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METHOD FOR THE PREPARATION OF ELECTROCHEMICALLY MODIFIED WATER

ABSTRACT

An ultrapure water and a method for producing electrochemically modified water are proposed, wherein the water has an electrical conductivity of less than 0.1 $\mu\text{S}/\text{cm}$ and is substantially free of organic constituents and gases, and OH ions and H_3O^+ ions are formed by autoprotolytic processes. The ultrapure water has an OH excess and a pH of 7.5 to 9.5.

The invention is further directed to a process for preparing a high purity chloride salt solution from the ultrapure water having the OH excess and the pH of 7.5 to 9.5.

In order to obtain disinfectant solutions of high durability and reproducibility of the disinfectant action, the preparation of a disinfectant solution from the chloride salt solution is provided.

DESCRIPTION

[0001]

The present invention relates to an ultrapure, electrochemically modified water, a process for preparing ultrapure, electrochemically modified water, and the use of this water for preparing high-purity chloride salt solutions and the use of these high-purity chloride salt solutions for preparing disinfecting solutions. WASTER

[0002]

Water is a fundamental prerequisite for life and is ubiquitous in nature.

It exists on the surface of the earth and in the atmosphere in all three states of aggregation, solid, liquid and gaseous. Plants and animals consist of 50 to 80% of water; in the human body, the water content is approximately 70% of the total weight. The human normally takes up water daily in the context of liquid absorption, but water is also a constituent of solid human foods.

[0003]

As a chemical compound, water can be synthesized from the elements hydrogen (H₂) and oxygen (O₂) by an oxidation reaction (ball gas reaction).

This reaction proceeds exothermically. In the context of electrolysis, for example, water can be decomposed by energy supply with the aid of electrical current into the constituents hydrogen and oxygen in opposite directions.

[0004]

The water molecule, H₂O, has a central place in many applications because of its particular chemical and physical properties.

These are, in particular, the dipole moment which arises on account of the different electronegativities of the elements involved, hydrogen, H, and oxygen, O, and on account of the geometry of the water molecule having a bond angle of approximately 104° and pronounced partial charges, and this is associated with the ability to form hydrogen bonds. This also results in the further particular properties of the high melting point and boiling point for a substance having the molecular weight of the water, the density anomaly of the water, the high specific heat capacity and high thermal conductivity as compared with other liquids and the high surface tension.

[0005]

In nature, water cannot be found as a pure substance, but it contains dissolved substances such as ions of salts and gases.

Thus, water is available in different qualities and has different properties and constituents. One refers to and distinguishes, inter alia, wastewater, brackish water, groundwater, sea water, mineral water, utility water, surface water, rain water, raw water, salt water, sweet water.

[0006]

The processed or checked water qualities include, inter alia.

Drinking water, demineralized water, deionized water, distilled water and ultrapure water.

Establishing WASTER

[0007]

Untreated water has a variety of foreign matter. Water removed from natural resources, such as surface water, rainwater or groundwater, but also seawater or mineral water, contains impurities, different salts and minerals,

depending on the origin. Thus, inter alia ions of magnesium Mg^{2+} , sodium Na^{+} , calcium Ca^{2+} , potassium K^{+} , iron Fe^{2+} , Fe^{3+} , chloride Cl^{-} and sulfate SO_4^{2-} are present in the water. Furthermore, dissolved gases are contained in the water, for example. B. Oxygen, Nitrogen and Carbon dioxide present in aqueous solution in equilibrium with the hydrated form as carbonic acid and the associated ions, carbonate, CO_3^{2-} and hydrogencarbonate, HCO_3^{-} . In addition, water may also contain nitrates, nitrites, organic ingredients, and other materials that are introduced into the water as "pollution" by direct or indirect sources. Direct sources are, for example, various wastewaters from the sewerage of habitual fields and industry.

Indirect entries of unwanted substances into the water are effected, for example, by pollutants introduced into the ground or surface water with the rain from the ground surface, from the air or from the soils, such as pesticides, fine dust, oil, sulfur compounds, nitrogen oxides or nitrose gases, fertilizer residues, heavy metals, constituents of sewage sludge.

[0008]

In treated water, in contrast, depending on the treatment method and intended use, the abovementioned constituents are more or less removed.

The treatment of water can be carried out, for example, by purification, filtration, softening, desalting, removal of heavy metals such as lead, manganese, cadmium, mercury, iron, sterilization and/or sterilization.

[0009]

The recovery, treatment and composition and thus the quality of drinking water are subject to high demands in Germany.

This regulates the drinking water regulation as a national conversion of the EG drinking water guideline of 1998. Thus, the drinking water regulation contains various regulations, by which human health is protected against adverse effects arising from contamination of water intended for human use. For this purpose, drinking water must not contain pathogens which can be transmitted by water or chemical substances in concentrations which could cause damage to human health. Furthermore, limits for defined microbiological parameters and chemical parameters must not be exceeded and other limits for indicator parameters must be maintained. The defined parameter values for radioactive substances must also not be exceeded. Thus, for example, the value for the electrical conductivity of drinking water at 25° C. must not exceed 2790 $\mu S/cm$. For the parameter for the total organic carbon content (TOC) which is a measure of the burden on the water with organics, there is no limit value in the prescription, the measured value must satisfy the requirement of "without abnormal change".

The proportional value for the "oxidizability" must not exceed 5.0 mg/l O_2 . It describes the oxygen requirement for oxidation of all organic constituents. The pH of the drinking water must be between 6.5 and 9.5.

[0010]

In a disinfecting treatment of the drinking water, only certain substances may be used and minimum concentrations of free chlorine, chlorine dioxide or other treatment substances must be present for disinfection after the conclusion of the measure.

[0011]

For pharmaceutical purposes, demineralized water and distilled water are listed in the European Pharmacopoeia.

Accordingly, there are included, inter alia, the monographs of "purified water (Aqua purificata)" and of "water for injection purposes (Aqua ad Injectabilia)".

Aqua purificata is produced from the raw material drinking water which is prepared by ion exchange, reverse osmosis, distillation or other suitable methods. The treatment corresponds to a demineralization, since the anions and cations occurring in the drinking water are largely removed by the methods mentioned. Aqua ad Injectabilia is distilled water, it may be generated exclusively by distillation, since there are high demands on sterilization.

[0012]

Ultra pure water (URW) contains no foreign matter as well.

It consists essentially of the chemical compound H_2O . This URW is needed in many technological areas. For example, laboratory and medical technology, chemical analytics, biochemistry, research, pharmacy, drug preparation, the preparation of injection fluids and infusion solutions, and technology, for example. For example, in the production of integrated circuits, as well as in the production of cosmetics, but also for cleaning medical devices and preparations (e.g. B. Endoscopes, Implants) and precision parts for use.

[0013]

URW is produced by various processes such as reverse osmosis, electrodeionization, ion exchange or distillation, even in combination with purification by adsorption on activated carbon.

Often ultrapure water plants are used, which combine different purification processes in order to produce as pure a water as possible.

[0014]

The electrodeionized water (EDI water) obtained by electrodeionization units already has a very high water quality.

It can be used as a precursor for preparing URW. EDI water is used, for example, in a continuous process by flowing through already softened or otherwise prepared water through an arrangement of cathode and anode and chambers located therebetween, each of which is formed by anion exchange membrane or by an anion exchange membrane. Cation exchange membrane is obtained. With the aid of the resulting electric field and the ion-selective membranes between the chambers, the ions dissolved in the inflow water (permeate) are directed in the direction of the electrodes, wherein they accumulate in the corresponding chambers in the concentrate remaining as rinsing water, while they are removed from the product water removable as diluate. The diluate consists of highly pure EDI water.

[0015]

Furthermore, various specifications exist for water of different degrees of purity.

According to ISO 3696:1987, water for analytical purposes is prepared in three different grades. Quality levels divided. ASTM D1193-06 (2011), an American Society for Testing and Materials specification, describes 3 grades for pure water and one for purest water.

[0016]

Various parameters are used for dividing the different water qualities described.

Electrical Conduct conductance

[0017]

The electrical conductivity of water indicates how much the water has the ability to conduct the electrical current.

It is represented by the quotient of current density and electric field strength and represents one of the most meaningful parameters with respect to the content of charged or ionic foreign substances. To determine the electrical conductivity, an anode and a cathode with a defined area and at a defined distance are introduced into the water to be investigated, a voltage is applied between these two and the resulting current strength is measured. The electrical conductivity, in particular of water and solutions, is temperature-dependent and is regularly specified for a temperature of $25^{\circ}C$. Since the water molecules themselves cannot conduct the current in principle because of their molecular structure, the electrical conductivity makes a statement about the concentration of the ions dissolved in the water, which make possible the current flow because of their electrical charge. As the ion concentration increases, the electrical conductivity increases and the electrical resistance of the water decreases.

For seawater with its dissolved salts, for example, very high conductivity values of 56 mS/cm (corresponding to $56,000\text{ }\mu\text{S/cm}$) are present. In the drinking water, the conductivity value at $25^{\circ}C$ may be up to $2790\text{ }\mu\text{S/cm}$. On average, the German drinking water, on account of the salts dissolved therein, reaches values of between $300\text{--}800\text{ }\mu\text{S/cm}$ depending on the range and is thus significantly below the required limit value. Whereas a

conductance of approximately 30 $\mu\text{S}/\text{cm}$, on average, is present in the rainwater, approximately 80-130 $\mu\text{S}/\text{cm}$ can be measured in mineral-containing swelling water.

[0018]

For most applications, for example in technology, industry and medicine, a low ion concentration of water is of decisive importance.

The conductivity value of distilled water at 25° C. is 0.5 to 5 $\mu\text{S}/\text{cm}$ due to the largely removed ions, whereas electrochemically deionized (EDI) water has an electrical conductivity of less than 0.2 $\mu\text{S}/\text{cm}$ (up to 0.08 $\mu\text{S}/\text{cm}$). According to DIN ISO 3696:1987, water may have a maximum conductivity of 0.1 $\mu\text{S}/\text{cm}$ at 25° C. for analytical purposes of quality stage 1; the conductivity of stage 2 may be up to 1.0 $\mu\text{S}/\text{cm}$ and that of stage 3 may be up to 5.0 $\mu\text{S}/\text{cm}$.

[0019]

According to ASTM D1193-06 (2011) there is a requirement for URW for a conductivity of at most 0.056 $\mu\text{S}/\text{cm}$.

[0020]

URW which contains almost no foreign matter will conduct the current only because of the chemical circumstance that the water molecule is an ampholyte, a chemical compound that can both accept and release protons.

