NON-PROVISIONAL PATENT APPLICATION OF

[INVENTOR(S) NAMES]

FOR

A DEVICE FOR ELECTRO-CHEMICAL WATER OR WATER SOLUTIONS PROCESSING

CROSS-REFERENCE TO RELATED APPPLICATION:

This application claims the benefit of the priority date of PCT application number RU2006/000478, filed on September 8, 2006.

FEDERALLY SPONSORED RESEARCH: Not Applicable

SEQUENCE LISTING OR PROGRAM: Not Applicable

STATEMENT REGARDING COPYRIGHTED MATERIAL

Portions of the disclosure of this patent document contain material that is subject to copyright protection. The copyright owner has no objection to the facsimile reproduction by anyone of the patent document or the patent disclosure as it appears in the Patent and Trademark Office file or records, but otherwise reserves all copyright rights whatsoever.

BACKGROUND

[0001] The invention pertains to the electrochemical treatment of water and salt water solutions and more specifically to changing their oxidation-reduction properties. The invention also pertains to water purification and disinfection, cathode softening, and washing and disinfectant liquids.

[0002] Water processing devices are known in the art. One device for electrochemical water processing contains an external cylindrical electrode with an inside electrode and semi-permeable diaphragm between the electrode separating the electrode space into external and internal electrode chambers. [Japanese Patent

Application No. 1-104387, class C02F 1/46, 1989, Russian Patent No. 2078737, class CO2F 1/46, 1997].

[0003] However, achieving desired water or water solution characteristics using these devices is difficult due to the limited functional resources of the devices which make it impossible to affect compounds with oxidation-reduction potentials in a wide range of different pH values.

[0004] One device for water or solution processing contains the external electrode in the shape of a hollow cylinder with an internal cylinder-shaped electrode placed coaxially within it. The semi-permeable diaphragm is placed coaxially between the electrodes, separating the electrode space into internal and external electrode chambers, wherein the internal electrode chamber is directly connected by a channel for liquid supply. [Russian Patent No. 2145940, class C02F1/461, 2000].

[0005] Achieving desired water or water solution characteristics using this device is difficult, due to the limited ability of the device to organize the hydrodynamic currents in the liquid, making it impossible to achieve a high distilled water current with the required values of mineralization.

[0006] The most similar device in terms of its properties to the instant invention is a device for electrochemical water or water solutions processing which contains an external pipe-shaped electrode with an inner electrode disposed inside and a semi-permeable diaphragm separating the electrode space into internal and external electrode chambers; wherein the external chamber, through the holes on the side surface of the external cylindrical electrode, is connected to the incoming and outgoing channels and the internal electrode has at least one hole connecting the inner chamber with the channel for water removal. [Russian Patent No. 2132821 6 C02F1/46, 1999].

[0007] Achieving the desired water or water solution characteristics is difficult using this device due to the limited resources of the device, making it impossible to get compounds with the required oxidation-reduction potentials in a wide range, low productivity and complex installation and repair.

[0008] There is therefore a need for an electrochemical water and water solution processing device with high productivity. It is an object of the present invention to increase productivity, widening the range of the received pH and oxidation-reduction potentials of processed water, increase safety, increase the operational lifespan of the device; decrease installation and repair labor, and reduce energy consumption while operating the device. Finally it is an object of the present invention to perform these functions using a compact device.

SUMMARY

[0009] In order to achieve the objects of the invention, the device for electro-chemical water or water solutions processing contains an external electrode in the shape of a hollow cylinder with a cylinder shaped internal electrode inside. A coaxially placed semi-permeable diaphragm is disposed between the electrodes, separating the electrode space into internal and external electrode chambers. In the upper part of the side wall of the external electrode, a hole connects the external electrode chamber with a channel for liquid removal. In the upper part of the internal electrode at least one hole connects the internal electrode chamber with the channel for removing liquid. The internal electrode chamber is directly connected to the channel for liquid supply and the internal electrode is constructed with a flat wall in its lower dimension.

[0010] In one preferred embodiment of the invention, the external electrode, internal electrode and diaphram are fixed at a lower flange, where a channel has been made for liquid supply, connected to the internal electrode chamber. In another preferred embodiment of the invention, the internal electrode and diaphram are fastened at the top with a lid where the diaphragm is positioned with the aid of slot joints and a hermetic rubber seal.

[0011] In another preferred embodiment, the internal electrode has a conical shape at the end inserted into the external electrode.

