

THE INFLUENCE OF “WATER MAGNETIZATION” ON THE DISSOLVING RATE OF SULFURIC NICKEL AND THE LUMINESCENCE INTENSITY OF THE WATER SOLUTIONS OF DISSOLVED ORGANIC MOLECULES.

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ABSTRACT

It has been established that the nickel sulfate dissolving rate depends on the magnetic treatment of bidistilled water. When water is passed through a magnetic field of a strength of 600 and 3000 G more than five times, the rate increases by 3-5%. Passing water solutions of organic substances through a magnetic field testifies to some changes in the spectrum of their luminescence. A hypothesis was proposed to account for the observed magnetic field effects (MFE). It unambiguously explains these and other numerous experimental data on water magnetization.

INTRODUCTION

The problem of “water magnetization” was considered in thousands of papers and many monographs [1-3]. (“Magnetization” means a change in the physico-chemical properties of water after its passage through a magnetic field. “Water” is not the pure water, H₂O, but the real one with numerous impurities [4]. The words “magnetization” and “water” will further be used without quotes.) Although numerous attempts were made to create a model of the mechanism of this phenomenon, at present, there is no even qualitative hypothesis which agrees with the fundamental concept of the up-to-date physico-chemistry. The main reason is the absence of experiment or a set of experiments reliably reproduced in different laboratories. Finally, the objective reason preventing the creation of water magnetization model is the complexity of this phenomenon that calls for joint work of specialists belonging to different scientific areas (particularly, sound chemistry, hydrodynamics, spin chemistry, etc.).

The reproduced experiment giving information on a change in the state of water, subjected to magnetization, should be highly simple, i.e., the possibility of systematic errors should be minimal. The analysis of the literature data allowed us to conclude that one of the simplest experiments is that on the comparison of the dissolving rates of inorganic acids (and, particularly, of sulfates) in magnetized and nonmagnetized water. The existence of magnetic field effects (an increase in the dissolving rate of salts in the magnetized water) in such experiments was repeatedly reported [1-3].

The main goal of this paper was to create a consistent qualitative model of water magnetization mechanism. (Existence of a consistent qualitative model should precede further quantitative studies). To this end, we have performed the methodically available experiments on the comparative observation of the dissolving rate of NiSO₄ in magnetized and nonmagnetized water. These experiments do show a change in the water state after magnetic treatment. To study changes in the state of water after magnetization, we compared the luminescence spectra of dissolved organic molecules (DOM) in magnetized and nonmagnetized water solutions. In this case, both the natural and specially prepared DOM solutions (humic acid, HA) were used as DOM. These experiments recorded the luminescence of both HA remaining after water distillation and HA in water solutions of known concentration. All experiments on the observation of DOM luminescence in water solutions testified to the sensitivity of its intensity to magnetization. Analyzing our results and the literature data, we proposed the hypothesis for water magnetization mechanism which means that in the flowing water, the magnetic field affects product yield in the chemical reactions among the molecules of organic and inorganic impurities.

EXPERIMENTAL

Magnets. In experiments on water magnetization, we used two types of constant magnets. The first magnet was a commercial variant of magnitron “Voronka” with a magnetic field strength in the working zone of 600 G and a distance between poles of 8 mm. The second one is a constant magnet with the strength in the working zone of 3000 G and a distance between poles of 4 cm.

“NiSO₄” experiment. NiSO₄ (“clean for analyse”) was used as a salt. Solutions were prepared using a standard bidistilled water passed and not passed (test experiment) through a magnetic field. The water was kept in the same closed polyethylene vessel at room temperature. Experiments were carried out using the water stored from 0 to 360 h. In magnetic field and test experiments, the water passed through a hose made of polypropylene with a 3 mm diameter. The weight of the initial weighed portion of NiSO₄ was 6-9 g. It was placed in a tube with a volume of 15 cm³ filled with water samples up to 9 - 11 cm³. (The NiSO₄ solubility is 6g/l [5]). The number of tubes for magnetized and nonmagnetized samples was five. After mixing, the solution was carefully stirred up and precipitated for 20 min. Then a 1 cm³ sample was collected with a pipette (“Gilson”) from the upper part of a solution (two samples from each tube). The sample was then weighed (electron balance of class 0.5). A solution was not filtered because the results of the test experiment on the measurement of filtered and nonfiltered solutions within the experimental accuracy ($\pm 0.5\%$) coincided. No special thermostating was performed because the temperature during experiment (about 4 h) remained the same.

