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Research paper

Thermodynamic Concept of Nanotechnological Processes Reagent-Free Water Treatment in Heat and Power Systems of Construction

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Abstract

In the article the thermodynamic concept of nanotechnological processes of non-reagent preparation of technical water of thermal power engineering enterprises is considered. The thermodynamic functional characteristic is presented in heat energy systems of construction with non-reagent water treatment in electromagnetic fields. It is noted, with regard to biological impurities in water, that this method eliminates the accumulation of salts in the pipeline, biological damage, as the emergence of potentially possible critical technogenic situations.

Keywords: *nanotechnology, efficiency of functional processes, electromagnetic fields, technogenic-resource processes*

1. Introduction

The use of innovative energy-saving integrated technologies used in non-reagent water treatment (BOV) in heat energy facilities (TEF) is nanotechnology. Nanotechnology, which develops very intensively, allows us to solve our problems. From the standpoint of today's nano-science - creation, nanosystems, and objects that include components of less than 100 nm in at least one dimension [1].

Since the middle of the XX century in the beginning of the scientific substantiation and practical application of magnetized water in various fields began. The first one was appreciated by the possibility and prospects of the problems of magnetic water treatment, Academician P.A. Rebinder, Corresponding Member B.V. Deryagin in France and Germany, the effects of magnetic water on the crystallization of calcium and magnesium salts are studied. In various tests, it was noted that when switching to power water treated with a magnetic field, the deposited scale was desalinated, the installation as if "self-cleaning". In the countries of Western Europe and the USA there is a growing interest in magnetic processing. Our compatriots have developed a large range of technologies for magnetic processing of water systems for use in many industries. Magnetic water treatment is already effectively used in heat-generating systems (boilers, heat points, and other heat-exchange equipment), including in heat-power construction systems.

In 80 the years M.I. Davidson was theoretically and experimentally confirmed the possibility of activation of water systems by magnetic and electromagnetic fields. According to existing scientific hypotheses [2, 3, 4, 5], the magnetic field affects water molecules. It causes changes in the "spin" of the protons of the nuclei of these molecules with the release of some of the molecular energy, which leads to the destruction of water clusters and the transformation of magnetized water into a fluid with unbalanced H_2O molecules that tend to actively interact with other substances. Due to the small size of the mono-molecules, this leads to an active growth of the velocity of the diffusion processes of the transfer of such water, including in the ultra micropores of capillary-porous bodies, in which ordinary water cannot penetrate.

The hypothesis about nanotechnology, using magnetized water, the use of an electromagnetic field as an activator, plasticizer, is used by us in TEF [6] to solve the problem of bio-damage of capillary-porous bodies. Developments in this area are aimed at creating progressive ecological-economic, investment-attractive technologies.

2. The main part

One of the basic concepts in the theory of electromagnetism is the concept of electromagnetic field (EMF). Some of its components include: electric potential and electric capacity, electric field voltage and electric dipole moment, etc.; magnetic induction in the form of a magnetic induction stream and the same inductance (self-induction coefficient), the process of magnetization intensity, etc. The consequence of these physical processes is the emergence of an electromagnetic field as a driving force in obtaining magnetized water.

To obtain the effect of EMF in heat engineering, a method for determining functional bonds is used by comparing dimensions [7-9]. The physical basis of the method [10] establishes the list of physical quantities that take part in the process of formation of EMF and by comparing the dimensions it becomes possible to establish the nature of the relationship that binds these values when they interact. It should be noted that the chosen method of analysis (dimensions) is based on the requirements of the independence of the relationships between physical quantities and

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the choice of units, which makes it possible to state the coincidence of dimensions in the equations.
Magnetic properties of an electric current can be used in different directions of electromagnetism.
Thus, the theory of electromagnetism, its physical basis, is successfully used [10] for the development of installations for the production of magnetized water, the use of nanotechnologies for further application as a non-reagent method in TEF [11]. At the same time, the definition of the type of interactions that accompany the EMF in TEF becomes of special significance. Due to this, at the first stage of the implementation of the proposed method of controlling the process of self-organization of material flows in TEF determine the set of certain physical equations, which determine directly BOV. EMF or magnetic properties of the electric current can be used differently depending on the design features of the installations for receiving the magnetized water (Fig. 1).