This reaction, also referred to as autoprotolysis, originates from the chemical reaction NER1 that also proceeds in ultrapure water.

It must be taken into account here that the free individual ions H_3O^+ and OH^- are thus never present, but are always stabilized in their hydrated form, surrounded by non-protolyzed water molecules of the form H_2O and via common hydrogen bonds.

[0021]

The equilibrium of this reaction is strongly on the left side here.

Nevertheless, the charged products of the right-hand side are present in very low concentration. Therefore, the electrical conductivity of the URW has a calculated limit value of 0.055 $\mu\text{S}/\text{cm}$ at 25° C., which cannot be undershot in pure water even in the absence of foreign ions.

TOC Content

[0022]

Another meaningful parameter of water quality is the value that reflects the sum of the total organically bound carbon (TOC) in a sample volume. The TOC includes all organics, among others. Microorganisms, constituents from biofilms, various sugars, alcohols or plastic-based derivatives. No consideration is given to inorganic carbon such as carbonate and hydrogen carbonate. The TOC content of a water sample is a measure of the organic burden on the water, and is preferably given in $[\text{mg}/\text{l}]$, $[\text{ppm}]$, or $[\text{ppb}]$. Here, 1 mg/l = 1 ppm = 1000 ppb corresponds. It can be determined by chemical or thermal oxidation of the organic carbon compounds contained in the water to form carbon dioxide and subsequent determination of the CO_2 formed. Reference is made here, for example, to DIN EN 1484, in which various methods for determining the TOC content in different samples are described.

[0023]

Drinking water must have TOC content "without abnormal change" after prescription.

This corresponds approximately to a value of less than 1.5 mg/l .

[0024]

For URW according to ASTM D1193-06 (2011), a limit value of the TOC content of at most 0.050 mg/l, corresponding to 0.05 ppm or 50 ppb, is specified.

[0025]

Distilled water regularly has a TOC content of 0.2 mg/l, with ultrapure water plants URW with a TOC content in the range of 3 ppb can be achieved.

[0026]

In some cases, chemical oxygen demand (CSB) is also determined in water samples for numbering the organic contaminants rather than the TOC content value.

The CSB value is a measurement value indicating the amount of oxygen that would be consumed if all oxidizable materials were oxidized with oxygen as the oxidant.

The measurement is carried out wet-chemically in sulfuric acid with an excess of dichromate.

Due to the experimental setup, the CSB value also comprises in some cases inorganic oxidizable compounds in water.

Designation

[0027]

The disinfection involves measures to place dead or living material in a state in which it is no longer possible to infect those individuals with which it comes into contact. In this case, infectious germs must be removed, decimated or inactivated.

[0028]

Infectious germs are pathogenic microorganisms or subcellular structures which, in humans, animals or plants, trigger infection by their penetration and their propagation in these organisms and possibly also an infectious disease as a result of the infection.

These germs include in particular various bacteria, fungi, algae, microalgae and protozoa. Parasites, viruses, retroviruses, viroids, bacteriophages, prions or transposons are also included in the further sense.

[0029]

The amount of germs present in a sample.

Microorganisms are expressed in the number of colony-forming units (KbE). To prevent infections, existing germs should be reduced, and thus the number of KbEs should be reduced. The germ reduction is measured in log 10 steps. A log10level corresponds to a germ reduction by a power of ten. In the case of hand washing with soap, for example, a germ reduction by two log 10 steps is achieved, corresponding to a removal of 99% of the KbE present before the measure. Effective disinfection is achieved with a germ reduction of about three to seven log 10stages. In the case of sporulating germs, for example. B. Clostridium species such as Clostridioides difficile or Bacillus species such as Bacillus subtilis, an agent already applies as a sporicidal when the number of germatable spores is reduced by three log 10 steps during the intended use.

[0030]

In contrast to disinfection, in which an object or a surface is treated in such a way that it can no longer infect, sterilization in the actual sense involves the removal of all propagationable germs, pathogenic and apathogenic, including their permanent forms, for example.

B. Spores, as well as viruses and infectious proteins.

[0031]

For sterilization, a germ reduction of eight or more log 10 steps is required for technical delimitation from disinfection.

This is done on the basis that in practice complete sterilization cannot be ensured with absolute certainty.

[0032]

In the context of disinfection, a distinction is made between the various fields of use.

The hygienic and surgical hand disinfection, the skin antiseptics, surface disinfection, instruments disinfection, laundry disinfection and room disinfection and the disinfection of waste should be mentioned here. In addition, the disinfection of water plays a decisive role for a wide variety of applications, since microorganisms present in the water at a suitable temperature proliferate well due to the physiological conditions. Drinking water is only to be disinfected under appropriate germ loading. Both swimming pool and pool water and process, cooling or boiler water used in industry generally have to be disinfected.

[0033]

Besides physical processes, use is made, in particular, of chemical disinfectants (and disinfection processes) which can be divided according to their spectrum of action into bactericidal, fungicidal, levurocides, sporicides and virucides, and also into mycobacterial and tuberculocides (and processes).

[0034]

In addition, disinfectants, if they are to be put into traffic, have the problem of being subject to various legal regulations.

Depending on the field of application, they are thus regarded as medicaments, medical products, cosmetics or biocides.

As a biocide, they undergo EU biocidal regulation (EU) NR. 528/2012 of European Parliament and Rate 22. May 2012. The prescription also regulates that a proof of efficacy must be provided for the required approval of a biocidal active substance.

[0035]

The respective effectiveness of a disinfectant against different germs and for different fields of use is investigated with the aid of test instructions which are found, for example, in the European standards.

[0036]

Here, the efficacy testing of a disinfectant in accordance with specifications of EN 14885 involves a multistage process.

A qualitative screening test is carried out in phase 1.

Phase 2 is subdivided into phase 2 stage 1, in which a quantitative test is carried out in suspension in the test tube, and phase 2 stage 2, in which an investigation of the effectiveness in the experiment close to practice is carried out. The following European standards (EN) are used, inter alia:

[0037]

The European standards, the scope of which is in human medicine and industrial fields, are reviewed:

[0038]

Depending on the constituents, chemical disinfectants have different germ-reducing mechanisms which characterize them for different use.

One of these mechanisms is the oxidizing action of various disinfectants.

Here, microorganisms are killed or inactivated by the electron transfer, for example, SH groups of proteins are oxidized, thereby losing their operability.

[0039]

Oxidizing disinfectants contain, in addition to hydrogen peroxide, peracids and ozone, in particular chlorine and chlorine compounds.

Aqueous solutions of chlorine and chlorine compounds act bactericidal, fungicidal, levurocidal, virucidal and also sporicidal.

[0040]

Chlor dioxide as a disinfectant is effective over a wide pH range and forms little chlorinated by-products from the organic contaminants of the treated water.

It is disadvantageous that chemical hazardous substances are required for preparing chlorine dioxide solutions from hydrochloric acid and chlorite. Furthermore, the solutions have insufficient stability because chlorine dioxide easily decomposes to chlorite. Toxic gases are released from aqueous chlorite solution under the action of acid.

[0041]

Hypochloric acid presents fewer risks in use.

Particularly hypochlorite or chloramine T in aqueous solution is suitable for use in disinfecting surfaces, instruments, skin and water. The hypochlorous acid is suitable for a variety of uses, including in the food industry and drinking water treatment. The disinfectant action develops within a few seconds to minutes.

[0042]

In the disinfectants in which alkali hypochlorite is contained in aqueous solution, dissolved hypochlorite anion, hypochlorous acid and gaseous chlorine are present in a pH-dependent equilibrium.

When gaseous chlorine is introduced into water, the chlorine disproportionates and hydrochloric acid and hypochlorous acid are formed. NER3_-

[0043]

The hypochlorous acid is an unstable compound.

Even in low concentrations, it tends to disproportionate into hydrochloric acid and hydrochloric acid in aqueous solution. NER4_-

[0044]

The pH is therefore raised in solutions with hypochlorous acid in order to stabilize the latter.

With the addition of NaOH, for example, the hypochlorous acid dissociates. NER5_- NER5_-

[0045]

Similarly, when alkali hypochlorite is dissolved in water in a low concentration, the above equilibrium is initially established with the formation of a basic-reacting solution (pH approximately 9.7).

As the pH increases, this equilibrium shifts increasingly to the hypochlorite anion side.

[0046]

Figures 1 and 2 illustrate these equilibrium relationships in graphical form.

[0047]

According to FIG. 2, only about 35-40% of the chlorine present as HClO is present in a pH range of 2, and about 65-60% are chlorine gas (Cl₂).

This can escape from the system in gaseous form, spreads an unpleasant odor and no longer develops the desired disinfecting effect.

[0048]

In a pH range of about 3.5 to about 7.5, equilibrium is in favor of undissociated hypochlorous acid and the disinfection effect is optimal.

HClO is very reactive and reacts with a large number of oxidizable biomolecules, for example to SH groups, C-C double bonds or different nitrogen groups.

The denaturation of proteins in microorganisms destroys or inactivates them.

[0049]

If the pH rises above 7.5, the dissociated form of HClO weighs with the hypochlorite anion.

The OCl⁻ anion is present in hydrated form and can exert only little action against microorganisms, since it can only insufficiently interact with the surfaces of the microorganisms due to the hydrate shell and the negative charge.

[0050]

Therefore, the problem arises for disinfectants containing hypochlorite that on the one hand the hypochloric acid is present only in a limited pH range of 3.5 to 7.5 in sufficient concentration in undissociated form in which the best disinfecting effect can be achieved and on the other hand is unstable in this form and tends to decompose.

[0051]

Furthermore, in the case of the disinfectants which have an oxidizing action, the redox voltage, also referred to as redox potential (ORP), has a considerable influence on the oxidation capacity and thus the effectiveness of the agent.

[0052]

In principle, electrons are transferred from one substance to another substance in a redox reaction.

The electron accepting substance such as hypochlorous acid as the active ingredient of the disinfectant is reduced, and the electron donating substance such as microorganism to be eliminated is oxidized.

The redox potential is a measure of the respective readiness with which the active substance can absorb electrons and thus exhibits the disinfecting effect.

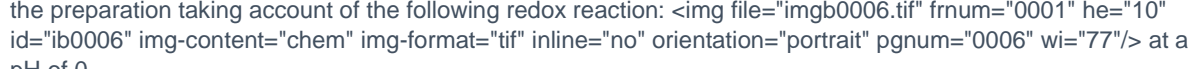
It depends on pressure, temperature and pH and is measured as an electric voltage in mV. A high positive redox potential of a disinfectant solution means a high readiness to pick up electrons and destroy microorganisms. The redox potential referred to here describes the electrical voltage generated by an active substance in oxidized form with respect to a reference electrode under customary standard conditions (25° C.; 101.3 kPa; pH=0; ion activities 1 mol/l).