The volume of water passing through the magnet was 150 cm³. The rate varied from 15 to 37 cm/s. The maximum time necessary for passing this amount of water through the magnet was about 40 s. The time between water transfusions (manually) in experiments studying the dependence of magnetic field effects on the number of passages through a magnetic field was about 10 s. The ratio α_p between the densities of solutions prepared using magnetized ρ_H and nonmagnetized ρ_0 water was taken as MFE magnitude,

$$\alpha_p = \rho_H / \rho_0 \quad (1)$$

In this case, ρ_H and ρ_0 are the measured values for the density of NiSO₄ water solutions prepared using water passed and not passed through a magnetic field through the same hose. The total number of experiments on the determination of solution density amounts to 48. The total number of measurements was 500. Experiments were performed all the year round.

Absorption spectra were recorded using a “Specord M40” spectrometer. In experiments on the observation of absorption, the water was 10 times passed through a magnitron. The method for preparing NiSO₄ solutions was similar to that used to measure density. After clearing, the sample under study was placed in a standard quartz cuvette 1x1x4 cm in which the absorption spectra were recorded.

The ratio α_a between the absorption intensities of solutions prepared using magnetized I_H and nonmagnetized I_0 water was used as the MFE value

$$\alpha_a = d_H / d_0 \quad (2)$$

In this case, d_H and d_0 are the measured values of the optical density of NiSO₄ water solutions at a wavelength of 560 nm prepared using water treated and not treated by magnetic field upon its passage through the same hose.

We performed ten experiments in summer and winter. Experimental temperature amounted to $21 \pm 2^\circ\text{C}$.

“DOM” experiment. The luminescence was measured with the help of magnetized and nonmagnetized bidistillate used to prepare NiSO₄ solutions. The water solutions of humic acid (HA) subjected and not subjected to magnetic treatment were prepared using initial bidistillate. Before magnetization it was kept for no less than 170 h. The water-soluble HA isolated from the tundra podzolized gley soil was taken as a sample. (The station of the Khari Salekhard region of the Sverdlovsk area). Being passed through the hose, the water (or HA water solutions) were placed in a standard quartz cuvette of 1x1x4 cm. Thereafter the luminescence spectra were recorded without time resolution using a strob-fluorimeter with a nitrogen laser ($\lambda_{exc} = 337.1$ nm) [6]. Since the luminescence spectrum parameters remained constant, the ratio α_l between luminescence integral intensities was taken as the magnitude of magnetic field effect.

$$\alpha_l = I_H / I_0 \quad (3)$$

In this case, I_H and I_0 are the measured values of the luminescence integral intensities of water solutions prepared using water treated and not treated by magnetic field upon its passage through the same hose.

Experiments were carried out in the Spring and Summer. Experimental temperature was $21 \pm 2^\circ\text{C}$.

RESULTS

“NiSO₄” experiment. When determining the density of NiSO₄ water solutions, a positive magnetic field effect ($\alpha_p > 1$) was reliably recorded after 5-7 overflows in 45 experiments of 48 ones. A negative MFE ($\alpha_p < 1$) was recorded in one experiment and no MFE were recorded in two experiments ($\alpha_p = 1$).

