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ULTRASOUND IN CHEMICAL ANALYSIS OF MINERALIZED WATER AND BRINES

Abstract: *Literature sources, deals with ultrasound use in chemical analysis of mineralized water and brines were analyzed. It was shown that ultrasound (US) may be used for intensification of analytic signal and sample preparation. The source of analytic signal are ultrasounds rate, its absorption, sonoluminescence of liquids at ultrasound influence metals lines, hydroxyl ions, exaltation of water molecules, processes of sonoluminescence decay. It was shown that ultrasound may be used for destruction of organic compounds, concentration of sorption, extraction and coprecipitation.*

Key words: *mineralized water, brines, ultrasound, sonoluminescence, chemical analysis, sources of analytic signal, sample preparation intensification.*
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Introduction

Brines are quite important products for food and chemical industry. They are widely used in medical purposes. The classification of brines is: weak (up to 140 g/l), strong (140 -270 g/l), and super strong (up to 270 g/l). [1,p.24;2,p.16;3,p.11;4,p.72]. There are the next types of solutions: chloral-calcium, chloral-magnesium, sulphate-magnesium, hydrocarbonate-sodium, chloral-sodium. The all of that types of solutions are used in chemical industry to obtain the next products: baking soda, kitchen salt, potassium salts, magnesits. Tungsten is produced from the lake Serlz brines in the USA.

Mineralized water are: mines water (3 -15 g/l), sea water (12 -250 g/l), brines (250 -600 g/l), mineral water (3 -100 g/l), kitchen salt, etc.

Chemical analysis of brines and mineralized water is quite complicated task because of significant matrix influence. To decrease it various chemical and physical methods are used. The most widely distributed is ultrasound treatment of the system. Due to it, energy concentration is 3-5 times more than one using another physical methods. [5,p.20; 6,p.39; 7,p.52; 8,p.99; 9,p.18; 10,p.1895; 11,p.123; 12,p.509; 13,p.305; 14,p.18; 9,p.48; 15,p.95]

The main purpose of the paper is to propose ultrasound use to analyze brines and mineralized water.

Results and discussion

Direct determination of elements in mineralizated waters, in particular in natural brines, with the use of such widespread methods like atomic adsorption spectroscopy, spectrophotometry and polarography, appears possible because of low contain of considerable matrix influences; that causes a necessity for the use of concentration. To the number of the most effective methods of concentration of elements, which are reported: atomic adsorption spectroscopy, polarography and sorption. Determination of micronutrients in brines is influenced by organic substances, mainly humic and fulvic acids, which bind them in strong complexes and metallic compounds. Their presence leads to an underestimation of the results of the analysis and requires in the process of preparation of the stage of destruction of organic compounds. For the destruction of organic compounds, the methods based on chemical oxidation of organic compounds were the most widespread. Thus, in the Standard for Kitchen Salt, the preliminary destruction of organic substances by boiling with ammonium persulfate under temperature of 40° C is investigated. It was also described the application of oxidation by atomic chlorine; ozone, hydrogen peroxide, boiling with mineral acids, with potassium permanganate in an acidic medium. However, the chemical methods of destruction of organic substances lasts more than 6.5 hours, decrease contamination of the impurities in analyzed solutions. In this connection, the physical methods of destruction of organic substances are also used: ultraviolet irradiation, photochemical oxidation, electrochemical, etc.

The most fully studied is the use of ultraviolet irradiation and photochemical oxidation. When water and salts are treated with ultraviolet radiation, a mercury lamp with a power of 250 -500 is used. An ultraviolet irradiation allows to shorten procedure of destruction of organic matters to 15 -25 min, instrumentally deleting cut-in oxygen from the analyzed tests of water. But additional introduction of chemical reagents can cause contamination of analyzed tests. For destruction of organic matters in analyzed solutions used also and electrochemical tools, especially in solutions which contain chloride ions. A microwave irradiation is used for intensification of sample preparation – dissolution, destruction of organic compound. It has been experimentally established that the destruction of organic compounds in the analyzed kitchen salt under the influence of ultrasound occurs as a result of the formation of pedicels.

Thus, the best for the destruction of organic compounds of brines and mineralized waters is the use of ultrasound. Acoustic currents are called regular vortex displacement, which is associated with oscillations of individual particles of the medium. The action of acoustic currents leads to intense regular movement of the environment. Acoustic flows due to the effective mixing capacity lead to a significant intensification of mass transfer. That is, acoustic flows contribute to the intensification of the following analytical processes:

1) extraction;
2) singing to the deposition;
3) sorption;
4) directional crystallization;
5) flotation .

The most important nonlinear effect of ultrasound is cavitation. Cavitation is the formation of bubbles under the action of ultrasound on the liquid, which have the ability to pulsate, collapse. Cavitation bubbles (KP) are formed in a liquid filled with steam, gas and their mixture. Cavitation bubbles are formed in liquids if the pressure P is critical value of the pressure Pk. It is at Pk that cavitation begins, is called the cavitation threshold. For pure water Pk is 1500 kg / cm^2. Since real liquids contain impurities, gas bubbles, and solid particles, Pk has lower values, for example, for doubly distilled water Pk = -280 kg / dm^3. Cavitation occurs due to the collapse of the manual transmission.