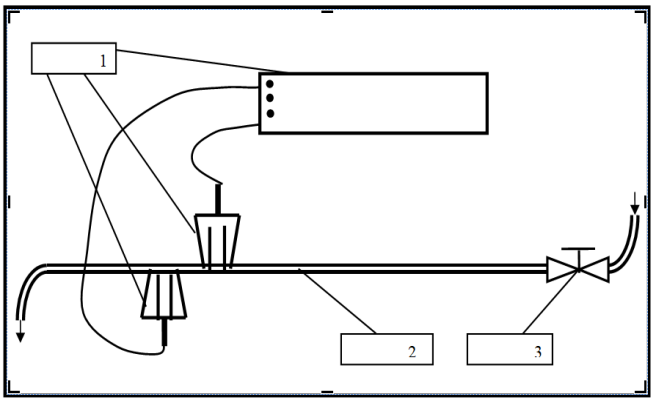


Fig. 1. Stand for the preparation of magnetized water: 1 - device "Ilios-M"; 2 - plumbing; 3 – valve

The enzymatic water was received at the stand using the high-frequency electromagnetic device "Ilios-M", the scheme of purification 2 (ОЧ2), the configuration of the signal consists of high-frequency pulses. They generate a field of 0.23 to 0.43 T with a frequency of 0.9 kHz.
In the course of experimental studies, physical and technical characteristics of water were obtained before and after processing in EMF. Also, the full-scale studies of the influence of BOV in magnetic fields on different stages of the heating systems were conducted. They confirmed the increase in heat energy savings. Economy:
- economy of gas consumption,
- energy for heating water by cleaning from the pollution of the internal surface of heating devices and pipelines (salt in the pipeline, biological damage) [5, 15],
- thermal and electric energy (by reducing the number or capacity of pumps, compared to systems that operate on unprocessed water [10],
- to reduce the cost of repair and restoration work,
- for the solution of environmental problems at the expense of reducing harmful emissions into the atmosphere, as well as prevention of runoff during the implementation of chemical water treatment complexes,
- saving k.p.d. of all boilers and heat exchangers in the process of their long-term exploitation [10].

To establish the thermodynamic concept of the use of EMF for the production of magnetized water (technogenically-determined nature of material flows in TEF), a set of defining equations is used to determine the efficiency of functional processes in the preparation of technical water for heat supply systems. In this regard, every change in TEF related to the technology of heat supply systems should be qualified as an additive dynamic process. Aditive functional processes in accordance with their thermodynamic concept depend on the action of microparticles (atoms, molecules), which in the space of TEF enter into interaction, thus forming EMF - a field of forces, which manifests itself in the influence of force on other microparticles of spatial-temporal placement (Fig. 2). In fig. 2 shows the scheme of occurrence of the difference of the electric potential on the boundary of the metal solution due to electrochemical transformations.
Thus it is proved that as a result of magnetic processing of water, it is converted into a monomolecular system, that is, it becomes an electrolyte. The appearance of a double electric layer corresponds to the principle of the Stern model, when in water, due to adsorbed ions on the surface of the metal, the binding energy of the solution increases with the surface of the adsorbed layer and the distance of contact with the surface decreases in comparison with the double electric layer of non-magnetized water. Electrochemical transformations create an opportunity for the movement of magnetized water in those microcapsules where unmagnified water cannot move. It should be noted that the obtained results allow us to ascertain the feasibility of using BOV in an electromagnetic field. Such a conclusion is based on the stability and high efficiency of the proposed water technology.
The title of the article is related to these interactions, when there are functional interactions between electrically charged particles in electromagnetic fields. The direction of research and its results are consistent with the first and second law of thermodynamics. Table 1 shows the components of the information concerning the methods to control operation of TEF, as that summarizes them.\