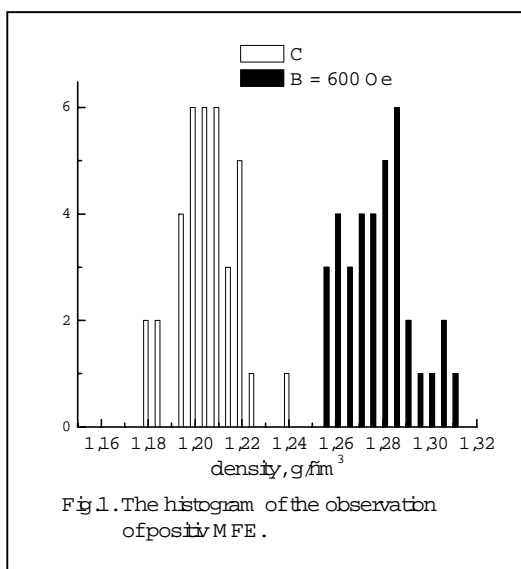
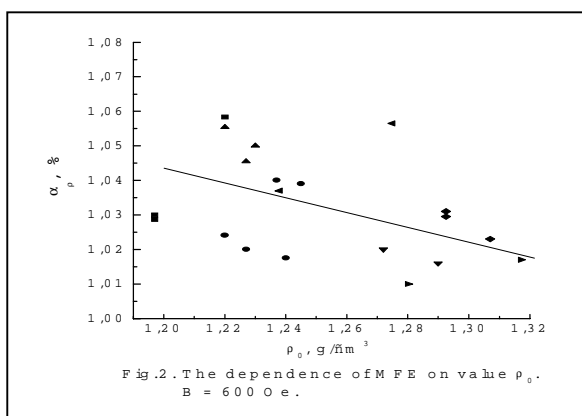


Fig. 1 shows the histograms of the results of a typical experiment on the observation of positive MFE. As follows from the figure, the values of the density of the NiSO₄ water solutions prepared using magnetized and nonmagnetized water are quite different. This difference was observed in all experiments (45) with the positive MFE. The positive MFE was reliably observed in all experiments in which the “age” of bidistilled water used to prepare solutions exceeded seven days.



To reproduce the absolute value of the specific solution weight, the ratio between the amount of NiSO₄ weighed portion and water should be constant because the dissolving rate depends on this ratio [1]. Therefore, there was an absolute spread in the measured values of the absolute value of solution density depending on the ρ_0 value (fig.2).

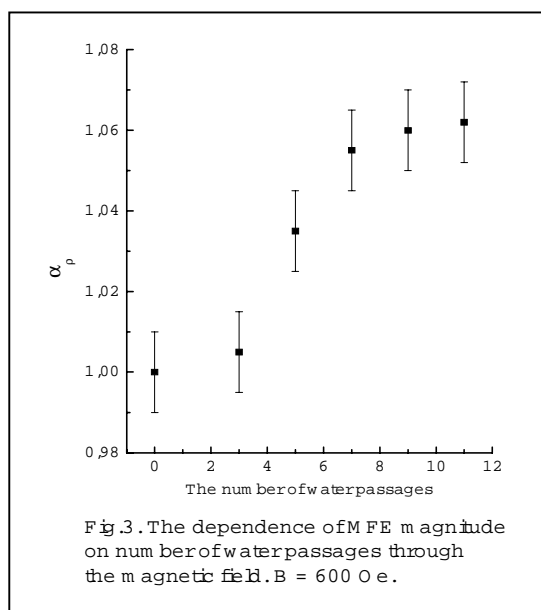


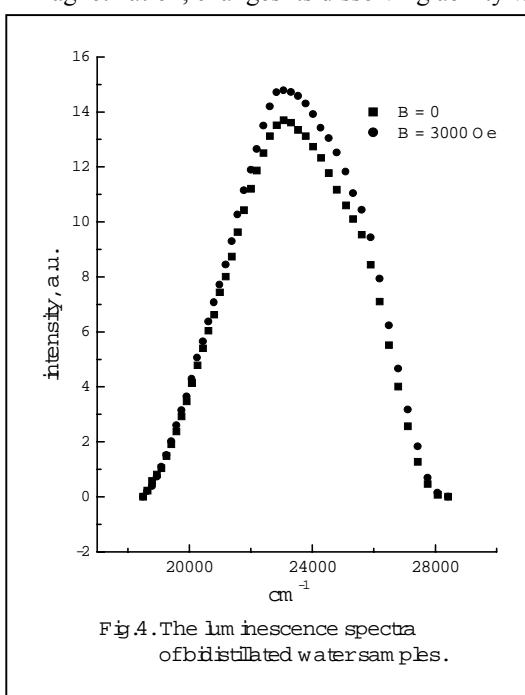
Figure 3 shows the typical dependence of MFE magnitude in experiments on the observation of density on the number of water passages through the magnetic field of magnitotrone “Voronka” (B=600 G) on manual overflowing. A similar dependence was obtained using another magnet (B=3000 G). These dependences show that the MFE magnitude reaches its maximum after seven passages. The same value can be reached by passing water through several hose coils so that only a part of the coil was in a magnetic field. According to the literature data, a noticeable effect of water magnetization can be reached with the water flow rate of no less than 1 m/s. Otherwise, the MFE can be obtained by passing water several times [1].