[0012] In another preferred embodiment, the internal electrode is made in the shape of a hollow cylinder with at least one plug placed inside to hermetically seal the internal cavity under the hole connecting the internal chamber with the canal for removing the liquid.

[0013] In another preferred embodiment, the electrode is a compound of two parts, wherein the upper part comprises at least one hole connecting the internal chamber with the channel for removing the liquid.

[0014] In another preferred embodiment, the parts of the internal electrode are joined together with the help of a mechanical joint, for example a threaded means.

[0015] In another preferred embodiment, in the low part of the sidewall of the external electrode there is at least one extra hole connecting the external electrode chamber with the liquid supply channel.

[0016] In another preferred embodiment, the internal electrode comprises the anode and the external electrode comprises the cathode.

[0017] In another preferred embodiment, the internal electrode is fixed with the help of a pin or a bolt at either or both the lower and upper flanges.

[0018] In another preferred embodiment, there is a circular hole in the lower flange which creates a channel for the liquid supply into the internal electrode chamber. In this embodiment there is at least one horizontal channel for the liquid supply connected with the channel for the liquid supply into the inner electrode chamber.

[0019] In another preferred embodiment, the semi-permeable diaphragm is made of ceramic based on zirconium oxides or textile.

[0020] In a final embodiment of the invention, the semi-permeable diaphragm may be ultra filtering, micro filtering, or nano filtering.

FIGURES

[0021] Figure 1 is a cut-away side view of the device for the electro-chemical water or water solution processing.

[0022] Figure 2 is a cut-away side view of the device for the electro-chemical water or water-solutions processing, with an extra channel for entering fluid.

[0023] Figure 3 is a cut-away side view of internal electrode in the shape of a hollow cylinder.

DETAILED DESCRIPTION

[0024] Referring to Fig 1, the device for the electro-chemical water or water-solutions processing contains an external electrode 1 in a shape of a hollow cylinder. An internal electrode 2 is disposed inside the external electrode 1, and a semi-permeable diaphragm 3 is disposed between the electrodes separating them into internal 4 and external 5 electrode chambers.

[0025] The upper part of the side surface of the external cylindrical electrode 1 comprises a hole 6, connecting the external electrode chamber 1 with a first exit channel 7. In the internal electrode 2 there is at least one hole 8 connecting the internal chamber 4 with a second channel 9 for removing the liquid. The internal chamber 4 is connected by a circular channel 10 with a horizontal channel 11 for the processed liquid supply.

[0026] The external electrode 1, internal electrode 2 and diaphragm 3 are fixed steadily and coaxially with the help of a lid 12 and lower flange 13. The lower flange 13 may be made of compound parts.

[0027] The diaphragm 3 is fixed in position with the help of slot joints in the lower flange 13 and lid 12, and has rubber seal circles on the face. The external electrode 1 is placed at the lower flange 13 and is attached by depressing the lid 12. The external electrode 1 may be fixed at the lower flange 13 by welding the external electrode 1 to the lower flange 13 in the shape of a flat circle. The joint may also be reinforced with the help of a bolt.

[0028] The internal electrode 2 is fixed at the lower flange 13 with the help of a pin 14, and fixed in the lid 12 with the help of slot joints and a fastening hollow bolt 19.

[0030] The diaphragm 3 may be made of ceramic on the basis of zirconium oxides or textile. Additionally, diaphragm 3 may be ultra filtering, micro filtering, or nano filtering.

[0031] To make the external electrode chamber 5 seal hermetically, sealing elements 15 are placed on the lid 12 and flange 13.

[0032] Referring to Fig 2, an extra hole 16 is disposed on the side surface of the external cylindrical electrode 1 connecting the external electrode chamber 5 with a third channel 17.

[0033] Depending on the functional use of the device, the internal electrode 2 may be cathode, and the external electrode 1 anode; the internal electrode chamber 4 may by a working one, and the external electrode chamber 5 an assisting one.

[0034] The internal electrode 2 may be made with a conical shape to one end and may consist of two parts: an upper 2/ and a lower 2// (as shown in Fig 1). In this embodiment, the holes 8 are made in the upper part of the pivot electrode 2//. The upper 2/ and the lower 2// parts of the electrode 2 may be joined together in different ways, including by threaded joints. In another preferred embodiment, the inner electrode 2 is made in the shape of a hollow cylinder with at least one plug 18 placed inside, sealing the inner cavity under the hole 8. The internal electrode 2 may also have external threadding at the ends for fastening the lid 12 and the flange 13.