[0053]

The redox potential of a solution can be measured, for example with a metal sensor which dips into the solution and via which the voltage in comparison with a reference electrode is measured with the aid of a pH/mV measuring device.

The standard hydrogen electrode can be used as reference electrode, a system with Ag/AgCl and with KCl electrolyte can also be used, or other common REDOX single-rod measuring chains.

[0054]

In an aqueous hypochlorite solution prepared in situ, a potential of +1.48 V can be measured immediately after the preparation taking account of the following redox reaction:  at a pH of 0.

At pH 8.5, a potential of +700 mV is still present.

[0055]

With the ageing of the solution, the ORP and thus also the oxidising power and the disinfecting effect decrease.

After storage or transport of about 7 Only a fraction of the original potential is present for days.

[0056]

At the same time, hypochlorous acid is also a component of the cellular immune response of vertebrates, including humans.

Within the framework of the oxidative burst, myeloperoxidase is formed by the enzyme in the neutrophil granulocytes composed of hydrogen peroxide and chloride ions, water and hypochlorous acid, and is released into the phagocyte in order to deactivate penetrated microorganisms.

[0057]

The desired germ-reducing effects of the disinfectants are accompanied by undesirable effects.

In the case of alcohol-containing agents, for example, a skin-damaging effect and a missing effect against bacterial endospores should be mentioned here. The use of some disinfectants may lead to the development of resistances in some microorganisms. As a result, the resistant organisms proliferate, whereby disinfection with the agent in question can no longer be carried out effectively.

[0058]

In the case of hypochlorite-containing solutions, a problem arises in that, owing to the high reactivity of the free HClO (=active chlorine), some of the disinfecting potential of the solution is already consumed by consuming chlorine.

The chlorine consumption represents the consumption of active chlorine released from hypochlorite which is triggered by binding to or reaction with all organic and inorganic compounds contained in the sample to be disinfected. The higher the initial concentration of impurities in a sample, the more hypochlorite must be used to still achieve a sufficient disinfecting effect after chlorine consumption.

[0059]

For the conventional disinfectants containing hypochlorite in aqueous solution, it is disadvantageous that the solution is most effective in a pH range of 4 to 7.5, but at these pH values, the hypochloric acid as described above is little stable even in a low concentration.

Both the HClO content and the redox potential of a hypochlorite solution decrease during storage.

[0060]

Furthermore, the storage and transport of ready-to-use aqueous disinfectant solutions cause relatively high costs, since large amounts of water have to be transported and stored because of the low concentrations of the disinfectant ingredient.

It would therefore be desirable to prepare an aqueous hypochlorite-containing solution only directly before use.

STAND OF TECHNIKING

[0061]

Various methods for treating water or for producing disinfectants are known from the prior art.

[0062]

For example, systems are offered which electrolytically activate drinking water and treat it for human enjoyment.

The activation takes place, for example, B. by membrane electrolysis. This treated water is referred to as "basic water" or "basic active water". It acts as an antioxidant in the body and neutralizes harmful radicals. This water contains the usual minerals and dissolved hydrogen. Furthermore, it has a redox potential due to the electrochemical treatment, but it degrades in 24-36 hours.

[0063]

Furthermore, it is known to prepare water without chemical additives by water electrolysis on diamond or metal electrodes.

In this so-called "electrical water disinfection", the action of current on the water without chemical additives gives rise to ozone, hydrogen peroxide and hydroxyl radicals having a high oxidising power. The method described is suitable for sterilizing highly pure process waters. This is described, for example, on the [www.samro.ch/Germany/Technologies/electric water disinfection ewd/Samro Technik AG](http://www.samro.ch/Germany/Technologies/electric%20water%20disinfection%20ewd/Samro%20Technik%20AG).

[0064]

The system ActiWa® of Samro Technik AG, likewise known, generates strong disinfectants from softened water by addition of a NaCl sol and subsequent electrolysis with membrane by means of diamond or metal electrodes, the pH of which is about 6 - 8.5 and the redox potential of which is about 800 - 1000 mV.

The effectiveness of the solution is only low at a pH of 8.5. At a pH of 6 the disinfection effect is present but the solution is very corrosive. The disinfectants are suitable for water disinfection and disinfection of wet surface type machines. The disinfection on drying surfaces which are not to be flooded with water is not possible. The solutions described are storage-stable only to a limited extent and do not develop a long-term disinfection effect. ([www.samro.ch/technologies/disinfectant actiwa/](http://www.samro.ch/technologies/disinfectant%20actiwa/)).

[0065]

DE 20 2018 102 846 U1 describes a disinfectant which comprises an aqueous sodium hypochlorite solution having a concentration of $\leq 0.1\%$ and which is additionally stabilized with sodium carbonate in a concentration of 0.4 to 2.5 g/l.

Due to the buffering action of the sodium carbonate, the pH in this disinfectant can only be very difficult to shift into the optimum range of action for hypochlorite of pH 3.5 to 7.5.

[0066]

DE 10 2006 043 267 A1 describes a method for producing a disinfectant by electrochemical activation (ECA) of water and a method for disinfecting water by means of such a disinfectant.

For this purpose, a method for disinfecting water is proposed, in which an electrolyte solution is added from drinking water or service water, rain water, industrial water or the like by electrochemical activation of at least a partial stream of the water to be disinfected, and the water exposed to the electrolyte solution is exposed to an anode in an electrolysis reactor having at least one cathode chamber having a cathode and having at least one anode chamber spatially separated from the cathode chamber, in particular by means of a diaphragm or a membrane, by applying a direct voltage to the electrodes in order to place the water/electrolyte solution in a state suitable for disinfection, wherein the electrical conductivity of the water to be electrochemically activated is set to a value of at most 350 $\mu\text{S}/\text{cm}$ before the electrolyte solution is added. Due to the present arrangement with a spatially separated anode and cathode chamber and a membrane between both chambers, an anolyte with a very low pH is obtained, and the catholyte with a high pH is completely discarded.

The yield is therefore low. The anolyte is highly corrosive to metals. In addition, chlorine gas can be produced due to the pH in the anolyte.

[0067]

WO 2007/093395 A2 describes a similar method for producing a disinfectant by electrochemical activation (ECA) of water, in which an electrolyte solution is added to water and the water subjected to the electrolyte solution is subjected to an electrical current in the form of a dilute water/electrolyte solution in an electrolysis reactor having at least one cathode chamber having a cathode and at least one anode chamber spatially separated from the cathode chamber, in particular by means of a diaphragm or a membrane, by applying a direct voltage to the electrodes in order to place the dilute water/electrolyte solution in a metastable state suitable for disinfection, wherein the pH value of the solution in the anode chamber is controlled to a value between 2.5 and 3.5.

Here too, strongly acidic anolyte water is prepared which is not suitable for all applications.

[0068]

EP 0 470 841 A2 describes a method and an apparatus for producing sterilized water, in which sodium chloride-added water and hydrogen chloride-added water are mixed, electrolyzed in an electrolysis cell without diaphragm, and the resulting electrolyzed water is diluted with water.

The pH should be adjusted in a range from 3 to 7 and the remaining chlorine concentration should be adjusted in a range from 1.0 to 200 ppm. The method is intended to prevent the deposition of calcium carbonate on the cathode. The active chlorine concentration and redox potential of the water resulting from this process decrease with time due to the low pH. Further, the water in the pH range of 3 has corrosive properties, for example, on the piping network. Only in a pH range of 6.5 to 9.5 does the water have drinking water quality.

[0069]

EP 1 036 037 B1 describes a composition with electrochemically activated water (ECA water) for disinfecting and sterilizing articles, in which the ECA water contains a corrosion inhibitor or a wetting agent and a combination of these components.

Electrochemical activation, electrolysis of salted water in cathode and anode chambers separated from one another by a membrane leads to ECA water with high surface tension, in which reliable wetting of the objects to be disinfected and reliable disinfection are not possible. Further, the ECA water is corrosive to metal, which is disadvantageous for metal articles or pipes to be disinfected. Therefore, for the present mixture, the ECA water is added with a corrosion inhibitor or a wetting agent or a combination of both. These additives limit the field of application of ECA water for disinfection, since additives are not desired in all fields.

[0070]

The methods known from the prior art, on the one hand, produce strongly acidic, anodic solutions which, owing to the low pH value, react corrosively, are complex to handle and contain the risk of chlorine outgassing.

On the other hand, those methods which electrolyze without membrane or which reassemble anolyte and catholyte after membrane electrolysis produce a water which, at the time of production, is disinfecting and at this time supplies germ-free water. However, due to the composition, this water does not have a disinfecting long-term effect and can be subject to recontamination at any time. The disinfectant ingredients react back to sodium chloride and water.

Startup

[0071]

It is therefore an object of the present invention to provide a water with the aid of which the described disadvantages and the problems of the prior art can be overcome. In particular, disinfectant solutions based on hypochlorite are to be able to be produced with this water, the content of hypochloric acid HClO (active chlorine content) and the redox potential (ORP) thereof remaining substantially constant at the time of use despite storage and/or transport.

[0072]

It is a further object of the present invention to provide disinfectant solutions having a low content of sodium chloride to enable the use of corrosion-sensitive surfaces.

INVENTION

[0073]

This object is achieved by the ultrapure water according to the invention having the features of Claim 1, by the process for producing ultrapure, electrochemically modified water according to Claim 5, and by the process for producing a disinfectant solution according to Claim 9.

[0074]

The disinfectant solution produced by the method according to the invention can be used universally.

It is suitable both for skin and hand disinfection by spraying or application and rubbing, as well as for the spraying disinfection or the wiping disinfection of surfaces and the instrument disinfection.

Furthermore, it can be used for aerosol disinfection of surfaces and rooms or rooms. Space air, but also for wound disinfection. It can also be used for cold fogging in the sanitization of room air and odor neutralization.

[0075]

The disinfecting effect is tested in accordance with European standards.

With the inventive disinfection solution, a germ reduction by at least the factor 10⁵ can be achieved compared to bacteria. Against mycobacteria, yeasts, fungi and viruses, but also bacteriophages, a germ reduction by at least the factor 10² is possible. Spores are decimated with at least the factor 10³.

[0076]

Ultrapure water according to the preamble of claim 1 is a ultrapure water as described in various standards, for example DIN ISO 3696, ASTM D1193-91, DIN EN 13060, Ph. Eur.

