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Methods for the Analysis of Iodine in the Objects of the Natural Environment

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Annotation. This article discusses the methods of analysis of iodine in natural objects. In the world, iodine is used in the food and pharmaceutical industries, medicine and veterinary medicine, in the production of mineral fertilizers, is used in the chemical industry as a catalyst, in the production of some highly pure materials, special glass and synthetic rubbers. In addition, iodine is a major factor in preventing endemic goiter and other types of diseases. Therefore, in order to meet the demand for iodine in the republic, the priority task is to develop a perfect technology for obtaining iodine on an industrial scale from the main sources, such as underground hydrothermal waters.

Key words: technology, iodine, chemical industry, groundwater hydrothermal water, medicine, food, iodine ions, oxidation kinetics, optimal technological parameters.

Introduction. In the world, iodine is used in the food and pharmaceutical industries, medicine and veterinary medicine, in the production of mineral fertilizers, is used in the chemical industry as a catalyst, in the production of some highly pure materials, special glass and synthetic rubbers. In addition, iodine is a major factor in preventing endemic goiter and other types of diseases. Therefore, in order to meet the demand for iodine in the republic, the priority task is to develop a perfect technology for obtaining iodine on an industrial scale from the main sources, such as underground hydrothermal waters.

In the world, the use of iodine-containing resources for the production of medical iodine is given special attention. At the same time, the development of iodine production technology for the demanded medical, food and chemical industries is one of the urgent tasks. When developing a technology for producing iodine based on iodine-containing underground salt water containing iodine compounds, it is necessary to substantiate a number of, including scientific solutions in the following areas: determining the optimal technological parameters of the kinetics and mechanism of iodide ion oxidation in drilling waters in an acidic environment; selection of oxidizers for precipitation of iodine from iodine concentrates and determination of the optimal process conditions, as well as development of a technology for the isolation of molecular crystalline iodine.

In the Republic, in order to meet the demand for iodine in the chemical industry related to medicine, pharmaceuticals and veterinary medicine, as well as the food industry for iodizing table salt and for other purposes, targeted measures are being taken to develop a technology for isolating iodine from iodine compounds that are part of underground salt water.

In this regard, the development of technology for the production of iodine by the oxidation of iodine compounds in the composition of underground saline waters, air desorption of the obtained molecular iodine, absorption by an alkali solution and crystallization in an acidic medium is of great importance.

Literature review. The results of studies of industrial iodine-containing groundwater in Uzbekistan are covered in the works of T.A.Avazova, L.S.Balashova, B.A.Bedera, S.S.Bondarenko, M.G.Valyashko, G.A.Golevoy, L.A.Kalabugin, V.V.Krasintseva, V.A.Kudryakova, A.M.Ovchinnikova, A.I.Perelman, K.E.Drinking, N.A.Plotnikova, D.Z.Sidikova, L.V.Slavyanova, A.E. Smirnova, A.N.Sultankhodzhaeva, A.S.Khasanova, E.A.Khodzhakulieva, M.V.Shvets, K.D.Potaenko, S.Ishankhodzhaeva, S.Bakieva, R.A.Kulmatov and others who made a significant contribution to solving this problem.

However, the aforementioned scientists have not conducted research to improve the technology for obtaining iodine from iodine-containing groundwater deposits of the to date. This dissertation work allows

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to ensure iodine deficiencies in the republic, aimed at the chemical industry and the pharmaceutical industry by isolating iodine from saline groundwater containing iodine compounds.

Iodine is an element with a pronounced biological activity. It has antiseptic properties, due to which it is widely used in medicine. A deficiency, as well as an excess of iodine in food and drinking water, is fraught with serious consequences for the human body. Diseases associated with iodine deficiency are among the most common non-communicable human diseases. At least 100 million Russians have an increased risk of developing an iodine deficiency disease [4]. Iodine deficiency in the diet may not have pronounced manifestations. Therefore, it was called "hidden hunger". On October 5, 1999, the Government of the Russian Federation adopted Decree No. 1119 "On measures to prevent diseases associated with iodine deficiency."

Research Methodology. Thyroxine enhances metabolism in the body, stimulates tissue growth, activates the enzyme carotinase involved in the synthesis of vitamin A and also increases the absorption of glucose in the body and intensifies its utilization. In thyroxine and other thyroid hormones, iodine atoms replace certain hydrogen atoms in the tyrosine amino acid molecule. It is well known that thyroid hormones are essential for normal growth and development of the body. They control the generation of heat, the rate of oxygen absorption, are involved in maintaining the normal function of the respiratory center, stimulate the motility of the gastrointestinal tract, and stimulate the synthesis of many structural proteins in the body. In humans, a decrease in the biosynthesis and secretion of these hormones leads to a delay in physical and mental development, as well as to a violation of the differentiation of the skeleton and the central nervous system.

Analysis and results. It has been shown that iodine deficiency itself leads to the development of goiter and dysfunction of the thyroid gland, and the severity of these disorders is directly dependent on the degree of iodine deficiency in the body. The prevalence of goiter diseases directly depends on the iodine content in the air, soil, water and food consumed by people. Thus, a reliable figurative relationship between the spread of goiter endemic foci and the iodine content in natural waters is revealed.

Lack of iodine initially leads to only a slight increase in the thyroid gland, but as it progresses, endemic goiter affects many body systems and leads to serious metabolic disorders. Along with an increase in the thyroid gland, symptoms of hypothyroidism appear. But iodine deficiency has the most severe consequences on the growing brain of children, forming its irreversible damage. An example is the statistical data for the Volkhov district of the Leningrad region.

