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(71) Applicant: **Robert Bosch GmbH**
70442 Stuttgart (DE)

(72) Inventors:
• **HAO, Xiaogang**
Shanghai 200335 (CN)
• **XIE, Xu**
Shanghai 200335 (CN)

(54) **ELECTROLYTIC CELL UNIT, BIPOLAR PLATE FOR ELECTROLYTIC CELL, AND ELECTROLYTIC CELL SYSTEM**

(57) The present invention relates to an electrolytic cell unit, comprising at least: a membrane electrode assembly having a proton exchange membrane in the middle, an anodic catalyst layer, a cathodic catalyst layer, an anode side gas diffusion layer, and a cathode side gas diffusion layer located; an anode plate disposed on an anode side, the anode plate being configured with a plurality of anodic flow channels between the anode plate and the anode side gas diffusion layer, the anodic flow channels extend along a longitudinal direction and are spaced apart from one another in a transverse direction perpendicular to the longitudinal direction; and a cathode plate disposed on a cathode side, the cathode plate being configured with a plurality of cathodic flow channels positioned between the cathode plate and the cathode side gas diffusion layer, the cathodic flow channels extending along the longitudinal direction and are spaced apart from one another in the transverse direction; a plurality of through holes being provided on the anode plate, the through holes being configured to communicate the anodic flow channels to an exterior of the anode plate away from the anodic flow channels. The present invention further relates to a bipolar plate and an electrolytic cell system for electrolytic cells. This can significantly improve the working efficiency of the electrolytic cell and reduce mass transfer losses.

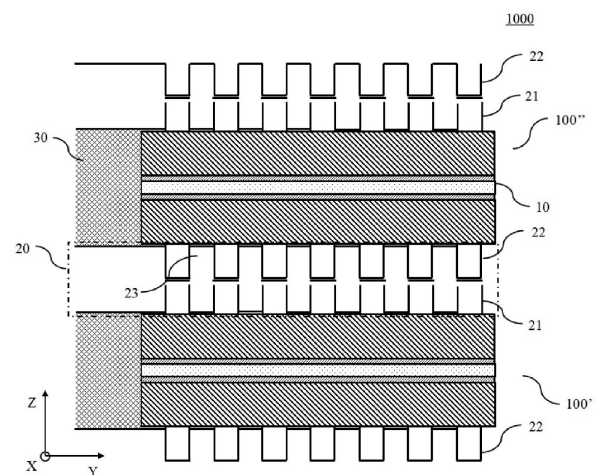


FIG. 3

Description

Technical Field

[0001] The present invention relates to the field of electrolytic cells, in particular to an electrolytic cell unit. The present invention further relates to a respective bipolar plate used for the electrolytic cell and an electrolytic cell system.

Background

[0002] The electrolytic cell is a device that converts electrical energy into chemical energy. Through the device, an electrical current passes through an electrolyte, causing oxidation-reduction reactions at the anode and cathode. Here, a proton exchange membrane electrolytic cell can utilize the principle of electrolysis to generate oxygen gas and hydrogen protons through an oxidation reaction at the anode. The hydrogen protons are transferred to the cathode through the proton exchange membrane and combine with electrons to produce hydrogen gas. Here, the proton-exchange membrane electrolytic cell has the advantages of high electrolysis efficiency, high product purity, environmental friendliness, and safety, and is therefore widely used in the production of oxygen and hydrogen.

[0003] When the proton exchange membrane electrolytic cell is running normally, water is supplied to the anode of the electrolytic cell through an anodic flow channel of the anode plate, while the oxygen gas generated at the anode is also transported from the electrolytic cell to the outside through the anodic flow channel. Here, the direction of water supply and the direction of oxygen gas flow in the anodic flow channel are exactly opposite, which causes the oxygen gas to block the path of water reaching the anode of the electrolytic cell, thereby reducing the electrolysis efficiency of the electrolytic cell and causing a mass transfer loss. In addition, existing electrolytic cell systems are difficult to disassemble and assemble, resulting in high maintenance costs.

Summary of the Invention

[0004] Therefore, an object of the present invention is to provide an improved electrolytic cell unit that can effectively direct the separate flow of water supplied and product oxygen gas, reliably prevent oxygen gas from blocking water conveyance, and reduces pressure in the anodic flow channel to increase the water conveyance speed, thereby significantly improving the efficiency of the electrolytic cell and reducing the mass transfer loss.