THE INFLUENCE OF "WATER MAGNETIZATION" ON THE DISSOLVING RATE OF SULFURIC NICKEL AND THE LUMINESCENCE INTENSITY OF THE WATER SOLUTIONS OF DISSOLVED ORGANIC MOLECULES

An additional argument in favor of an increase in the density of NiSO₄ solution prepared using magnetized water are the results of experiments on the observation of the spectra of electron absorption of NiSO₄ water solutions. The results are the following: $\alpha_e = 1.06 \pm 0.01$. These results were obtained using the 7-days water. Thus, the data on a change in both the density of NiSO₄ water solutions and the optical density testify to an increase in the concentration of NiSO₄ solution prepared using magnetized water.

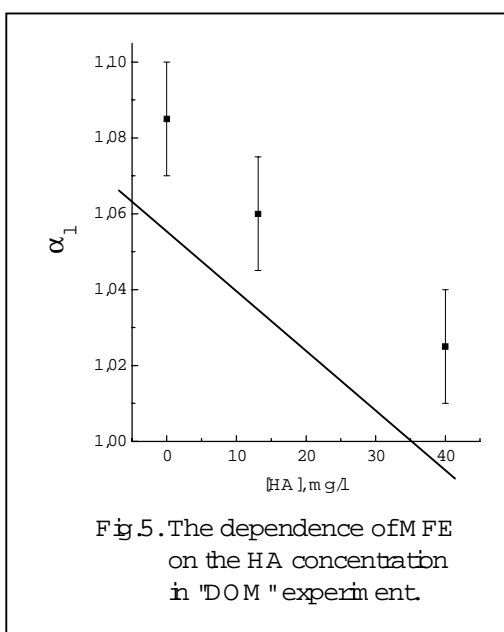
Thus, we conclude that to observe the reliably reproducible positive MFE, the water kept for several days should be used to prepare solutions. Therefore, the MFE can appear only in the presence of impurities. It has been demonstrated [4] that this effect does occur and is due to either the washing of impurities from the walls of the vessel in which the water is kept or the ingress of aerosols and/or other particles from the air.

Thus, the effect of water magnetization (for most experiments where $\alpha_p > 1$) manifests itself in that the rate of water dissolving ability increases after passing through a magnetic field. At present, we will not interpret a concrete reason for a change in the rate of dissolving in magnetized water (It is not our task in this moment). Actually, in the literature [1,2] the examples are available of a change in the physico-chemical properties of water (viscosity η , dielectric permeability ϵ , wetting, pH, etc.) after its passage through a magnetic field. A change in these properties can affect the dissolving kinetics. Unfortunately, these data are not confirmed and it is early to compare them with our results. Thus, we restrict our verification to the fact that the water, after magnetization, changes its dissolving ability which it denotes a change in its physico-chemical properties.



Experiment "DOM". Figure 4 shows the

luminescence spectra of water samples used to prepare NiSO₄ solutions subjected ($B=3000$ G) and not subjected to magnetic treatment. The luminescence observed in water is caused by the presence of residual dissolved organic molecules (DOM) and, particularly, of residual HA. (Thus, the researchers working with pure water actually work with very weak HA solutions [4]). According to the above data, the intensity of luminescence bands treated and not treated by the magnetic field of water samples differ. The luminescence intensity in water treated by magnetic field is about 10% higher ($\alpha_1 = 1.085$).



Similar results were also obtained for the luminescence spectra of the specially prepared water solutions of HA. The luminescence spectrum intensities of the solutions passed and not passed through magnetic field are also different. Values of MFE had the concentration dependence (fig.5). The test experiments on the observation of the luminescence of water samples and HA passed through the hose in the absence of magnetic field

testified that these spectra coincided with those belonging to initial samples. Thus, passing water or HA water solutions leads to an increase in luminescence intensity. Since the spectral parameters of luminescence band do not change, the intensity increasing is, probably, caused by a decrease in the contribution of quenching processes to the formation of the luminescence intensity of HA molecule. This can be readily imagined assuming that the HA molecule consists of a set of luminophor groups surrounded by numerous groups of quenchers [7]. The quenchers in the HA molecules are of both the hydrophobic and hydrophylic origin. Thus, the conformation of HA molecule is sure to change with changing physico-chemical characteristics of water. This has been already reliably established [7]. Thus, assuming that the physico-chemical characteristics of water change after its passage through a magnetic field (e.g., values η , ϵ , pH), these changes should lead to a change in both the HA molecule conformation and the luminescence spectrum.