[0035] In order to actuate the device, the horizontal channel 11 is used to supply processed water or salt solution to the device. The third channel 17 is used to supply a salt solution, and the second channel 9 is used for removing the processed anolitic liquid. The first exit channel 7 is used for removing catolite or salt solution.

[0036] To produce anolit and catolit, the chloride sodium solution is sent through the horizontal channel 11. The circular channel 10 introduces the solution into the internal electrode chamber 4. Voltage is applied to the electrodes, wherein the internal electrode 2 is anode and the external electrode 1 is cathode. Under pressure, the solution goes through the semi-permeable diaphragm 3 into the external electrode chamber 5. While the device is working on the external and

internal surfaces of the diaphragm 3, oppositely charged ion currents occur. The potential difference between these charged currents increases the intensity of the electrical field at the diaphragm 35-50 W/cm2. As a result, the activity of the ions in the pores of the diaphragm increases and the electrical resistance of the device decreases. As a result, an electro-activated solution anolit appears, which is removed through the second channel 9, and a solution catolit, which is removed through the first channel 7. If the device is made with an additional hole 16 and third channel 17, chloride sodium can be also supplied through the third channel 17.

[0037] In order to produce a disinfected solution, water is supplied through the horizontal channel 11, which then goes into the internal electrode chamber 4. 30% solution of chloride sodium is supplied through the third channel 17, which circulates in the cavity of the external electrode chamber 5. The first internal channel 7 is used for removal of this solution into a salt solution container, which is used as a reservoir of the solution and supplies it back to the device through the third channel 17. Water, having gone through the inner electrode chamber 4, is removed through the second channel 9 in the form of anolit.

[0038] The polarity of the electrodes can vary; the external electrode 1 may be cathode and the internal electrode 2 anode, and vice-versa. Due to this variable electrode polarity, problems with cathode precipitation and salt precipitation on the membrane are avoided, making the device safe and long lasting. Cathode precipitation, which may appear during the working process, can be removed by changing the electrode polarity, making the device easier to use.

[0039] The device is more compact because the internal electrode 2 is made with a flat wall in the lower part and the internal electrode chamber 4 is connected directly with the circular channel 10. At the same time, the heights of the external

and internal electrodes as well as the diaphragm differ only in the size of the fastening slots. Therefore, the entire surface of the electrodes and diaphragm is used in the electro-chemical process, which increases the productivity of the device and economy of the electrode materials. These characteristics enable the pH range of the processed water properties to widen.

[0040] The direct connection of the internal electrode chamber 4 with the circular channel 10 ensures uniform current flow through the electrode chambers; a high degree of mixing in the chambers, and uniform electro-chemical liquid processing, including processing all micro volumes of water in the diffuse part of the double electric layer on the phase border "electrode-electrolyte."

[0041] The diaphragm 3, placed between the anode and cathode, plays the most important role in creating the electrical resistance of the device. The effective use of the diaphragm's surface decreases electrical resistance, making the device more energy efficient. By changing the permeability of the diaphragm, solutions with different pH values and oxidation-reduction potentials are possible.

[0042] The hole made in the upper part of the internal electrode 2 connecting the second channel 9 for processed liquid removal, and the internal electrode 2 can be made with a solid wall in its lower part, and a direct connection between of the internal electrode chamber 4 with the circular channel 10. This permits the internal electrode chamber 4 to be used in electrochemical processing. Compared with existing devices, the processed water additionally goes inside the hollow internal electrode 2.

[0042] After the water is processed and enters hole 8, it slows down and is stirred. Water flowing into the second channel 9 creates turbulent stirring. This process prevents the formation of stagnant zones at the exit of the internal electrode

chamber 4. It also decreases the number of stagnant zones at the entrance and exit of the anode chamber and makes a more effective use of the diaphragm surface.

[0043] The design of the device results in a decreased number of compressed parts, making the device safer.

[0044] The installation and repair of the device is very easy. With the help of slots, diaphragm 3 is placed vertically in the lid 12, a pin 14 is screwed into the electrode 2, then the parts are fastened by turning the bolt at the bottom of the pin 14 and adding a fastening bolt 19.

