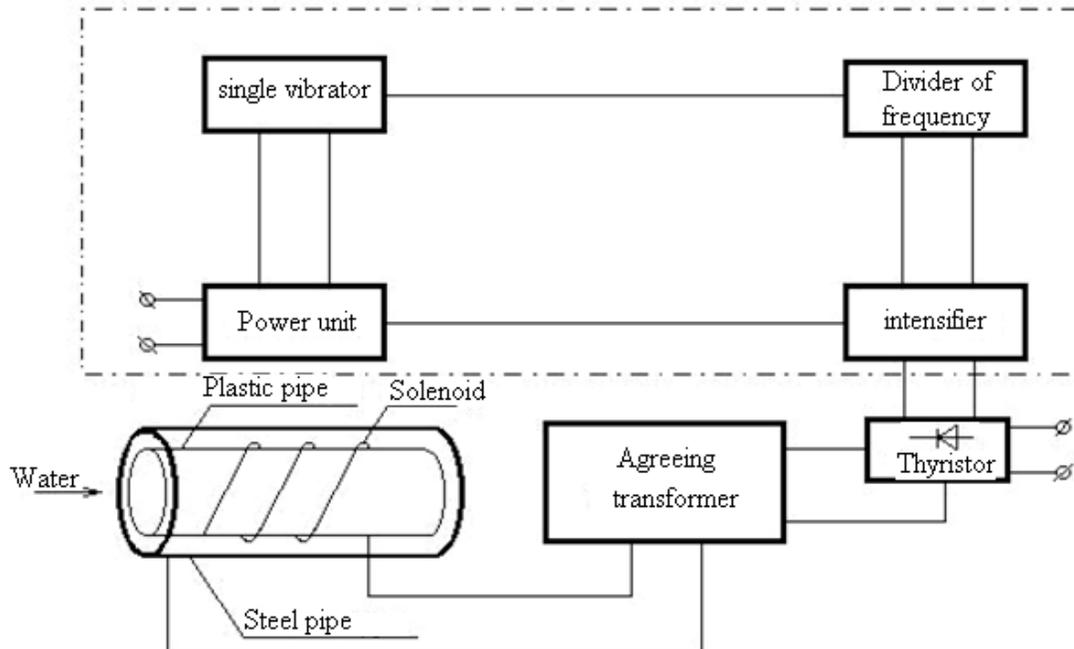


Fig. 1: A function chart of the device for disinfecting water.

2. DESIGN EQUATIONS

2.1 Parameter description

The comparative analysis of existing ways and devices of disinfecting of water allows the determination of ways selecting the optimal application of electromagnetic field on processable water. It is found that the application of a cross magnetic field in which power lines are directed perpendicularly to the direction of the flow of a liquid, and also the effect of a vertical electric field created by a core, taking place inside and in the middle of a dielectric pipe gives the best results in terms of the efficiency of purification of water. The latter is found to be a recommended device [6-7] with control systems with uniform spatial electromagnetic field is presented in Fig. 2. Improvement of technical and operational characteristics are required for higher efficiency and opportunities in practical application of the device.

Proceeding from this, the dissertator puts the following problem: to raise the area of possible application with the improved power parameters and reliability. This problem is solved by improvement of designs of devices of control systems with uniform spatial electromagnetic field. The pulse generator will consist of the following functional blocks: the one-vibrator, a divider of frequency, the amplifier of capacity, a power unit thyristor, and the agreeing transformer. Installation is fixed on the mobile device, i.e. can work at any place.

For reduction of losses contacts are executed as trunks, long wires pass in pipes for exception of influence of an electromagnetic field on them. For cancellation of the influence of electromagnetic field on the operator the coil of inductance are closed by an aluminum foil. The degree of disinfecting of water is adjusted by the frequency of pulses, developed the generator of pulses.