It is concluded then that our data obtained in both the “NiSO₄” and “DOM” experiments testify to the difference between waters treated and not treated by a magnetic field. In this case, the MFE can be reliably observed using bidistillate kept for several days. A possible reason for MFE appearance is changing physico-chemical properties of water under magnetization.

DISCUSSION

Hypotheses available in the literature which try to explain the phenomenon of water magnetization can be arbitrarily divided into two groups: 1) magnetic field has a direct effect on water structure, and 2) magnetic field “has effect” on the impurities found in water.

The first hypothesis cannot be considered reasonable for two reasons.

The first reason. Rigid conclusions on the direct magnetic field effect on water structure should be based on the data obtained in experiments from which all impurities are excluded. However, as a rule, all experimental work with water which always contains residual DOM [4] even if it is carefully purified. The origins of these impurities are different: they either come from the air or are washed out from the vessel walls. Therefore, it is assumed that all experiments performed with the supposedly pure (ideal) water containing no impurities actually, are not of this type. It is reasonably concluded that at present, there are no experiments using pure water. It is concluded then that there are no ground for discussing magnetic field effect on the structure of pure water.

The second reason. In addition to the abovementioned, all available “structural” hypotheses basing on the present physico-chemical knowledge cannot reliably account for the following: the preservation of magnetic field effect at times longer than those of rotational relaxation of water molecule in water. This time is known to be about 10⁻¹¹s [8] whereas the times of the “memory” of the magnetic treatment of water after its passage through a magnetic field vary, according to the data of various authors, from (as minimum) 10 minutes [9]. Because of the difference in the characteristic times by 13 orders of magnitude along with the absence of any data on pure water magnetization, we do not dare to discuss our results in terms of the hypotheses for the direct magnetic field effect on water structure. Thus, the magnetization effect can be explained using hypotheses belonging to the second group.

As a whole, we suggest the following mechanism for explaining the phenomenon of water magnetization in terms of the second group hypotheses. This mechanism includes three main statements reliably established by the modern physical chemistry: 1 – the existence of organic impurities in water; 2 – the formation of radicals (or radical ions) in water upon its flow; 3 – the influence of the application of external magnetic field on the product yield of chemical reactions.

Statement 1. All constructive hypotheses for water magnetization consider, as a rule, only the presence of inorganic impurities in water [1-3]. This approach has, probably, historical roots, because the necessity of the theoretical understanding of water magnetization comes from the practical needs of industry due to the problem of scale formation, i.e., the process in which mineral salts are of dominating importance. Probably, the role of organic impurities in water was never discussed in this respect. At the same time, DOM always exist in any even carefully purified water [4]. Therefore, it is a priori clear that their role in magnetization should be taken into account. The possibility of the presence of organic component in water is one of the main statements of our qualitative explanation of the phenomenon of water magnetization.

Statement 2.

a) The flow of water (more accurately, of DOS water solution) causes pressure pulsations in air bubbles [10] whose considerable number is reliably determined [11]. These processes always accompany cavitation

THE INFLUENCE OF “WATER MAGNETIZATION” ON THE DISSOLVING RATE OF SULFURIC NICKEL AND THE LUMINESCENCE INTENSITY OF THE WATER SOLUTIONS OF DISSOLVED ORGANIC MOLECULES

processes, occurring upon the laminar (not turbulent) liquid flowing. Pressure pulsations (even in a laminar flow) cause sound chemical reactions at the air (bubbles)-liquid interface [10]. As reagents of sound chemical reactions, one can use the DOM molecules, or more precisely, the molecules of humic substances. Sound chemical reactions result in radicals (or radical ions) as intermediates arising from any chemical reaction.

b) Another possibility of the formation of intermediates is that upon water flowing, the H₂O molecules can dissociate in wall flows to form OH and H radicals via mechanochemical processes [12]. These reactions can give rise to different branched reactions and, thus, to different radicals. Finally, the OH and H radicals form upon decomposition of hydrogen peroxide which is always present in any water [12]. The presence of the above radicals can cause numerous chemical transformations of DOM.