10, DAB 2019. The ultrapure water has an electrical conductivity of less than 0.1 $\mu\text{S}/\text{cm}$, and is substantially free of organic components and gases. The electrical conductivity is measured at a temperature of 25° C. The ultrapure water should be substantially free from inorganic and organic components other than the water molecules. A measure of the proportion of organic constituents is the TOC content. Ultrapure water containing practically no organic ingredients has a TOC content of at most 0.5 mg/L.

[0077]

Since contamination of the ultrapure water is caused by introduction of foreign substances from contact surfaces, for example.

For example, for containers, plugs and closures, pipes or filling installations or for gases as well as the ambient air, the water is substantially free of organic constituents and gases. Basically, the ultrapure water should have as few impurities as possible. It has a value of less than 0.1 $\mu\text{S}/\text{cm}$ for electrical conductivity. This conductivity corresponds to a water substantially free of ions. This also includes ions of heavy metals, alkali metals and alkaline earth metals.

[0078]

Due to autoprotolytic processes, in the ultrapure water according to the preamble, in addition to H₂O molecules, oxonium ions (H₃O⁺ ions) and hydroxide ions (OH⁻ ions) are also present in stoichiometrically equal ratio.

[0079]

In addition to the OH⁻ ions and H₃O⁺ ions formed by autoprotolytic processes, the water according to the invention has an excess of OH⁻ ions.

In the water according to the invention, the concentration of OH⁻ ions is thus higher than that of H₃O⁺ ions.

The concentration is thereby increased such that a pH of 7.5 to 9.5 is established.

[0080]

This excess of OH ions is called OH excess.

The OH ions are formed via a radical intermediate, OH • radicals. The OH • radicals in the production process are highly reactive and short-lived, so that OH ions are present in the water according to the invention.

[0081]

Due to the characteristic OH excess, the water according to the invention, unlike the water according to the preamble of claim 1, has a higher conductivity than 0.1 µS/cm.

As already stated above, this results from the negative charge of the excess OH ions and their ability to conduct the electrical current thereby. Said conductivity of less than 0.1 µS/cm refers to the starting material, the ultrapure water. Its conductivity is changed according to the invention by the excess of OH ions.

[0082]

It has been found that it is particularly advantageous if the concentration of excess OH ions is approximately adjusted such that the pH is 8.5 to 9.5.

A pH of 9.2 is particularly preferred.

[0083]

The pH of the water according to the invention can be determined by conventional methods, for example by means of a glass electrode and a reference electrode, such as a silver-silver chloride half cell, as a single-rod measuring chain.

Other suitable electrodes, such as a standard hydrogen electrode, can also be used as measuring and reference electrodes.

[0084]

In addition to the H₂O molecules and their autoprototically formed oxonium and hydroxide ions, with the exception of the excess OH ions, virtually no further constituents are present in the water according to the invention.

[0085]

The ultrapure water may also have an electric conductivity of at most 0.056 µS/cm and a TOC content of at most 0.05 mg/L.

The water according to the invention itself then no longer has this low conductance due to the excess of OH ions.

[0086]

The water according to the invention receives an excess of OH ions according to a preferred embodiment by an electrochemical modification.

[0087]

The excess of OH ions can be generated, for example, by H⁺ or H⁺ being electrochemically modified to the ultrapure water.

H₃O⁺ ions are withdrawn.

This can be effected, for example, by the method according to the invention, but any other method in which an excess of OH ions is generated is also suitable.

Thus, an electrochemical membrane process would be possible in which positively charged H^+ or H_3O^+ is present. H_3O^+ ions on one side of a membrane are enriched in a cathode, while negatively charged OH^- ions on the other side of the membrane are enriched in an anode. The cations are then removed with a rinsing liquid. It would likewise be conceivable to enrich ultrapure water with O_2 gas and subsequently electrochemically reduce the O_2 molecules to OH^- ions.

[0088]

The electrochemical modification can be achieved according to claim 3, in particular, by treating the ultrapure water with an electrolysis and removing the hydrogen (H_2) formed during the electrolysis.

The electrolysis comprises passing the water through an electrolysis cell, wherein the electrolysis cell has at least one cathode area and at least one anode area, wherein the cathode area is larger than the anode area by a factor of 103 to a factor of 107. Under Cathode and Cathode respectively. Anode surface is understood here to mean the surface which is available as reaction surface for the electrolytic reaction.

[0089]

During electrolysis, the ultrapure water is supplied from a DC voltage source via the electrodes, which are arranged at a certain distance from one another, with a voltage sufficient for electrochemical modification at the selected distance.

[0090]

The removal of the hydrogen formed during the electrolysis takes place already in the electrolysis cell or preferably after the electrolyzed water has been passed through the electrolysis cell by known methods.

Thus, the gaseous hydrogen formed can be removed, for example, by membrane degassing or by vacuum degassing by means of a water jet pump.

The hydrogen formed can furthermore be removed by thermal degassing or ultrasonic degassing. In the case of ultrasonic degassing, usually a further method has to be added in order to achieve as complete a removal of the gas as possible. The degassing can advantageously take place on a large surface area. In this case, withdrawal of the hydrogen is facilitated by a larger reaction area.

[0091]

Furthermore, such cathodes are to be used whose surface area is greatly increased in comparison with the anode used.

The surface here refers to the interface between electrode and water at which the electrolytic reaction can take place. A rough, granular surface provides more reaction surface than a bare, smooth surface. The reaction area of the cathode is greater by a factor of 103 to a factor of 107 than that of the anode. This is achieved, for example, by a larger dimension of the cathode in comparison with the anode, but also by a changed geometry, such as, for example, B. achieves a folded surface, a perforated surface or a grid. In particular, a large surface area can be achieved by increasing the roughness.

[0092]

A stainless steel or niobium electrode can be used as electrodes.

Also, an iron electrode, a platinum electrode or a platinized titanium electrode may be used. Furthermore, the use of diamond electrodes is preferred. These are industrial substrate electrodes such as niobium, tantalum, silicon, graphite or conductive ceramic coated with a conductive diamond layer. The diamond layer may be boron doped. Electrodes of this type are the Diachem® electrodes from CONDIAS GmbH.

[0093]

The electrochemical modification of the ultrapure water is preferably carried out with an electrolysis cell without a membrane or diaphragm.

In the electrolysis, a diaphragm or a membrane is provided between the two electrodes in the electrolysis solution if a reaction of the products formed at the two poles must be avoided. According to the invention, according to claim 4, the ultrapure water can be electrochemically modified in an electrolysis cell without a membrane or without a diaphragm. The advantage here is that the electrolysis cell without a membrane does not require high pressures of the water to be electrolyzed in the electrode chambers and therefore no high maintenance effort and significantly less wear arise.

[0094]

The electrodes can be arranged in the electrolysis cell without a membrane or diaphragm at a distance of 1 to 4 mm.

A voltage of 4.5 to 48 V is applied for conversion. A higher voltage is to be applied with a further spacing of the electrodes and vice versa. Electrolysis of the ultrapure water is performed for the low power supply water of the present invention. In conventional methods, for example, voltages of 50 to 100 V are common.

[0095]

In contrast to conventional electrochemically modified water, which is also referred to as "basic water", the water according to the invention has almost no other ions or molecules or inorganic components apart from H₂O molecules, H₃O⁺ ions and OH ions in excess concentration.

Unlike conventional ultrapure water, it is characterized by a higher pH. This is 7.5 to 9.5, preferably 9.2.

[0096]

Surprisingly, it has been found that the water according to the invention is excellently suitable for preparing high-purity solutions of chloride salts.

Furthermore, it is very suitable to prepare disinfectants based on hypochloric acid. These disinfectants are superior to those of the prior art. They are distinguished, in particular due to the pH, by a high long-term stability or high long-term stability. Durability. At the same time and surprisingly, they have in use a high proportion of undissociated hypochlorous acid in contact with surfaces as well as with human or animal skin. This high proportion of undissociated hypochlorous acid is of critical importance for the disinfectant action of the compositions. As indicated above, hypochlorite anion has only reduced efficacy due to its negative charge and the hydrate shell attached in aqueous solution. In contrast, the undissociated hypochlorous acid is able to attach well both to surfaces to be disinfected and to the microorganisms to be oxidized because of the lack of electrical charge.

[0097]

Furthermore, the disinfectant produced with the water according to the invention is distinguished by a high long-term effect, i.e. a reduced germ colonization, measured in KbE, is also observed after a few hours on a surface treated with this disinfectant.

This long-term action has the advantage that surfaces do not have to be disinfected as often as would be the case with conventional means with disinfecting action.

[0098]

According to the present invention, an ultrapure electrochemically modified water of the present invention can be prepared by a method according to claims 5 or 6.

[0099]

URW can be used, for example, as starting material for the ultrapure, electrochemically modified water.

This URW has an electrical conductivity of at most 0.1 µS/cm, preferably of 0.06 µS/cm, and a TOC content of at most 0.5 mg/l, preferably of at most 0.05 mg/l.

URW with this specification can be obtained, for example, from Sigma Aldrich or Merck. In a first step (1), this URW is degassed. This can be effected by any suitable method, for example by vacuum degassing by means of

a water jet pump or also by membrane degassing, thermal degassing or ultrasonic degassing. In the case of ultrasonic degassing, a further method is usually to be added in order to achieve as complete a removal of the gases as possible. The degassing advantageously takes place on an increased surface area. The extraction of the gases from the URW is facilitated by a larger reaction area.

[0100]

In a further step (2), the degassed URW is treated in a flow-through electrolysis cell without a membrane or diaphragm.

An electrolysis according to the prior art provides for the application of a voltage to at least two electrodes, to an anode and a cathode. DC current is passed through an electrolyte between these electrodes by the applied voltage. In the present method, the degassed URW is used instead of an electrolyte.

[0101]

In the electrolysis, different parameters can be selected in part independently and in part depending on one another.

Overall, however, it is necessary to coordinate the parameters with one another. These include the volume and the geometry of the electrolysis cell, the volume flow of the liquid flowing through the cell, the geometry of the electrodes, the material or the coating of the electrodes, the number and polarity of the electrodes, the spacing of the electrodes from one another and from the cell, the magnitude of the applied voltage, the spacing of the electrodes from one another and from the cell.

Table 2 Table 2

Change change change change change

Effect on Reaction

Increasing Current Strength

Increased Electrolytic Rate

Increasing the voltage

Increased Current Strength and thus Increased Electrolytic Rate

Increasing the concentration of ions in the electrolyte

Increased Current Strength and thus Increased Electrolytic Rate

Increasing the size of the electrode surface

Increased Current Strength and thus Increased Electrolytic Rate

Reduction of Spacer Between Electrodes

Increased Current Strength and thus Increased Electrolytic Rate

Replacement of Metal Electrode with Inert Electrode

Electrode material is no longer oxidized/dissolved.