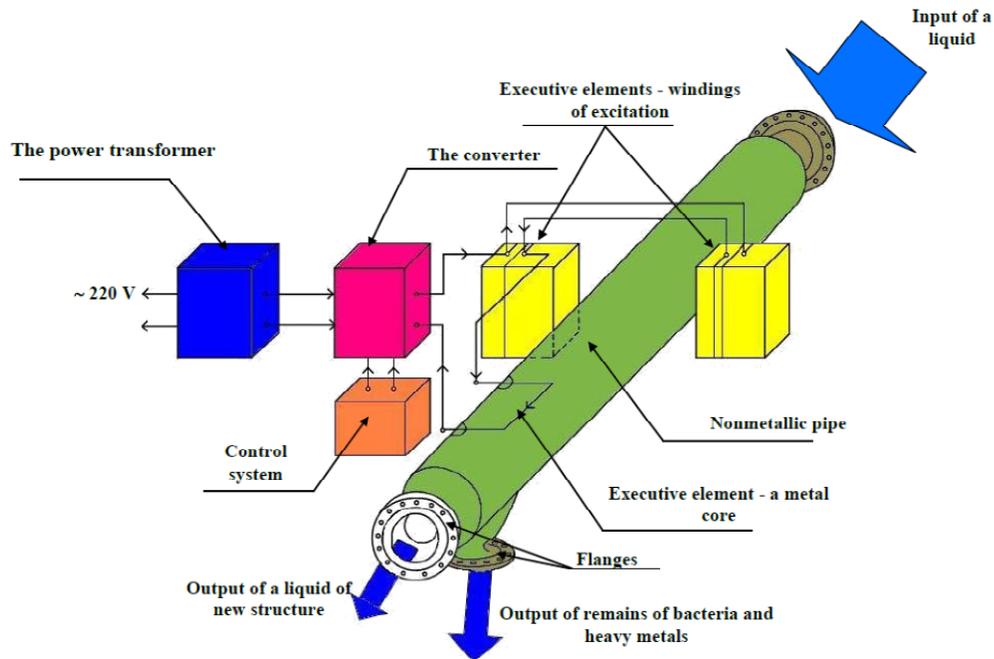


Fig. 2: The schematic image of a design and blocks of the device of disinfecting water using uniform spatial electromagnetic field.

In installation for disinfecting water it is possible to allocate 4 power-intensive elements: the power transformer, coils of inductance (the dry transformer), control system and a core which are connected by the closest image with each other. The power transformer has system of two coils inductance, included among them selves in parallel, opposite and is consecutive with them - a core. From a control system the pulse which opens thyristor moves and through coils of inductance the current 120 A. Cheers a pipe water with a speed of 0.2-0.4 m/s proceeds.

Coils of inductance create a cross electromagnetic field. On the part of a field force which creates additional pressure. Under the action of this pressure the distance between molecules of water increases, the area in which microbes and microorganisms are to be collected is formed. Then water gets in the vertical electric field created by a core. The electric field slams area, microbes perish and also the water supplied with ions of oxygen, is wound on this core, and larger particles settle downwards and are thrown out through a branch pipe located under a corner at 45° to to the basic pipe. Intensity of clearing can be changed by changing the frequency of pulses, and by change the diameter of apertures in a pipe. For this purpose the input and the output of a pipe are supplied with the adapters, allowing to changing entrance and target diameters of a pipe.

2.2 The Parameter Theory

The theory of a uniform spatial field allows to look through the questions of an effective decontamination, a demineralization and water treating, and also to study agencies of electrical, magnetic fields and electromagnetic waves on the physical, chemical and biological processes occurring in fluids.

In the arbitrary section of a pipe with the current fluid which centre of gravity is at height h from a zero level of readout, the following parity (Bernoulli's theorem) should be carried out:

$$p + \rho g h + \frac{\rho v^2}{2} = const \quad (1)$$

where p - an ambient pressure;

v - velocity of movement through the given section;

ρ - density of a fluid.

From the power point of view pressure is the operation made by superposed forces above individual volume of a fluid:

$$W = \rho g h + \frac{\rho v^2}{2} \quad (2)$$

For two arbitrary sections of a fluid stream the law of conservation energy for the current fluid is observed:

$$p_1 + \rho g h_1 + \frac{\rho v_1^2}{2} = p_2 + \rho g h_2 + \frac{\rho v_2^2}{2} \quad (3)$$

Water, being in the made space (a non-conducting pipe), and tests pressure on the part of a uniform spatial field which is defined by the force coming per unit of an exterior surface [8]:

$$F = \int_0^\tau \mu_0 H J dx = \mu_0 H_0^2 \int_0^\tau \frac{\tau - x}{\tau^2} dx = \frac{\mu_0 H_0^2}{2}, \quad (4)$$

where F - the force working on the part of a uniform spatial field;

H - a field force;

J - conduction currents;

τ - length of a lamina.

$$\text{On the other hand: } F = \frac{\mu_0 i^2}{8\pi^2 a^2} \quad (5)$$

where a - radius of a pipe.

However, Maxwell and representation about pressure of a field seems to be too formal - to us to present an origin of such pressure, as interaction of a uniform spatial field and a current of propellant charges more ease and more evident.