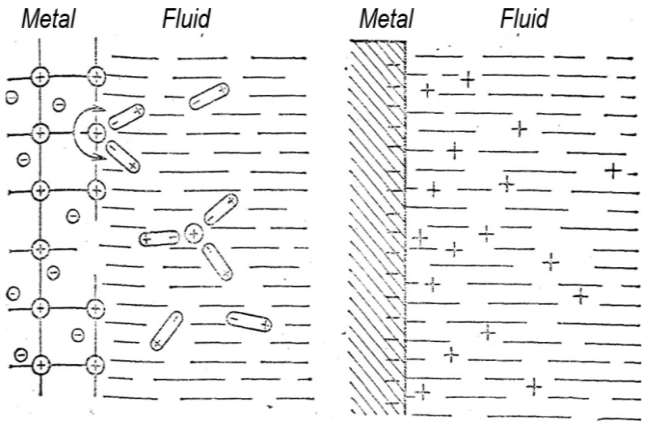


Fig. 2. The scheme of occurrence of the difference of electric potential

For the thermodynamic properties of EMF, it is important in the calculations of electric dipoles that the fact that if the axes of the dipoles are on the same line and the distance between them is significant, then the interaction power between them is proportional to the product of the electric moments (frequency of oscillations of the electromagnetic field) and inversely proportional to the distance between them:

$$F_m = K_4 \cdot \mu \cdot \frac{l \cdot I_1 I_2}{a}, \text{ where} \quad (1)$$

I_1, I_2 - contour electric currents
K_4 - is the fourth degree of distance between the interacting particles of the magnetized water,
a - is the distance between conductors,
μ - magnetic permeability,
l - the length of the study area.
The second important aspect of the thermodynamic concept is the determination of induction, which is determined by a set of equations that connect the electric field intensity (E) and the magnetic field induction (B) and the auxiliary magnitude - magnetic field strength (H) (see formulas 2 ... 4).

$$B = K_6 \cdot \mu \cdot \int \frac{I_2}{r^2} \cdot dl \cdot \sin\varphi \text{, where} \quad (2)$$

dl – solution contour element

r - is the vector radius that defines the distance from this element to the point at which the field is determined,

φ - is the angle between r and dl.

$$M = K_5 \cdot B \cdot I_1 \cdot S \cdot N \cdot \sin\alpha \text{, where} \quad (3)$$

S – area of the contour,

α - is the angle between the positive directions of the normal to the plane of the contour.

$$H = K_8 \cdot \frac{B}{\mu} \quad (4)$$

All these equations interconnect the intensity of the electric field (E) and the induction of the magnetic field (B), thus it is possible to conclude that the amount of heat ΔQ received by the microparticles is spent on increasing its internal energy ΔU and the work carried out microparticles ΔA, i.e.

$$\Delta Q = \Delta U + \Delta A \quad (5)$$

The quantitative characteristic of the thermal state of micro-sites of material flows is entropy, which is defined in this way

$$S = K \cdot \ln \Gamma, \quad (6)$$

where:

Γ – quantitative characteristic of the thermal state,

K - is the Boltzmann coefficient, $K = 1.38 \cdot 10\text{-}23$ J / K.

It is known [12, 13] that the entropy of a system increases in closed systems of thermal energy objects: the maximum possible entropy value of a closed system is achieved in the thermal equilibrium, $\Delta S \geq 0$.

By the thermodynamic properties of EMF it is possible to attribute to the fact that when calculating the interaction of electric dipoles, take into account the necessary fact. If the axes of the dipoles are on one straight line and the distance between them is significant (in relation to the length of the dipoles), then the interaction power between the dipoles (EMF) is proportional to the product of the electric moments and is inversely proportional to the fourth degree of distance between them.

To determine the method for analyzing the dimensions in determining the additive functional relationships (interpretation of data by way of comparison) is a factor of the interaction of particles. The results are presented in Table 1. Based on the results of the generalized results obtained in relation to the functional interactions between microparticles, one can determine the potentially possible critical state of TEF. When it becomes unstable with respect to fluctuations, then the appearance of the system's heterogeneity is a chaotic state of material flows [14]. The system of heat supply and the level of its self-organization will already be characterized by a new differential level of ordering of heat and power processes. The boundary between the stable operation of TEF and the heterogeneity of its self-organization is also a factor. Bifurcation point (TB), disorder of system order, graphical representation of these processes are presented in Fig. 3.