[0102]

For example, rod-shaped electrolysis cells can be used, the anode of which comprises a hollow tube which is connected to the positive pole of a voltage source and the cathode of which also comprises a hollow tube which is arranged coaxially outside the anode and is connected to the negative pole of a voltage source.

Preferably, cylindrical electrolysis cells are used, in the hollow space of which disk-shaped or virtually disk-shaped electrolysis plates are arranged perpendicular to the axis.

These have, for example, a volume of about 2 to 4 l.

However, larger cells can also be used if large amounts of ultrapure, electrochemically modified water are to be prepared.

For smaller amounts, for example on a laboratory scale, a smaller electrolysis cell with a volume of 0.5 to 2 l can also be used.

[0103]

The volume flow can be selected from about 10 l/h up to 500 l/h depending on the size of the cell and the generator.

It is also dependent in particular on the volume of the electrolysis cell.

In this case, a cell of approximately 3 l volume can be operated with a volume flow of up to 500 l/h.

[0104]

The electrolysis is preferably carried out on plate-shaped electrodes.

Suitable anode here are, for example, plates made of (coated) titanium, of (high-strength carbon) fired graphite plates or else diamond-coated electrolysis plates.

Titanium can be coated, for example, with iridium oxide or rhodium.

The diamond coating must be doped with boron.

The coating is applied to a technical substrate, such as fluorinated plastic.

Suitable cathodes are, for example, plates made of stainless steel, niobium, fired graphite or else diamond-coated electrolysis plates.

The size and shape of the electrolysis plates again depend on the dimensions of the electrolysis cell.

Several plates may be contained in an electrolysis cell.

The number of plates is determined here both by the size and shape, in particular the thickness of the plates, but also by the size and shape of the electrolysis cell.

At least 3 plates are to be provided.

In the case where coated plates are used, plates coated on both sides can be used centrally; on the sides facing the cell, in each case one plate coated on one side can be used, wherein the coating points toward the next counterelectrode.

Particularly suitable are electrolysis cells in which there are 5 to 11 plates.

[0105]

It is advantageous in the method according to the invention if the cathode surface is larger than the anode surface.

This can be done on the one hand by a larger geometry or larger dimensions of the plates.

On the other hand, due to the roughness of the respective electrode material or of the electrode coating, a surface of different sizes can also be achieved with the same dimensions.

To increase the surface area, a so-called expanded metal can also be coated.

The cathode area is greater than the anode area by at least a factor of 103 to a factor of 107.

[0106]

Further, the voltage to be applied is to be selected depending on plate material, plate number, plate size and plate shape.

The volume flow used also influences the voltage to be applied.

A DC voltage is required for the method according to the invention.

For example, at a volume flow of 200 l/h, the degassed URW can be supplied with a voltage of 18 V.

[0107]

The following table gives examples of the various possible parameters that can be chosen for the electrolysis of the ultrapure water in the flow-through electrolysis cell:

Table 3 Table 3

Volume of electrolytic cell [ml]

500

1000

3000 - 3500

3500 - 5000

Volume flow [l/min]

0,3

0,6

2

,5

4

,0

Material Electrode

Diamond, boron doped; Ir/Rh; Plating stainless steel, niobium, titanium

Diamond, boron doped; Ir/Rh; Plating stainless steel, niobium, titanium

Diamond, boron doped; platinized stainless steel, niobium, titanium

Diamond, boron doped: platinized stainless steel, niobium, titanium

Geometry of Electrodes

4 x6 cm thickness 1.5 mm

4 x12 cm thickness 1.5 mm

Amid 12 cm thickness 2 mm

Amid 12 cm thickness 2 mm

Distance of Electrodes [mm]

1,5

1,5

2,5

2,5

Applied Voltage [V]

7,5 -12

12-18

24

24-36

Current intensity [Amp]

20

20

40

65 - 80

Technical Stream Mode

DC DC DC DC DC DC DC DC DC

DC DC DC DC DC DC DC DC DC

DC DC DC DC DC DC DC DC DC

DC DC DC DC DC DC DC DC DC

[0108]

In addition, oxygen is supplied to the degassed and electrolyzed URW in a separate step (3).

This can take place, for example, via the supply of pure gaseous O₂.

A gas mixture with O₂, such as ambient air, can also be used.

In the thus oxygenated product, the electrolyzed water is then reacted with the O₂.

This advantageously takes place at a surface, preferably at a large surface, over which the product is guided.

In this case, it is possible to use, for example, a filter, a silicate fiber membrane or another solid body having a porous surface.

[0109]

It is important that the water thus obtained is subsequently degassed again in step (4).

The abovementioned processes can again be used for degassing.

Gasification under vacuum is advantageous.

This can also take place on a silicate fiber membrane.

[0110]

Alternatively, in step (3), the ambient air and/or O₂ on a membrane, preferably a silicate fiber membrane, can be reacted with the water obtained after step (2).

In this case, the water obtained in step (2) is conducted on one side of the membrane, the ambient air and/or O₂ on the other side of the membrane.

This is done, for example, by applying a vacuum.

Advantageously, the ambient air and/or the O₂ does not come into direct contact with the water, but only via the membrane.

The H₂ contained in the water is thus enriched on the one side of the membrane, penetrates through the membrane and can react on the other side of the membrane with the O₂ or the O₂ supplied there from the supplied ambient air to form H₂O.

Subsequently, further degassing according to step (4) can be carried out.

[0111]

Steps (2) and (3) of this method can now be repeated once or several times.

For this purpose, the product obtained after step (3) is again passed through a flow-through electrolysis cell.

It can be returned here and once again flow through the first electrolysis cell, but it is also possible to use a second or further electrolysis cell which is operated with the same or different parameters in relation to the first cell.

Step (3) follows in each case.

Finally, degassing according to step (4) takes place.

[0112]

The parameters mentioned in Table 3 are selected in such a way that an ultrapure, electrochemically modified water having a pH of 7.5 to 9.5 is obtained already after a run from step (1) to step (4).

[0113]

Furthermore, steps preceding the process according to the invention can also be produced from drinking water or water of different quality, such as for example swelling water, groundwater or surface water, as starting material.

If water of different quality than URW is to be used as a starting material for the production of the water according to the invention, this starting material is appropriately pretreated.

This is advantageous, for example, in water-poor areas with difficult access to water in drinking water quality or due to other natural conditions.

As starting material, surface water, for example, can be used.

B. originated from traffic jams, lakes or rivers, or else retained rain water were used.

[0114]

Depending on the TOC content in the starting material, it is first treated in an electrolytic cell.

This step (a) is to be provided whenever the TOC content is more than 0.5 mg/L.

Thus, in clean swelling water, the TOC content is regularly at about 1-2 mg/l, a TOC content of about 2-5 mg/l can be measured in lightly loaded flows, and values above 100 mg/l of TOC can be found, for example, in heavily soiled waters.

[0115]

As the electrolytic cell, any cell suitable for treating waste water or for disinfecting water is suitable.

A flow-through electrolysis cell is preferred.

For example, electrolysis cells with lead electrodes or with boron-doped diamond electrodes can be used.

These have been developed by the Fraunhofer Institute for Layer and Surface Engineering (IST).

The electrodes available from Condias GmbH or Samro Technik AG are preferred, for example.

In particular, it is advantageous if the anode area is larger than the cathode area.

In this case, for example, an anode area which is larger than the cathode area by a factor of 103 up to a factor of 107 is suitable.

[0116]

Another suitable method for reducing the TOC content in the starting material is UV treatment with UV-C radiation having a wavelength of about 254 to 185 nm.

Ultrafiltration is likewise possible at moderate TOC contents in the starting material.

[0117]

The corresponding method reduces the TOC content of the starting material to a value of at most 0.5 mg/l.

If the corresponding starting material has a TOC content of 0.5 mg/l or less, this process step can be omitted.

In addition, it is preferable for the method that the TOC content of the raw material can be lowered to a value of 0.05 mg/L or below.

[0118]

In a subsequent optional step (b), the starting material, the TOC content of which has been correspondingly reduced, is degassed with a suitable process.

This can be effected by vacuum degassing by means of a water jet pump or else by membrane degassing, thermal degassing or ultrasonic degassing.

In the case of ultrasonic degassing, a further method is usually to be added in order to achieve as complete a removal of the gases as possible.

The degassing advantageously takes place on an increased surface area.

[0119]

In the water obtained after the step (a) or (b) or in the starting material having a TOC content of at most 0.5 mg/L, in a step (c), the non-organic content is reduced.

This takes place if the content of gases and/or of heavy metals and/or nitrogen compounds is more than 0.05 mg/l.

The gases in question are, for example, Cl₂, CO₂ and/or N₂.

The heavy metals include antimony, arsenic, lead, cadmium, chromium, nickel, mercury, selenium, iron and/or manganese.

The removal of the respective constituents is effected, for example, by filtration through or adsorption on activated carbon, filtration through graphene oxide, reduced graphene oxide or graphite or another suitable method.

In this case, the content of the abovementioned substances is reduced to a value of at most 0.05 mg/l.

[0120]

If the water obtained after step (a), (b) or (c) or the starting material already having a TOC content of at most 0.5 mg/l and non-organic constituents of at most 0.05 mg/l and a conductivity of more than 30 µS/cm, step (d) is carried out.

The concentrations of alkaline earth metal ions, the anions carbonate, bicarbonate, sulfate, chloride, nitrite, nitrate and/or phosphate in the water obtained after step (a), (b) or (c) or in the starting material are lowered here by means of customary mixed ion exchangers and/or by means of separate cation and anion exchangers, with the result that the conductance amounts to at most 30 µS/cm.

This corresponds to a degree of hardness of 1° German hardness.

[0121]

The conductivity can be measured with a conductivity probe, for example by HANNA Instruments.

As the ion exchanger, a strongly acidic cation exchanger is preferably combined together with a weakly basic anion exchanger and a strongly basic anion exchanger.

[0122]

Subsequently, or if the starting material already has a conductance of at most 30 $\mu\text{S}/\text{cm}$ and a TOC content of at most 0.5 mg/l and non-organic constituents of at most 0.05 mg/l, the content of ions, in particular sodium ions and chloride ions, is further reduced in a step (e) by means of reverse osmosis.