[0005] According to a first aspect of the present invention, an electrolytic cell unit is provided, wherein the electrolytic cell unit comprises at least:

- a membrane electrode assembly having a proton exchange membrane located in the middle, an anodic catalyst layer, a cathodic catalyst layer, an anode side gas diffusion layer, and a cathode side gas diffusion layer;
- an anode plate disposed on an anode side of the membrane electrode assembly, the anode plate being configured with a plurality of anodic flow channels positioned between the anode plate and the anode side gas diffusion layer, the anodic flow channels extending along a longitudinal direction and spaced apart from one another in a transverse direction perpendicular to the longitudinal direction; and
- a cathode plate disposed on a cathode side of the membrane electrode assembly, the cathode plate being configured with a plurality of cathodic flow channels positioned between the cathode plate and the cathode side gas diffusion layer, the cathodic flow channels extending along the longitudinal direction and spaced apart from one another in the transverse direction,

wherein a plurality of through holes are provided on the anode plate, the through hole being configured to communicate the anodic flow channels to an exterior of the anode plate away from the anodic flow channels.

[0006] Compared with the prior art, in the electrolytic cell unit according to the present invention, there are a plurality of through holes provided on the anode plate. The through holes communicate the anodic flow channels to the exterior of the anode plate away from the anodic flow channels, so that the supplied water can flow in the anodic flow channels under its own gravity. The oxygen gas generated at the anode floats upwards due to its lower density than water, and at least partially flows out from the anodic flow channels through the through holes, especially flows out into inter-cell channels of the adjacent electrolytic cell units. This effectively guides the water and oxygen gas to flow separately and reduces the pressure in the anodic flow channels, thereby preventing oxygen gas from blocking the flow path of water to the anode of the electrolytic cell, allowing the supplied water to be smoothly delivered to the anode of the electrolytic cell at a higher flow rate. This can significantly improve the working efficiency of the electrolytic cell and reduce mass transfer losses.

[0007] Exemplarily, the anodic flow channel is defined by two sidewalls spaced apart from one another in the transverse direction and a top wall, wherein, in the thickness direction, the through holes are arranged in the upper portion of at least one of the sidewalls adjacent to the top wall.

[0008] Exemplarily, the through holes are symmetrically arranged on the sidewalls with respect to a central plane of the anodic flow channel perpendicular to the transverse direction.

[0009] Exemplarily, the through holes are distributed evenly spaced along the longitudinal direction; and/or, the through holes are configured as elongate holes extending along the longitudinal direction.

[0010] Exemplarily, the electrolytic cell unit further comprises a sealing structure that encloses the membrane electrode assembly in a circumferential direction; and/or, the anode plate and the cathode plate are configured as an integrally formed metal stamping piece; and/or, the anode plate is bonded and fixed on the anode side gas diffusion layer, and the cathode plate is bonded and fixed on the cathode side gas diffusion layer.

[0011] Exemplarily, the proton exchange membrane, the anodic catalyst layer, and the cathodic catalyst layer

are collectively constructed in the form of a catalyst coating film; and/or, the anodic catalyst layer is made of a noble metal catalyst, and the cathodic catalyst layer is made of a non-noble metal catalyst; and/or, viewed in the direction of gravity, the anode plate is positioned at the topmost of the electrolytic cell unit.

[0012] According to a second aspect of the present invention, a bipolar plate for an electrolytic cell is provided, wherein the bipolar plate comprises at least:

- an anode plate, configured to be arranged on an anode side gas diffusion layer of a first electrolytic cell unit, the anode plate being configured with a plurality of anodic flow channels extending along a longitudinal direction and spaced apart from one another in a transverse direction perpendicular to the longitudinal direction; and
- a cathode plate in fixed connection with the anode plate, the cathode plate being configured to be suitably arranged on a cathode side gas diffusion layer of a second electrolytic cell unit, the first electrolytic cell unit and the second electrolytic cell unit being arranged stacked in a thickness direction, the cathode plate being configured with a plurality of cathodic flow channels extending along the longitudinal direction and spaced apart from one another along the transverse direction,

wherein a plurality of inter-cell channels are formed between the anode plate and the cathode plate, the inter-cell channels being arranged alternately with the anodic flow channels and the cathodic flow channels in the transverse direction, respectively, wherein a plurality of through holes are disposed on the anode plate, the through hole being configured to communicate the various anodic flow channels with at least one adjacent inter-cell channel, wherein at least the first electrolytic cell unit is constructed as the electrolytic cell unit according to the present invention.

[0013] Exemplarily, the anode plate and the cathode

plate are fixed to each other by welding or bonding.

[0014] According to a third aspect of the present invention, an electrolytic cell system is provided, wherein the electrolytic cell system comprises at least a plurality of electrolytic cell units according to the present invention that are stacked with one another, wherein an anode plate of one electrolytic cell unit and a cathode plate of an adjacent additional electrolytic cell unit of the electrolytic cell units are securely connected and collectively function as the bipolar plate according to the present invention.

[0015] Exemplarily, the electrolytic cell system includes a water supply manifold in communication with an anodic flow channel of the anode plate of the electrolytic cell unit, an oxygen gas discharge manifold in communication with an inter-cell channel of the bipolar plate, and a hydrogen gas discharge manifold in communication with a cathodic flow channel of the electrolytic cell unit.