The rate of expansion of the bubble can be described by the formula:

$$u = \sqrt{Q}/\rho$$

where ρ is the density of the liquid, g / cm^3.

The minimum radius of the CP when collapsing will be as follows:

$$R_{min} = R_{max}[P/(\gamma-1)P_o]^{1/3((\gamma-1)}$$

where P is the gas pressure in Kp at Rmax,

Ro is the hydrostatic pressure,

when adiabatic collapse of the CP temperature is determined as follows:

$$T_{max} = T_o[(\gamma-1)P_o/P]^{3((\gamma-1)}$$

where T is the temperature of the liquid.

At given values of temperature and pressure, the substances in the CP and in the nearest region decompose into atoms or radicals, due to which the glow of the liquid appears, its known physical phenomenon of sonoluminescence. Radicals in the decay of Kp have a significant reactivity, they react with substances, present in Kp, water, steam, gas. Thus there is a destruction of POP. Due to the ability to change these conditions, it is possible to control cavitation. Under the action of ultrasound on solutions due to cavitation, the collapse of the CP and the formation of a significant number of radicals with high oxidative capacity occurs.

When exposed to ultrasound solutions, the following substances are formed by hydrogen peroxide, nitric acid, other redox substances. It is known that the action of ultrasound on an alkali solution leads to the formation of H_2O_2 in the presence as a catalyst of osmium oxide. It should also be noted that the degree of decomposition of H_2O_2 increases from 1.8 up to 100% . Irradiation of solutions of 10% KJ ultrasound 20 kHz, leads to its decomposition and hardening of J2.

UZ accelerates the following redox processes:

1) the reduction of plutonium (V) by hydrazine is accelerated almost 10 times; solutions of acids (nitric and hydrochloric) were taken as the object of research;

2) the rate of oxidation of americium (VI) under the action of ultrasound in 1 M HNO_3 increases by 5-7 times;

3) the rate of reduction in 1 M NaOH in the presence of H_2O_2 Ne (V) to Ne (VII) under the action of ultrasound increases by 7-10 times.

US also can be used in sample preparation for dispersion, dehydration, mixing, for the destruction of suspensions, to stabilize suspensions, to accelerate coagulation, to speed up filtering. Sample preparation is the longest stage of analysis and takes >95% of the time.

US is widely used to speed up the process of sample preparation.

1) To accelerate the dissolution of samples in water, acids, alkalis, organic solvents . It is known to accelerate the process of dissolving superphosphate samples from 4 to 10 times due to the use of ultrasound. This was used in the material analysis of forms P (V) .

2) to accelerate the melting of rocks; the process is accelerated 8-10 times .

US accelerates the extraction of elements from the soil with a mixture of acids for subsequent analysis by the method of AAS .

The use of ultrasound for sample preparation in determination the content of Mercury in food products is described. The photometer "Julia-2" was used. Also, the value of Sr decreases from 0.10 to 0.05. It was established, that the use of ultrasound in comparison with the use of mechanical mixing increases the efficiency of mass transfer processes from 50 to 94%. Extraction of Au from gold-bearing ores increases by 25-50%, with a decrease in reagent consumption and time. The use of ultrasound in the concentration of bitumen from coal is described. The process itself is accelerated by 3-5 times, and the number of reagents used can be reduced by 15-20%. US accelerates the sorption of U^{238} from seawater in 4-6 times. The amount of polymeric sorbent can be reduced by 15-20%. US accelerates ultrafiltration using cellulose acetate, and membrane regeneration . It should be noted that the efficiency of the process increases with the power of ultrasound.

Ultrasound is used in the electrochemical method. Ultrasound is used in IP to increase the sensitivity of the analysis, as well as the signal-to-noise ratio. This increases the sensitivity factor. Ultrasound is used to clean the membranes of ion-selective electrodes. This also leads to a decrease in Sr analysis results. The use of ultrasound reduces the negative impact of Mo in the polarography determination of W. The effect of ultrasound on the salt solution leads to a change viscosity, densities, the pH of the solution, ion diffusion coefficients (increase from 1.4 to 1.6 times), the magnitude of the speaker in polarography.

Ultrasonic sprays are more efficient than mechanical and are widely represented in AAS and NPPs.

There are the following types of ultrasonic sprays for AAS:

1) connecting fluid;

2) vertically arranged crystal.

US spraying allows reduce NMV from 4 to 12 times, increases the efficiency of the solution by 25%, changes the size of the drops, which increases the controllability of the analysis process. This is done by changing the frequency of the ultrasound.

Conclusions

Ultrasound can be used as a source of analytical signal in the chemical analysis of mineralized waters and brines. The following parameters and characteristics of ultrasound can be used as a source of analytical signal: speed of propagation of ultrasound, processes of absorption of ultrasound; ultrasound attenuation processes; sonoluminescence of liquids under the action of ultrasound: metal lines; lines of hydroxyl ions and excited water molecule (the main continuum of sonoluminescence); extinguishing processes of the main continuum of sonoluminescence.

Ultrasound can be used to intensify the following stages of sample preparation of mineralized waters and brines: 1) destruction of organic matter, 2) concentration by extraction, sorption, co precipitation.

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