The molecule of water has the major dipole moment ($P_w = 6,1 \cdot 10^{-30}$ calorie \cdot meters), owing to what on the distances having the order of distance between molecules in fluids ($r = 10^{-10}$ meters), around of her there is the strong electric field agrees:

$$E = \frac{\varphi_1 - \varphi_2}{d} \quad (6)$$

Where:

$$\varphi \approx \frac{P_e}{4\pi\epsilon_0 r^2} \approx \frac{6 \cdot 10^{-30} \cdot 36 \cdot \pi \cdot 10^9}{4 \cdot \pi \cdot 10^{-20}} \approx 6B. \quad (7)$$

It is the parent of an electrical dissociation.

Hence, the uniform spatial field reinforces process of dissociation in water, and orbital electrons of two atoms of hydrogen and one atom of oxygen of water establish around of themselves the strong no uniform electric field that gives in division of water and connections contained in her into devices.

If the fluid goes with velocity v across lines of flux of a field with induction B , in volume of a fluid the elf of induction is aimed:

$$\mathcal{E} = v \cdot B \cdot l, \quad (8)$$

Where l - length of a section of a fluid in a pipe.

$$\text{Resistance of a section of a fluid: } R = \frac{l}{\gamma}, \quad (9)$$

Where γ - a specific conductance of a fluid.

$$\text{Induced current in a fluid: } i_{\text{ind.}} = \frac{\mathcal{E}}{R} = \gamma \cdot v \cdot B \cdot l^2 \quad (10)$$

On a Lenz rule the induced current interacts with a field so that incipient force of interaction interferes with travel of water. Thus, except for usual hydrodynamic forces, in a fluid work also electromagnetic forces.

Induction density of a field of induced currents:

$$B_{\text{ind}} = \mu_0 \cdot H_{\text{ind}} \approx \frac{\mu_0 \cdot i_{\text{ind}}}{l} \approx \mu_0 \gamma v B l \quad (11)$$

The force working on the part of a magnetic field:

$$F_a = \gamma v B^2 l^3 \quad (12)$$

This force can be compared to a friction force:

$$F_{TP} = \eta \cdot l \cdot v, \quad (13)$$

where, η - a coefficient of viscosity of a fluid. Force of resistance of pressure:

$$F_{\text{pressure.}} \approx p \cdot v^2 \cdot l^2 \quad (14)$$

The attitude of force of the Ampere to force of resistance of pressure term as measure Stuart:

$$N = \frac{F_A}{R} = \frac{\gamma \cdot B^2 \cdot l}{\rho \cdot v} \quad (15)$$

Comparison of force of the Ampere (12) with force of resistance of pressure (14) gives us measure Hartman:

$$M = \sqrt{\frac{F_A}{F_{TP}}} = Bl \sqrt{\frac{\gamma}{\eta}} \quad (16)$$

If the fluid flows on a pipe across a uniform spatial field at small numbers Hartman or Stuart the field feebly influences character of fluxion, and the attractive resistance originates in basic because of viscosity of a fluid. At major numbers Hartman or Stuart viscosity of a fluid draws off on the second plan, the attractive resistance originates in basic because of interaction of a fluid with a uniform spatial field. Therefore water is saturated subzero with the charged ions of oxygen that is she is pure. Positive charges of hydrogen are pernicious for an alive organism.

Let us consider model of installation at insert of a field. Fig. 3, A) shows the inside view of a solenoid set and B) shows a cross-sectional view the set. It is known, that water has diamagnetic properties (coefficient of its magnetic conductivity $\mu = 0,999991$), and at interaction with a magnetic field from him is pushed out. In result there should be a force, breaking a stream. As the number of molecules of water in each unit volume is the orthographic pure of braking forces will represent a straight line. Thus, inside the solenoid and directly ahead of it in a stream there is a section of compression where pressure of a fluid is higher, and velocity of movement is less, than in other stream. But, due to bulk strength of a fluid, its {her} stream is indissoluble, and immediately behind a section of compression the section of a tension where pressure is less should be formed, and velocity is higher, than in a main stream (a point "With" on Fig. 3).

Origination under a field action of a pressure gradient can cause effect of cavitations in water [9]. Studying interaction of a field and fluid stream is of interest at different alternatives of a direction of a field (perpendicularly to a stream and in bridge to it - opposite and it agrees), his different form (a field constant, pulsing, rotaries, the homogeneous and the no uniform), at the single or no single action of a field on water, etc.