And, finally, the content of biological impurities was carried out according to the Student's coefficient (biomass). This made it possible to establish in TEF the ability of magnetized water to affect the reduction of bio-formation on the pipelines [10]. Thus, they have installed the system's heat indication on the dynamics of changes in biological impurities. The positive role of BOV, technical, in the systems of TEF was established by us in the study with the help of clarification of functional interactions and interaction of microparticles of magnetized water (EMF). It is determined that EMF is the driving force for achieving the required heat capacity of the TEF systems. Concerning biological impurities in the water? It should be noted that the BOP method itself in the EMF excludes formation and bio-formation [15].

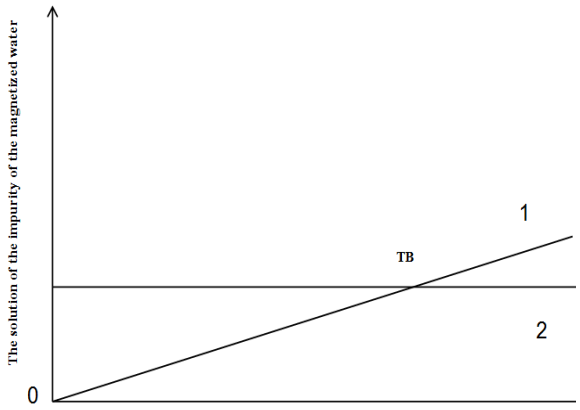


Fig. 3: The emergence of potentially critical technological situations conductivity, TB - point of bifurcation, 1 - oxidation-reduction potential, 2 - specific electrical

Table 1: Components that determine the technogenic-resource characteristics of the BOV in the TEO systems *

Grades of self-regulation of material flows due to the action of electromagnetic fields	Integral quantitative indicators of the operation of the feasibility study for different graduation modes			
	The index of forces electro-dynamic relations material flow	The index of efficiency of material flow functions	The index of the specific heat as a result of self-organization of material flow	Energy Saving Index of the TEO construction industry
Artificially created systems of technical feasibility, which are technogenically conditioned ** the nature of technical water in them, under the conditions of optimal modes of their functioning	0,98	1,5	1,2	1,3
Artificially created systems of technical feasibility, which are technogenically conditioned ** the nature of technical water in them, under the conditions of critical modes of their functioning	0,92	1,1	1,1	1,03

* - all digital values are presented in the form of specific indicators, which conditioned their expression in conditional units, ** - anthropogenic conditioned systems obtained as a result of EMF action.

3. Conclusions

An important aspect of the thermodynamic concept of the use of EMF when receiving magnetized water (anthropogenic character of the material flows in the TEF systems) is necessary:

- efficiency of functional processes,
- component process parameters,
- a set of defining equations, by which the efficiency of functional processes is calculated in the preparation of technical water for heat supply systems.

In this regard, every change in TEF related to the technology of heat supply systems should be qualified as an additive dynamic process. Additionally, functional processes are presented in accordance with their thermodynamic concepts, which depend on the action of microparticles (atoms, molecules) in the space of the TEF that enter into interaction. They form with this EMF - a field of forces, which manifests itself in the influence of force on other microparticles of space-time their placement. The system of heat supply and the level of its self-organization will already be

characterized by a new differential level of ordering of heat and power processes. The boundary between the stable operation of TEF and the heterogeneity of its self-organization is also a factor sign of the interaction of particles

It should be noted that the obtained results allow us to ascertain the feasibility of using BOV in an electromagnetic field. This conclusion is based on the stability and high efficiency of the proposed water technology.

It is determined that EMF is the driving force for achieving the required heat capacity of the TEF systems. As for biological contaminants in water, in the struggle with the salt in the pipeline, biological damage. Established capacity magnetized water to this effect. The BOV method in the EMF eliminates the formation and deformation in the solution of space-time placement [15].

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