Iodine in the form of organic and inorganic compounds enters the gastrointestinal tract with food and drinking water and is absorbed in the intestine in the form of iodides.

The absorption of iodine can also be inhibited by competition if other negatively charged anions enter the body in excess. The fact is that the cell membranes of thyrocytes that capture iodides (I-) cannot distinguish monovalent anions from one another and therefore are able to capture them along with iodide. In such cases, insufficient uptake of iodides by the thyroid gland leads to a decrease in their amount in this organ, and as a result, to insufficient synthesis of thyroid hormones.

The transport of iodide across the thyrocyte membrane is an active, energy-consuming process in which iodide moves from an environment with a lower concentration (blood plasma) to an environment with a high concentration (thyroid tissue). The concentration of free iodine in the thyroid gland is 30-40 times higher than in blood plasma.

From what has been said, it is clear how important the problem of studying the regularities of the distribution of iodine in fresh drinking water is it was pointed out that the concentration of iodine in drinking water is not standardized by accepted standards. Meanwhile, the severity of the iodine problem has increased significantly in connection with nuclear weapons tests and accidents at nuclear power plants. According to the extensive experimental and clinical material available, radiation has a detrimental effect on various organs and systems of the human body.

This prediction is justified not only because of the high content of radioactive iodine in the emissions from the accident at the Chernobyl nuclear power plant, but is also based on clinical material accumulated over decades in many countries.

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Studies have revealed a decrease in reactivity among liquidators, an increase in the frequency of chronic diseases. According to the Register, since 1987 there has been a steady increase in endocrine pathology, in the structure of which the leading place belongs to diseases of the thyroid gland. There is also an increase in the number of cancers in children who fell into the zone of influence of the Chernobyl nuclear power plant accident.

Early studies on the distribution of iodine in nature were carried out by Academician V.I.Vernadsky, who was one of the first to obtain data on the iodine content in sea and river waters, minerals.

The works of Academician A.E.Fersman on the distribution of iodine and its compounds in environmental objects have been published. A significant amount of iodine is found in rocks, soils, waters, and in living organisms.

The distribution of iodine in nature has been studied in detail in connection with the enormous role played by this element in the life of humans, animals and plants. This became obvious especially after it became clear that iodine deficiency is the cause of a serious disease - goiter, observed among the population of some mountainous and marshy areas.

Minerals, in which iodine is the main component, are few and very rare in nature. Such minerals are individual or mixed halides of silver or copper, they are found in some deposits of silver ores.

Mineral and industrial waters can be thermal at the same time.

From mineral industrial waters, iodine, bromine, boron, rubidium, cesium, tungsten, rhodium, sulfur (from hydrogen sulfide), ammonium products, various salts - sodium chloride and sulfate, magnesium, potassium and others are extracted or can be extracted.

The mineral industrial waters and brines of the basin studied by us have a calcium-magnesium composition. A large number of various salts in brines hinders the industrial extraction of iodine and other valuable elements.

Despite the large reserves of iodine and bromine, there is currently no technology for extracting valuable components from associated oil waters in the associated oil waters of Uzbekistan.

In this regard, the main goal of this study is to develop a more efficient technology for extracting iodine from associated oil waters.

The thermally reversible process of formation of a blue starch-iodine complex has been studied. Experimental results are presented that allow one to quantify the kinetic parameters of this thermally reversible equilibrium. A difference was found in the kinetics of transformations of the components of the system - iodine-containing clathrate compounds of amyloiodine and amylopectoiodine - under the influence of temperature. It has been found that amyloiodin solution loses color faster than amylopectoidin solution. The parameters of the thermally reversible process for amyloiodin, amylopectoidoin and starch iodine complex were determined: rate constants; activation energy; temperature coefficients. The fact of incomplete restoration of the color of the solution of amylopectoiodine upon cooling was found. An explanation is proposed for the different behavior of the individual components of the system and the starch-iodine complex as a whole.

The authors performed a mass spectrometric study of the gas-phase Heck reaction with isoprene and trimethylammonium iodide (p-iodophenyl). The article presents the results of the thermal behavior of potassium iodate and periodate obtained using differential scanning calorimetry combined with thermogravimetric analysis. Based on the thermograms of the salts, conclusions were made about the stages of their thermal decomposition.

In this paper, the results of modeling the transfer of molecular iodine through the interface between heptane and water are discussed. The potential energy surface describing the transfer of an ion is constructed on the basis of phenomenological concepts using the results of quantum chemical calculations.

The rate constant for overcoming the barrier was calculated using the Kramers theory and the Brownian molecular dynamics method. The data obtained make it possible to interpret the results of experiments on studying the kinetics of thiosulfate oxidation by iodine at the heptane/water interface.

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Conclusion. The parameters of the thermally reversible process for amyloiodin, amylopectoidoin and starch iodine complex were determined: rate constants; activation energy; temperature coefficients. The fact of incomplete restoration of the color of the solution of amylopectoiodine upon cooling was found. An explanation is proposed for the different behavior of the individual components of the system and the starch-iodine complex as a whole.

For comparison, below are the results of the analysis of the same samples of iodine concentrates by different methods. The proposed potentiometric method is very simple and convenient in its design and allows you to accurately and quickly determine the amount of iodine in iodine concentrates.

Thus, various methods are widely used in the determination of iodine: radiochemical, photometric, ion-exchange, electrochemical, etc. However, they require a long time and are very laborious. Unfortunately, there are still no fast and accurate express methods, which requires their development.

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