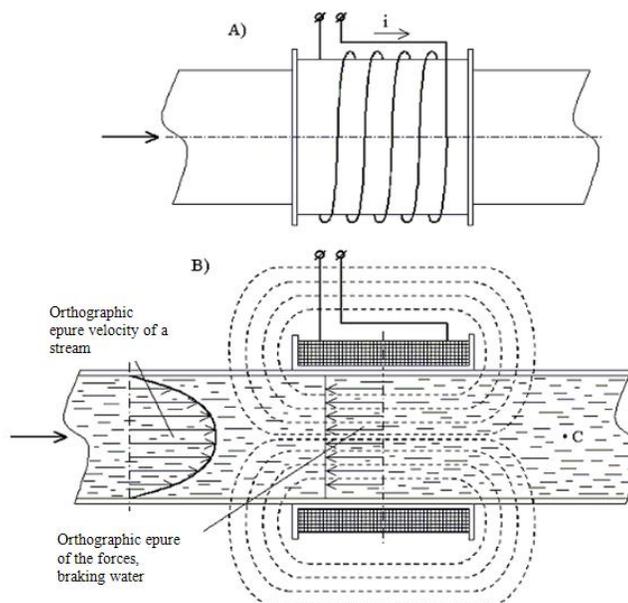


Fig. 3: Model of the installation.

3. FINITE ELEMENT ANALYSIS

On the basis of the enunciated theory it is possible to make the following deductions: (1) The uniform spatial field allows to decontaminating and strip water (2) Pulsing electrical and magnetic fields allow to saturating water with ions of oxygen (3) The spatial field allows to deleting heavy metals from water (4) With the help of pulsing electromagnetic fields it is possible a carry reagent less disinfection of water, to annihilate viruses, a carry sterilization of milk and juices, to heat up a fluid for the account, increases of an internal energy to create non-polluting devices with high efficiency (5) Use of a uniform spatial field in development of technology and technological means for decontamination and water treating allows to sparing considerably power and material resources in deserted and semi-desertic requirements of the Republic of Uzbekistan. The device of clearing and disinfecting of water can be applied in structure of a technological complex for the following applications:

- On clearing industrial drains of metal works, including drains of galvanic manufactures, dairy and fat-and-oil combines, meat-packing plants, confectioner's shops and paper-mills;
- On water treating from the dissolved mineral oil, to increase of an overall performance of clearing constructions of the oil refining enterprises;
- On regeneration of cooling liquids;
- On clearing wash over waters, for removals of adjournment in capacities from under mineral oil;
- On clearing mine waters; on clearing passing wash over and bedded waters at extraction of gas and oil.
- Executive element of devices of a winding excitation

4. CONCLUSION

Our offers on the following additional application of the pulse electromagnetic device for disinfecting and treating water:

- Processing silt clearing constructions.
- Clearing drains of any impurity.
- Recycling the polluted waters, its return in agricultural revolution.
- Minimization of salinity soil.
- Desalination, desalination, disinfecting of waste waters.
- The organization of a watering place of animals from salted well qualitative water.
- Recycling harmful impurity of waste components.

REFERENCES

- [1] Amirov S.F., Ibragimova O.A. "Device of disinfecting, to desalinate and heatings of water by a pulse electromagnetic field", *The International magazine, Chemical technology*. The control and management. Tashkent, 2012. No. 1. pp. 12-15.
- [2] Aynakulov E.B., Li- Fan M. "The Way of disinfecting of water". Ampere-second. IAP 0281. BI No. 5. 31.10. 2005. pp. 62-63.
- [3] US 005304302A. Patent Number: 5,304,302, Apr. 19, 1994.(no author and title of article)

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- [4] Radjapov A., Ibragimov M., Berdishev A.S., “Technology of water-preparation in rural settlements with use of in a complex electric and magnetic influence”. *Innovational technologies in management, formation, the industries*. A part 2 ACTINTEX-2007, Astrakhan, pp. 231-233.
- [5] Patent RU No. 2136600 published 1999.09.10. .(no author and title of article)
- [6] Ibragimova O.A. “Research of questions of stability and definition of stocks of stability of the devices, the developed control systems with a winding of excitation by a uniform superficial electromagnetic field’. A scientific seminar of young scientists, Actual problems of innovational technologies on a railway transportation. *IIUM Engineering Journal* 14.2 (2011): 142-143.
- [7] Ibragimova O.A. Classification , “The comparative analysis of power electromagnetic pulse systems and the theory of a uniform spatial field is considered”. *Seventh World Conference on Intelligent System for Industrial Automation-WCIS-2012*, b-Quadrat Verlag. -Tachkent , (2012) :163-177.
- [8] Kolesnikov I.K., Halikov A.A., Karimov R.K., “Electromagnetic field and waves”. Tashkent. New century generation, (2008): 218