Due to the reduction of the foreign substances in the water already effected in steps (a), (b), (c) and/or (d), or due to the high purity of the starting material, the osmotic pressure is already low and the reverse osmosis can be carried out with low energy consumption.

[0123]

In a subsequent step (f), the content of ions or ions is obtained.

Residual ions of alkali, alkaline earth metal, metal, halide, nitrate, nitrite by electrodeionization.

[0124]

The water obtained after step (f) has a TOC content of at most 0.5 mg/L and a conductivity of at most 0.1 $\mu\text{S}/\text{cm}$.

With this water the process according to the invention can now be carried out with the steps (1), (2), (3) and (4) according to claim 5 or 6.

[0125]

If surface water and/or service water is used as starting material, it is expedient if coarser and finer particles are separated off in advance in the starting material.

Larger particles have an average particle diameter of greater than about 100 μm .

They are separated by means of coarse filtration or by another suitable method.

The finer particles, which can be present depending on the starting material, have an average particle diameter of approximately 100 μm to 5 μm .

They are preferably removed by fine filtration or by another suitable method.

Likewise, instead of the coarse and fine filtration, separation by means of a hydrocyclone can take place.

[0126]

The ultrapure electrochemically modified water of the present invention is used in, inter alia, a process for producing a high-purity chloride salt solution.

One or more salts of hydrochloric acid having a purity of at least 99.0% are dissolved in the water according to the invention.

Particularly preferably, salts of hydrochloric acid having a purity of at least 99.5% are dissolved in the water according to the invention.

[0127]

A concentrated solution containing at least 20% by weight of chloride salt is prepared.

A brine can be prepared in which the chloride salt is contained until saturated.

In the case of a plurality of chloride salts, the maximum possible saturation concentration can deviate and be higher than in the case of a single salt.

[0128]

In principle, the solubility of a substance can be specified in different ways.

On the one hand, the solubility, in particular with regard to saturation, is specified as the present mass of dissolved substance in a volume of the solvent used.

The resulting solubility in [g/l] is mentioned, for example, in the pharmacopoeias.

On the other hand, there is considered solubility in inter alia the context of mass fraction, which consists of the ratio of dissolved substance mass to the total mass of the resulting solution, which is composed of substance and solvent.

In the following, the solubility is specified as mass fraction in % by weight, which denotes a measure of the mass of dissolved substance in the total mass of solution.

[0129]

Sodium chloride, potassium chloride, magnesium chloride and/or calcium chloride can be used as salts of the hydrochloric acid.

A mixture of different chloride salts can also be used at any time.

The purity of the chloride salts used is at least 99.0%.

This corresponds, for example, to the purity class "purissimum" according to various pharmacopoeias, such as the European Pharmacopoeia Ph. Eur., the British Pharmacopoeia BP, the Japanese Pharmacopoeia JP or the U.S. Pharmacopoeia USP. Particularly suitable are, for example, NaCl puriss.p.a., NaCl optical grade 99.9% or NaCl Suprapur®, 99.99%.

[0130]

At a temperature of 20°C the saturation concentration for NaCl is 26.36 wt%.

This corresponds to a solubility of 358 g NaCl in one liter of water.

Analogously, for KCl, there is obtained as maximum concentration at saturation 25.76 wt %, for MgCl₂ 35.15 wt %, and for CaCl₂ 45.53 wt %.

[0131]

The high-purity chloride salt solution can be used in particular in a method for producing a disinfecting solution.

For this purpose, the chloride salt solution described above is diluted to a concentration of about 0.025 to 10% by weight.

[0132]

The dilution is carried out with ultrapure water.

This water is not electrochemically activated, but is URW, as can be produced with conventional ultrapure water plants or ultrapure water systems.

The URW can be produced, for example, by means of electrodeionization.

For electrodeionization, softened, desalted water is used.

The softening and desalting may be carried out by suitable methods such as flow through polymeric anion and cation exchangers and reverse osmosis under pressure.

The electrical conductivity of the URW used is at most 0.1 µS/cm at 20° C. and the TOC content at most 0.5 mg/l.

[0133]

It is advantageous if the ultrapure water used for diluting the high-purity chloride salt solution is degassed by a suitable method before it is used for dilution.

[0134]

Furthermore, the high purity chloride salt solution can also be diluted with URW to a concentration of about 1% to about 6% by weight.

This is particularly suitable when a disinfectant solution having a concentration of HClO (free chlorine or chlorine is present.

Active chlorine) from about 600 mg/l to about 2500 mg/l should be prepared.

If a disinfecting solution having a concentration of 600 mg/L to 1200 mg/L HClO is needed, the chloride salt solution is preferably diluted to a concentration of 1 wt % to 3 wt %.

[0135]

Following dilution of the high purity chloride salt solution prepared using the water of the present invention, this diluted solution is treated by electrolysis in a cyclic electrolytic cell.

[0136]

HClO (active chlorine) forms during this electrolysis, which has a disinfecting effect.

Furthermore, Cl₂ (chlorine gas) is formed, which further reacts with the water present to form HClO, H⁺ and Cl⁻.

It is particularly advantageous in this electrolytic process that little disturbing by-products, such as NaOH, Cl⁻, OCl³⁻ or OCl⁴⁻, are formed.

[0137]

In the electrolysis in the process according to claim 9, preferably a cyclic electrolysis cell without a membrane or diaphragm is used.

Such a cell is characterized by lower maintenance requirements and longer durability than a cell in which cathode and anode compartments are separated by a membrane or diaphragm.

[0138]

The cyclic electrolytic cell is a closed cell into which the diluted chloride salt solution is introduced via an inlet line.

A voltage is then applied to electrodes, anode and cathode in the cell which dip into the dilute solution.

After a specific residence time, the electrolyzed dilute solution is discharged from the cyclic cell via an outlet line.

It can then be collected in a storage container.

[0139]

The cyclic electrolysis cell contains at least one anode and at least one cathode.

It is advantageous if the anode area of all anodes together is larger than the cathode area of all cathodes.

In particular, an anode area which is larger than the cathode area by a factor of 103 up to a factor of 107 is used.

[0140]

In electrolysis, the parameters relating to the volume and geometry of the electrolysis cell, the residence time of the solution in the cell, the geometry of the electrodes, the material or the coating of the electrodes, the number and polarity of the electrodes, the magnitude of the applied voltage, the technical current type (direct current (DC)), and the spacing of the electrodes from one another and from the cell walls are matched to one another.

The choice of parameters here has in particular an influence on the concentration of HClO formed in the disinfectant solution and the redox potential for OCl/Cl₂.

[0141]

For example, the following parameters are suitable:

Table 4 Table 4

Volume of electrolytic cell [ml]

500

1000

3000 - 3500

3500 - 5000

> 5000

Dwelling time [min]

0,45

1,0

1,0

2,0

2,0

Material Electrode Material

Diamond, boron doped; stainless steel, niobium

Diamond, boron doped; stainless steel, niobium

Diamond, boron doped; stainless steel, niobium

Diamond, boron doped; stainless steel, niobium

Diamond, boron doped; stainless steel, niobium

Geometry of Electrodes

4 × 6 cm, bar electrode

Rod Electrode Rod Electrode

<dnt0> 12 cm; thickness 1.5-2.0 mm

<dnt0> 12 cm; thickness 1.5-2.0 mm

8 × 10 cm

Distance of Electrodes [mm]

1,0

2,5

2,5 - 3,0

2,5 - 4,0

2,5 - 4,0

Applied Voltage [V]

5

,5 - 7,5

7

,5-10

10-15

20-45

> 24

Current intensity [Amp]

< 40

< 40

40 - 65

65 - 120

> 40

Technical Stream Mode

DC DC DC DC DC DC DC DC DC

DC DC DC DC DC DC DC DC DC

DC DC DC DC DC DC DC DC DC

DC DC DC DC DC DC DC DC DC

DC DC DC DC DC DC DC DC DC

[0142]

The parameters mentioned can in particular be selected such that the disinfection solution has a redox potential for OCI/Cl_2 of +700 to +950 mV after the corresponding residence time in the cell.

The parameters are advantageously selected such that after the residence time in the cell, the disinfectant solution has an ORP of +800 to +900 mV, in particular of +850 mV.

[0143]

The parameters mentioned are preferably selected such that the disinfectant solution has a concentration of 600 to 5000 mg/l of ClO ions.

In particular, disinfectant solutions which contain a concentration of ClO ions of 600 mg/l, 1200 mg/l, 1800 mg/l or 2500 mg/l are preferred.

In addition, the parameters can also be selected in such a way that a highly effective disinfection solution of 4000 to 5000 mg/l of OCI is obtained.

For this purpose, for example, the electrolysis of a highly pure chloride salt solution diluted to 5% by weight is carried out in an electrolysis cell with a volume of 1000 ml.

For this purpose, a DC voltage of 5 V is applied to stainless steel electrodes, the cathode area being larger than the anode area by a factor of 104.

The electrodes are arranged at a distance of 2 mm from each other.

A current of 25 Amp flows and the solution is treated for 0.45 min in the electrolytic cell.

Thus, for example, a disinfectant solution having a concentration of 1200 mg/l ClO ions and an oxidation potential of 800 mV is obtained. The present concentration of OCI^- can be determined in the course of the residence time by means of iodometric titration or iodometric back titration.

The redox potential can be measured by means of known methods, for example using a standard hydrogen electrode or also using a silver-silver chloride electrode.

[0144]

By diluting the high-purity chloride salt solution to a concentration of 0.025 to 10% by weight and treating this diluted solution with the electrolysis, the solution is converted to a disinfecting solution.

[0145]

In a particular embodiment of the process according to the invention, the disinfectant solution obtained is degassed by a suitable process after electrolysis in the cyclic electrolysis cell.

The already described methods of vacuum degassing by means of a water jet pump or also membrane degassing, thermal degassing or ultrasonic degassing are suitable here.

For example, degassing can take place on an increased surface area.

[0146]

The disinfectant solution described is superior in particular with respect to its long-term stability, but also with respect to the disinfecting oxidation potential and the reproducibility of the disinfection effect to the disinfectant solutions known from the prior art.

It still has an oxidation potential of +700 to +950 mV even after prolonged storage.

In any case, it still has an oxidation potential of +700 to +850 mV after prolonged storage.

[0147]

In the method according to the invention for producing a disinfection solution, an electrolysis cell without a membrane and/or diaphragm is used.

These electrolysis cells do not have an anode compartment and a cathode compartment separated by a membrane or by a diaphragm.

In the method according to the invention, a single cell is used in which the anode and cathode are in contact in a space with the solution to be electrolyzed.

This has the advantage that the method manages without high pressures.