[0045] INDUSTRIAL APPLICATION

[0046] Construction of the device

[0047] The diameter of the interior surface of the external electrode is 34 mm. The diameter of the working part of the interior electrode is 16 mm. The space between the electrodes is 9 mm. These measurements provide excellent conditions for all volumes of processed solution or water to interact with the surface of the diaphragm. The diaphragm is made of ceramic. It may also be made of other materials that are resistant to an extreme environment. The diaphragm may have different thicknesses and permeability depending upon the characteristics of the required solutions. The cathode of the device is made of stainless steel, titanium, glass carbon, acid proof materials good at electrical conduction and niobium. The cathode is covered with platinum, iridium, ruthenium and cobalt oxides as well as other materials. Anode is made of titanium, niobium, tantalum, graphite and covered with platinum, iridium, ruthenium and other materials' oxides.

[0048] When using the device, it is possible to obtain solutions with pH values from 2 to 12 and oxidation-reduction potentials from -950 mV to +1200 mV. In the

following table, characteristics of the instant device are compared with analogous devices currently produced.

[0049] Table: Parameters and characteristics of the devices used for electro chemical water processing

Parameters	Devices	
	Analogous	Presented
Volumetric current speed, cm3/s	2,8-8,3	27- 35
Linearity current speed, cm/s	5,8-24	25-64
Time of water processing, s	0,8-3	0,3-0,75
Current intensity, amp	3-8	1,5-30
Voltage, w	10-24	30-120
Water mineralization, gm/l	0,5-5,0	0,1- 5,0
Specific energy output, kl/l	360-2880	40-470
Amount of the processed liquid, l/hour	60	120
Recourse for the continual work, h	15000	40000

[0050] The table displays the increased performance characteristics of the instant device compared with similar existing devices.

[0051] By comparison with Russian Patent No. 2145940, which has a volumetric current speed of 5.5 cm3/s, voltage of 7-20 W, current intensity from 5 to 10 amps, and achieved mineralization is 0,27-0,7 gm/l; the instant invention has a volumetric current speed of 27-35 cm3/s, a current intensity of 1.5 – 30 amps, voltage of 30 – 120 W, and 0,1-5 gm/l mineralization.

[0052] The operation of the instant invention has a volumetric current speed 5 times faster than that of Russian Patent No. 2145940. The comparison of the values

of the volumetric current speed and mineralization shows the improved technical results of the instant device over those currently in the art.

What is Claimed is:

1. A device for electrochemical water or water solutions processing comprising an external electrode in a shape of a hollow cylinder, a cylinder shaped internal electrode inside, a coaxially placed semi-permeable diaphragm between the electrodes separating the electrode space into inner and external electrode chambers, a hole in the upper part of the side wall of the external electrode which connects the external electrode chamber with a channel for removing the liquid, at least one hole in the upper part of the internal electrode connecting the inner chamber with the channel for removing the liquid, wherein the inner electrode chamber is directly connected with a channel for liquid supply and the inner electrode is made with a flat wall in its lower part.

2. The device of claim 1, wherein the external electrode, internal electrode and diaphragm are fixed at the lower flange with a channel for liquid supply connected with the inner electrode chamber.

3. The device of claim 1, wherein the external electrode, internal electrode and diaphragm are fixed at the top with the help of a lid, and wherein the diaphragm is placed with the help of slot joints.

4. The device of claim 1, wherein the internal electrode is pivot-shaped at the extreme end inserted into the external electrode.

5. The device of claim 1, wherein the internal electrode is made in the shape of a hollow cylinder with at least one gasket inside, sealing the inner cavity under the hole connecting the chamber of the internal electrode with the channel for water removal.

6. The device of claim 1, wherein the electrode is compound, with at least two parts, wherein in the upper part there is at least one hole connecting the inner chamber with the channel for liquid removal.

7. The device of claim 1, wherein the parts of the internal electrode are connected with the help of mechanical joints.

8. The device of claim 1, wherein the parts of the internal electrode are connected with the help of threading.

9. The device of claim 1, wherein the lower part of the side wall of the external electrode there is at least one extra hole connecting the electrode chamber with the channel for liquid supply.

10. The device of claim 1, wherein the internal electrode is cathode, and the external electrode is anode.

11. The device of claim 1, wherein the internal electrode is fixed with the help of a pin or bolt at the lower flange.

12. The device of claim 1, wherein in the lower flange there is a circular hole, which creates a channel to supply liquid into the internal electrode chamber.

13. The device of claim 1, wherein in the lower flange there is at least one horizontal channel for liquid supply connected to the channel for the liquid supply into the internal electrode chamber.

14. The device of claim 1, wherein the semi-permeable diaphragm is made of ceramic on the basis of zirconium oxides or textile.

15. The device of claim 1, wherein the semi-permeable diaphragm is ultra-filtering, micro filtering or nano filtering.