Statement 3. This statement implies the external magnetic field effect on the rate of chemical (radical) reactions [13], i.e., the effect reliably established in spin chemistry. As a result, in certain conditions, the quantity (and quality) of the products of chemical reactions (in our case, sonochemical and mechanochemical) will change. Thus, the solution passing through a magnetic field can change chemically.

In the light of the abovementioned, the NiSO₄ dissolving in the magnetized and nonmagnetized water can be considered as the dissolving in two different solvents. Therefore, it is of no surprise that the dissolving rates are quite different. (We omit the details of concrete changes in water structure with a change in the structure of dissolved molecules).

In terms of the hypothesis proposed, the dependence of MFE magnitude on the number of passages (turns) in a magnetic field becomes clear: at low passing rates the intensity of cavitation and mechanical processes is not enough to give a noticeable amount of products in one passage. Therefore, the water should pass several times through a magnet for the magnetization effect to be recorded.

This hypothesis readily explains the above memory effect arising from water magnetization. In the framework of our hypothesis this is not the physical memory time of water structure but the chemical time of transition of one water solution state into another. The chemical memory time is sure to vary during hours and more. It will depend on the concrete form and properties of a molecule-product. For example, the known magnetic field effect on the cis-trans isomerization of stilbene can be preserved for days because both of the isomers are the thermodynamically stable compounds [14].

The fact that the MEF is observed in experiments on density directly testifies to the existence of the “time memory of water after magnetization” measured in tens of minutes. Indeed, no magnetic field effect could be observed in the absence of memory because the duration of our experiments on dissolving amounts and luminescence to several tens of minutes, and were the memory shorter, no MFE could exist.

Another case to be explained in terms of the hypothesis proposed is that the results for magnetization cannot be reproduced both in the limits of one group of scientists and between different groups. This is because in all experiments no control was given over the organic component that, in terms of our hypothesis, gives rise to magnetic field effect. However, it is not obvious that the MFE can be observed with the control over an organic component. Indeed, the presence and magnitude of MFE considerably depend on both the form of organic molecules among which the spin traps can occur and their concentration [15,16]. Therefore, water magnetization should be observed not at any water sample but only at the samples in which the set of radical (radical ion) pairs parameters corresponds to MFE formation. These parameters are: hf_i constants, exchange rate constants, the value of redox potentials, the ratio between the lifetimes of geminate pairs of different multiplicity, etc. Our results (fig.5) are arguments to supporting this conclusion. Thus, e.g., it is of no surprise that the reproducibility of the results of MFE observation by one and the same group of scientists depends on the season, i.e., depending on the season, the scientists work with water (even the bidistilled one) which contains the different amount of residual DOM of different quality.

Another phenomenon that can be explained in terms of the model proposed is the joint effect of magnetic and ultrasonic treatment on water. This effect has been repeatedly described [1] but lacks a simple physical explanation. It is easily seen that in these experiments, ultrasound plays the “sonochemical” and “mechanochemical” role in radical generation. Ultrasound so as the passage of water result in the formation of radical pairs which upon magnetic field effect on chemical reactions can give rise to MFE (in this case, magnetosonic).

Thus, the main essence of our hypothesis for the origin of “water magnetization” is that a) water always contains DOM; b) sound chemical reactions of DOM have place in the flowing water; c) the passage through a magnetic field results in the formation of products differing qualitatively and quantitatively from those observed in the absence of magnetic field. All three conditions can be a prerequisite to the appearance of water “magnetization”.

In terms of the mechanism proposed it is assumed that the phenomenon of water magnetization is not unique and can hold for other liquids. Indeed, the conditions for the appearance of MFE are not rigid and can be realized for any solvent. In the literature the data are available on the presence of magnetization of both alcohols with water added [17] and hydrocarbons [18].

It is concluded then that Closs [19] explaining the relaxation characteristics of activated water in terms of the relaxation of the nonequilibrium concentration of hydrogen peroxide, draws the conclusion similar to ours, i.e., water activation (including, "magnetization") results in relaxation determined by the chemical rather than physical lifetime of the system.

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