Due to these pressures, which have hitherto been applied to the membrane cell or membrane cell, respectively.

Diaphragm electrolysis had to be used, the previous method was expensive and maintenance-intensive.

Furthermore, the membrane cell or membrane cell is produced.

Diaphragm electrolysis in the separate chambers two different solutions with very low pH on the anode side and very high pH on the cathode side.

This anodic solution is highly corrosive, loses the ORP within a short time and the concentration of OCI decreases.

Due to the corrosivity and the instability, the solutions obtained are only to a limited extent to be used for disinfection, in which a constant and safe disinfecting effectiveness must be assumed in order to achieve validatable results.

[0148]

Surprisingly, the disinfectant solutions obtained with the method according to the invention are despite high storage and high storage stability.

Long-term stability can develop an optimum disinfecting effect on contact with the surface to be disinfected or with the hands or skin.

This is achieved by an optimum pH range for the microbiological effectiveness.

[0149]

The disinfection solution obtained due to the treatment in the cyclic electrolysis cell can then be further processed by passing the disinfection solution at least once, preferably several times, through a flow-through electrolysis cell.

The disinfectant solution in the cell is preferably treated with the following parameters:

Table 5 Table 5

Volume of electrolytic cell [ml]

1000

Volume flow [l/min]

5

Material Electrode Material

Niobium or Ir/Rh, Niobium/Stainless Steel

Geometry of Electrodes

round round round round round round round round round round

Distance of Electrodes

<2.5 mm mm

Applied Voltage [V]

24 from 24 onwards

Current intensity [Amp]

from 40 to 40 to

Technical Stream Mode

DC DC DC DC DC DC DC DC DC

[0150]

The chloride salt still dissolved in the disinfectant solution is reacted further.

In this preparation, the disinfection solution can be diluted with URW to a desired concentration of 500 mg/l up to 2500 mg/l.

Thus, for example, a concentration of 600 mg/l, 1200 mg/l, 1800 mg/l or 2500 mg/l of OCI can be used according to the specifications from microbiology.

[0151]

The disinfectant solution prepared by the described method or the disinfectant solution diluted by the preparation can advantageously be admixed with an addition of sodium hydrogen carbonate in a concentration of 0.1 g/l to 0.5 g/l.

[0152]

Furthermore, benzalkonium chloride and/or other quaternary ammonium compounds can additionally be added to the disinfectant solution or the disinfectant solution diluted by treatment.

Benzalkonium chloride comprises all those alkylbenzyltrimethylammonium chlorides whose alkyl radicals consist of C8 to C18 chains.

Furthermore, other quaternary ammonium compounds can also be used.

Here, for example, one or more substances from the group containing cetylalkonium chloride, cetylpyridinium chloride, cetyltrimethylammonium bromide, denatonium benzoate, dimethyldioctadecylammonium chloride, tetrabutylammonium hydroxide (TBAH), paraquat, polyquaternium-7, tetradecyltrimethylammonium oxalate, 3-chloro-2-hydroxypropyl-N,N,N-trimethylammonium chloride, benzyltrimethylammonium chloride are suitable for being added to the disinfectant solution.

[0153]

The disinfecting effect of the solution can thus be additionally increased.

This addition also improves the surface active properties of the disinfectant solution.

A disinfecting solution with benzalkonium chloride and/or other quaternary ammonium compounds has improved wetting of the surfaces treated with this solution.

This is advantageous for the disinfection effect.

[0154]

The benzalkonium chlorides are used here in a concentration of about 0.1 g/l to about 2.5 g/l.

A concentration of 0.5 g/l to 1.5 g/l is preferred.

The other quaternary ammonium compounds are preferably used in concentrations of 0.1 g/l to 1 g/l, in some cases up to 10 g/l.

[0155]

The disinfection solution is particularly suitable for disinfection by means of nebulizers, sprayers or atomizers.

Here, the hand disinfection, surface disinfection, disinfection in the veterinary field, aerosol-borne surface disinfection, odor neutralization or room air hygiene is possible.

For aerosol-borne surface disinfection or room air hygiene, the disinfection solution is finely sprayed through a nebulizer or a spray nozzle.

For better distribution, a fan or a ventilation system can be used.

Due to the non-corroding property, the disinfectant solution also does not attack nebulizing and distributing devices.

Due to the low content of HOCl and NaCl, the disinfection solutions according to the invention are particularly for aerosol disinfection of surfaces but also for air humidification, for example.

B. in the context of the sanitization of the room air or for odor neutralization.

[0156]

The disinfection solution is preferably used for surface disinfection, room air hygiene and odor neutralization.

[0157]

The method of producing ultrapure electrochemically modified water described in claims 5 and 6 can be used in combination with the method of producing a high purity chloride salt solution described in claims 7 and 8 and the method of producing a disinfecting solution in close proximity to the site of use described in any one of claims 9 to 11.

[0158]

This is done using water available on site and electricity available on site.

Thus, for example, the arrangement described above for producing a disinfectant solution can be connected to the water supply available on site, in particular to the drinking water supply and power supply.

[0159]

The arrangement comprises different electrolysis cells as well as apparatuses for ion exchange, reverse osmosis and electrodeionization of the water.

[0160]

The water removed on site first flows through a flow-through electrolysis cell which reduces the TOC content to a value of at most 0.5 mg/l.

The water is subsequently softened by ion exchangers and desalted in a reverse osmosis process and a subsequent electrodeionization process.

The resulting URW is then degassed with a suitable process.

Through the flow through a second flow electrolysis cell, the degassed URW is treated again with electrolysis.

The individual parameters of this flow-through electrolysis cell are selected according to the method according to the invention.

After addition of ambient air or O₂, the resulting water is passed over an enlarged surface and subsequently degassed again.

High purity chloride salt is present in a storage chamber.

This is metered into the ultrapure, electrochemically modified water, so that a highly pure solution forms.

This solution is treated with URW optionally degassed, diluted to a concentration of about 1 to 5% by weight, and then treated in a cyclic electrolytic cell for a particular residence time.

The individual parameters of this cyclic electrolytic cell are selected according to the process of the present invention.

Subsequently, the disinfectant solution is circulated through a flow-through electrolysis cell and diluted to a desired concentration with URW.

As soon as the disinfectant solution has the desired concentration, it is conducted into a storage chamber.

The disinfectant solution can be removed from this storage chamber.

[0161]

In this case, it is particularly advantageous that the disinfection solution provides a uniform, reproducible and validatable disinfection result.

In particular, the disinfection solution according to the invention has a low chloride salt content.

It is therefore particularly suitable for use on surfaces and/or devices which are susceptible to corrosion.

[0162]

Furthermore, the transport of disinfectant solution is avoided since water and stream are removed on site.

Only the chloride salt has to be transported.

Alternatively, the high purity chloride salt solution could be transported and on-site preparation of the disinfection solution would start with the cyclic electrolysis cell.

[0163]

Due to the consistent, reproducible and validatable disinfection result, a low concentration of 600 to 2500 mg/l HClO or HClO can be obtained in the method according to the invention.

Active chlorine can be adjusted.

The low concentrations of HClO result in skin-saving disinfection.

[0164]

Further features and advantages of the invention result from the following description of preferred exemplary embodiments, wherein these do not constitute a limitation of the scope of protection.

[0165]

These show:

FIG. 3 : FIG. 3 : FIG. 3 :

A clay sheer adult with a conglomerate of fur and red algae;

FIG. 4 : FIG. 4 : FIG. 4 :

The clay shears of Figure 3 after removal from the water after it has dipped into a disinfectant solution of the invention for 120 minutes and after it has dipped into a disinfectant solution of the invention for 15 hours;

FIG. 5:

A clay sander and aquaria accessories (air lift filters) immersed in disinfectant solution after 5 minutes, 1 hour, 12 hours and the clay sander after removal from the disinfectant solution after 12 hours and rinsing with water;

FIG. 6 : FIG. 6 :

A whirlpool and its tubing system, left before and right after 20 hours of treatment with the disinfectant solution of the present invention;

[0166]

1.

Production of the disinfectant solution: To produce the water according to the invention, first 50 l drinking water are passed through an electrolytic cell with a volume of 3 l and with five electrodes, wherein the anodes are diamond electrodes and the cathodes are stainless steel electrodes, at an applied voltage of 5 V and a volume flow of 5 l/min.

The water thus freed from organic impurities is degassed with a water jet pump.

Subsequently, the water treated in this way is passed through a cylindrical container integrated into the line, which is filled with activated carbon as a fixed-bed absorber (activated carbon filter from Fa. Aquaplan).

Thus, non-organic constituents are removed.

The water thus prepared is treated by a mixed bed ion exchanger of the Fa. Aquaplan is passed in order to remove the foreign ions still remaining before the subsequent reverse osmosis.

After reverse osmosis, 30 l of water are obtained which are passed through an electrodeionization plant.

Subsequently, degassing is carried out with a water jet pump.

[0167]

The ultrapure, degassed water is now passed through a flow-through electrolysis cell.

In this cell, the electrodes are diamond doped on the anode side and made of stainless steel on the cathode side.

5 V is applied and the flow rate is maintained at 2 l/min.

Subsequently, it is supplied via a cock in the line system O₂.

The electrolyzed O₂-enriched water is passed over a silicate fiber membrane and then degassed by membrane vacuum degassing.

[0168]

280 g/l of highly pure NaCl (Sigma-Aldrich, CAS 7647-14-5) are dissolved in the water obtained.

This chloride salt solution is suitable for storage.

[0169]

To produce a disinfectant solution, an amount of 0.5 l of the chloride salt solution is diluted with about 4 l of ultrapure water.

This approximately 3% solution is electrolyzed in a stainless-steel niobate cathode cyclic electrolytic cell and boron-doped diamond anodes at a voltage of 5 V for at least 1 min.

The area of the anodes is greater than that of the cathodes by a factor of 104 due to the diamond coating.

The geometry of the electrodes is adapted to the housing of the electrolysis cell.

The distance between the electrodes is 1.5 mm.

After 1 min, chloride has reacted to such an extent that the disinfectant solution has a concentration of OCl ions of 2000 mg/l and a redox potential of 800 mV.

[0170]

2. Elimination of algae growth on daily items: To investigate the disinfecting properties and the action against biofilms, an algae-grown clay shears according to FIG. 3 are immersed in this disinfecting solution.

[0171]

After 120 min and after 15 h, the clay shears are removed from the solution and inspected.

FIG. 4 shows that the solution according to the invention is capable of completely removing the biofilm on articles of use.

[0172]

3.

Influence onset: In order to assess the onset of action, clay shears grown with algae and further aquaria accessories (air lift filters) are immersed in the disinfectant solution.