Brief Description of the Drawings

[0016] In the following, the present disclosure is described in greater detail with reference to the accompanying drawings to provide a better understanding of the principles, features, and advantages of the present invention. The accompanying drawings include the following:

FIG. 1 shows a schematic cross-sectional view of an electrolytic cell unit according to an exemplary embodiment of the present invention;

FIG. 2 shows a schematic view of a bipolar plate for an electrolytic cell according to an exemplary embodiment of the present invention;

FIG. 3 shows a schematic cross-sectional view of an electrolytic cell system according to an exemplary embodiment of the present invention.

Detailed Description of the Embodiments

[0017] To provide a clearer understanding of the technical problems, technical solutions, and beneficial technical effects to be addressed by the present invention, the following detailed description of the present invention will be provided with reference to the accompanying drawings and multiple exemplary examples. It should be understood that the specific examples described herein are provided solely for the purpose of explaining the present invention and not for limiting the scope of protection of the present invention. For brevity, elements with the same reference numerals in the accompanying drawings are only labeled once herein.

[0018] It should be understood that in this document, terms such as "first", "second", etc., are used for descriptive purposes only and should not be construed as indicating or implying relative importance. Furthermore, such terms should not be understood as implying

a specific quantity of the indicated technical features. Features defined as "first" and "second" may expressly or implicitly mean that at least one of the features is included.

[0019] In the present specification, the terms "install," "connect," and "coupled" are to be broadly understood unless expressly specified and defined otherwise. For example, it may be a fixed connection, or a detachable connection, or an integral connection; it may be a direct connection, or it may be an indirect connection through an intermediate component, or internal communication within two elements. For those skilled in the art, the meaning of the above terms in the present disclosure may be understood as appropriate.

[0020] FIG. 1 shows a schematic cross-sectional view of an electrolytic cell unit 100 according to an exemplary embodiment of the present invention. Here, the electrolytic cell unit 100 is configured to decompose water into hydrogen gas and oxygen gas while energized, and a plurality of electrolytic cell units 100 stacked with each other may constitute an electrolytic cell stack.

[0021] As shown in FIG. 1, the electrolytic cell unit 100 includes a membrane electrode assembly 10 that is a core component of the electrolytic cell unit 100 and that undergoes an electrolytic process of water in the membrane electrode assembly, wherein the membrane electrode assembly 10 has a proton exchange membrane 11 in the middle, an anodic catalyst layer 12 and a cathodic catalyst layer 13 arranged on both sides of the proton exchange membrane 11, and an anode side gas diffusion layer 14 arranged on the anodic catalyst layer 12 and a cathode side gas diffusion layer 15 arranged on the cathodic catalyst layer 13, wherein the proton exchange membrane 11 is a polymer film with high proton conductivity and good chemical stability, and may be constructed as a perfluorosulfonic acid proton exchange membrane. The proton exchange membrane 11 is capable of transferring protons and preventing the mixing of hydrogen gas and oxygen gas. When an external power source is applied to the anode and cathode of the electrolytic cell unit 100, water is supplied to the anode of the membrane electrode assembly 10, reaching the anodic catalyst layer 12 through the anode side gas diffusion layer 14. Water molecules undergo electrolysis under the action of the anodic catalyst, producing oxygen gas and hydrogen protons. The oxygen gas is discharged through the anode side gas diffusion layer 14, while the hydrogen protons are transferred through the proton exchange membrane 11 to the cathodic catalyst layer 13 and undergo a reduction reaction by combining with electrons, thereby generating hydrogen gas. The hydrogen gas is discharged through the cathode side gas diffusion layer 15. Here, the anodic catalyst layer 12 is exemplarily made of a noble metal catalyst, such as platinum, to promote the oxidation reaction, while the cathodic catalyst layer 13 is exemplarily made of a non-noble metal

catalyst, such as nickel, to reduce costs and improve catalytic efficiency. In particular, the proton exchange membrane 11, the anodic catalyst layer 12, and the cathodic catalyst layer 13 are collectively constructed in the form of a catalyst coated membrane (CCM) to achieve a highly uniform and durable catalyst layer.

[0022] As shown in FIG. 1, the electrolytic cell unit 100 includes an anode plate 21 arranged on the anode side of the membrane electrode assembly 10. The anode plate is configured to support the anode side gas diffusion layer 14, supply water as a reactant and a coolant to the anode of the membrane electrode assembly 10, and discharge the generated oxygen gas. In particular, the anode plate 21 is bonded and fixed to the anode side gas diffusion layer 14. The anode plate 21 is constructed with a plurality of anodic flow channels 211 located between the anode plate 21 and the anode side gas diffusion layer 14. These anodic flow channels extend in a longitudinal direction X and are spaced apart from one another in a transverse direction Y perpendicular to the longitudinal direction X. The supplied water is guided to flow in the anodic flow channels 211 and is uniformly delivered to the anodic catalyst layer 12 through the anode side gas diffusion layer 14, while the oxygen gas generated at the anode also enters the anodic flow channels 211 through the anode side gas diffusion layer 14 and is further discharged.