Articles were evaluated after 5 minutes, 1 hour and 12 hours as shown in Figure 5.

[0173]

It can be seen that an onset of action takes place even after 5 minutes.

[0174]

4.

Treatment of tubing systems: 20 l of the disinfectant solution is introduced into the tubing system of a whirlpool.

After 12 h residence time, the treated tubing system is examined.

[0175]

It can be seen in the figures according to FIG. 6 that after 12 hours the biomass in the hose system can be removed with the disinfection solution.

The biomass removed here corresponds approximately to a mass of 1.8 kg.

The growth is visible on the two tubes running horizontally in the center of the image.

[0176]

The figures in FIG. 6 show that elimination of algae and biofilms is also possible in closed hose systems.

After 12 hours, the marked tubes (arrow) are completely free from algae growth and biofilm.

[0177]

All in all, experiments 1 to 4 show that the disinfection solution according to the invention has very good effectiveness even at a concentration of 2000 mg/l HOCl.

The effectiveness is about 80 times greater than that of a known sodium hypochlorite solution at the same concentration.

CLAIMS

1. ultrapure water having an electrical conductivity of less than 0.1 $\mu\text{S}/\text{cm}$, which is substantially free from organic constituents and from gases, and in which OH^- ions and H_3O^+ ions are formed by autoprotolytic processes, characterised in that the ultrapure water has an OH^- -excess and a pH value of 7.5 to 9.5.

2. Ultrapure water according to claim 1, wherein the excess OH^- is obtained by electrochemical modification.

3. ultrapure water according to claim 2, wherein the electrochemical modification comprises electrolysis of the ultrapure water by passing it through an electrolysis cell and removing the hydrogen (H_2) formed during the electrolysis, wherein the electrolysis cell has at least one cathode area and at least one anode area, wherein the cathode area is larger than the anode area by a factor of 10^3 to a factor of 10^7 .

4. ultrapure water according to claim 2 or 3, wherein the electrochemical modification is carried out with an electrolysis cell without membrane or diaphragm and with a distance between the electrodes of 1 to 4 mm and with a voltage of 4.5 to 48 V.

5. a process for the preparation of ultrapure electrochemically modified water having an excess OH^- and a pH of from 7.5 to 9.5, using as starting material water having a TOC content of at most 0.5 mg/l and an electrical conductivity of at most 0.1 $\mu\text{S}/\text{cm}$, wherein

(1) the starting material is degassed,

(2) a DC voltage is applied to the water obtained in step (1) in a flow-through electrolysis cell without membrane or diaphragm,

(3) ambient air and/or O_2 is supplied to the water obtained in step (2) and the water is reacted with the ambient air and/or O_2 at a surface,

(4) subsequently degassing the water obtained in step (3).

6. process for producing ultra-pure, electrochemically modified water according to claim 5, wherein the flow-through electrolysis cell has at least one cathode surface and at least one anode surface, the cathode surface being larger than the anode surface by a factor of 10^3 to a factor of 10^7 .

7. A process for preparing a high purity chloride salt solution, wherein one or more salts of hydrochloric acid having a purity of at least 99.0% are dissolved in the ultrapure electrochemically modified water according to any one of claims 1 to 4 or prepared according to a process of claims 5 or 6 to a concentration of 20% by weight up to the saturation concentration.

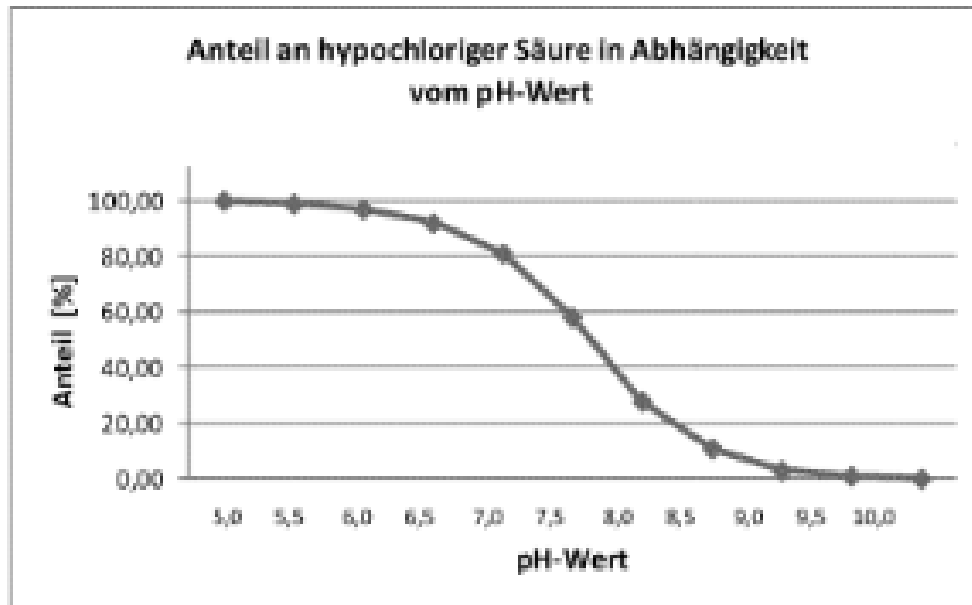
8. the process of claim 7, wherein sodium chloride having a purity of at least 99.9% is dissolved in the ultrapure electrochemically modified water to a concentration of 25.0 to 26.36% by weight at 20°C.

9. a process for preparing a disinfecting solution, wherein the high purity chloride salt solution of any one of claims 7 or 8 is diluted with ultrapure water to a concentration of 0.025 to 10% by weight chloride salt and the diluted solution is treated by electrolysis in a cyclic electrolysis cell.

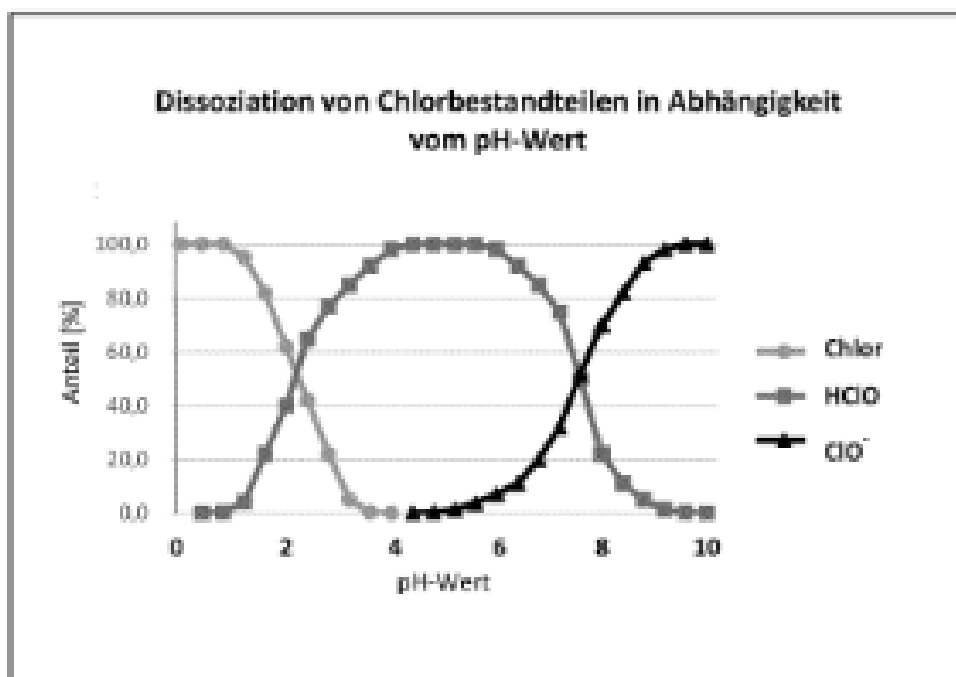
10. process for the preparation of a disinfecting solution according to claim 9, wherein during the electrolysis, inter alia, OCl^- and/or Cl_2 is formed and the disinfecting solution has an oxidation potential for OCl^-/Cl_2 of + 700 mV to + 950 mV.

11. A process according to any one of claims 9 or 10 for preparing a disinfecting solution, wherein the disinfecting solution has a concentration of OCl^- ions of from 600 to 5000 mg/l.

Figur 1:



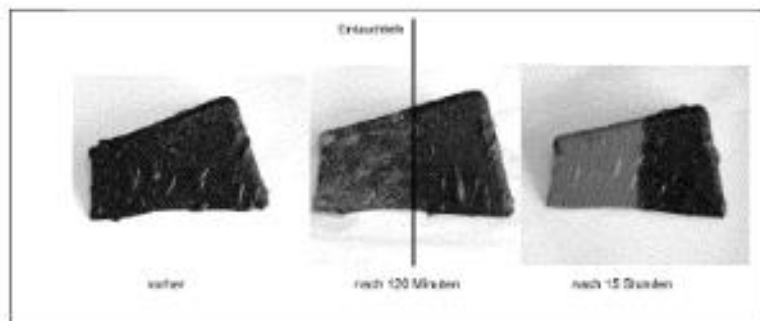
Figur 2:



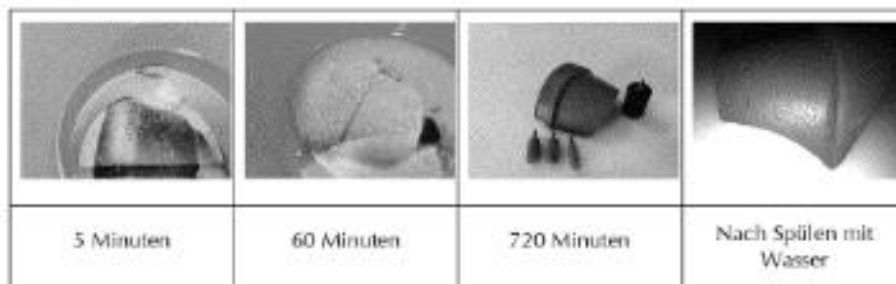
Figur 3:



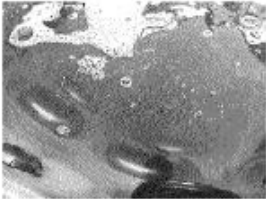
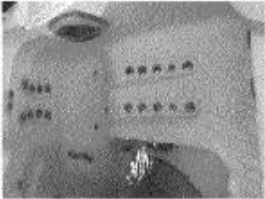
Figur 4:



Figur 5:



Figur 6:

	Vorher	Nach 12 Stunden
Whirlpooledüsen		
Schlauchsystem	