[0023] As shown in FIG. 1, the electrolytic cell unit 100 includes a cathode plate 22 arranged on the cathodic side of the membrane electrode assembly 10. The cathode plate is configured to support the cathode side gas diffusion layer 15 and discharge the generated hydrogen gas. In particular, the cathode plate 22 is bonded and fixed to the cathode side gas diffusion layer 15. The cathode plate 22 is constructed with a plurality of cathodic flow channels 221 located between the cathode plate 22 and the cathode side gas diffusion layer 15. These cathodic flow channels extend in the longitudinal direction X and are spaced apart from one another in the transverse direction Y. The hydrogen gas generated at the cathode enters the cathodic flow channels 221 through the cathode side gas diffusion layer 15 and is further discharged. The hydrogen gas in the cathodic flow channels 221 has a significantly higher pressure.

[0024] As shown in FIG. 1, a plurality of through holes 212 are provided on the anode plate 21, and the through holes are configured to communicate the various anodic flow channels 211 of the anode plate 21 to the exterior of the anode plate 21 away from the anodic flow channels 211. In this instance, the supplied water flows in the lower portion of the anodic flow channel 211 under its own gravity. The generated oxygen gas floats upwards to the upper portion of the anodic flow channel 211 due to its lower density than water after entering the anodic flow channel 211 via the anode side gas diffusion layer 14, and at least partially flows out from the anodic flow channel 211 through the through

holes 212 to the outside. This can significantly reduce the pressure in the anodic flow channel 211 caused by oxygen gas accumulation, allowing the oxygen gas to be smoothly discharged from the anode side gas diffusion layer 14, thereby preventing oxygen gas from blocking the flow path of water to the anodic catalyst layer 12. Further, the pressure of gas in the anodic flow channel 211 is reduced, and thus the supply flow rate of water can be increased accordingly. In summary, this can significantly improve the working efficiency of the electrolytic cell unit 100 and reduce mass transfer losses. It is readily understood that, viewed along the direction of gravity, the anode plate 21 of the electrolytic cell unit 100 is located at the top of the electrolytic cell unit 100. The direction of gravity corresponds to the thickness direction Z, which is perpendicular to the main extending plane of the electrolytic cell unit 100, which is extended by the longitudinal direction X and the transverse direction Y.

[0025] Here, the anode plate 21 of the electrolytic cell unit 100 is configured to be fixedly connected to the cathode plate 22 of another adjacent electrolytic cell unit and functions together as the bipolar plate 20, as explained below with respect to FIG. 2.

[0026] FIG. 2 shows a schematic view of the bipolar plate 20 for an electrolytic cell according to an exemplary embodiment of the present invention. Here, one bipolar plate 20 is simultaneously paired with two electrolytic cell units 100 that are stacked with one another.

[0027] As shown in FIG. 2, the bipolar plate 20 includes an anode plate 21 that may be arranged on the anode side gas diffusion layer 14 of a first electrolytic cell unit constructed as the electrolytic cell unit 100 according to the present invention. Here, the anode plate 21 is configured with a plurality of anodic flow channels 211 extending along the longitudinal direction X and spaced apart from one another in the transverse direction Y.

[0028] As shown in FIG. 2, the bipolar plate 20 includes the cathode plate 22 in fixed connection with the anode plate 21 and may be arranged on the cathode side gas diffusion layer 15 of a second electrolytic cell unit. The first electrolytic cell unit and the second electrolytic cell unit are arranged stacked with each other in the thickness direction Z. Here, the cathode plate 22 is configured with a plurality of cathodic flow channels 221 extending along the longitudinal direction X and spaced apart from one another in the transverse direction Y. Here, the cathodic flow channel 221 and the anodic flow channel 211 are arranged opposing to each other in the transverse direction Y.

[0029] As shown in FIG. 2, the bipolar plate 20 forms a plurality of inter-cell channels 23 between the anode plate 21 and the cathode plate 22. The inter-cell channels also extend along the longitudinal direction X and are alternately arranged in the transverse direction Y with the anodic flow channel 211 and the cathodic flow channel 221, respectively.

[0030] As shown in FIG. 2, a plurality of through holes 212 are provided on the anode plate 21. The through holes are configured to communicate the various anodic flow channels 211 with at least one adjacent inter-cell channel 23. Thus, the oxygen gas entering the anodic flow channel 211 from the anode side gas diffusion layer 14 can partially flow through the through holes 212 into the inter-cell channel 23, while the water as a reactant remains in the anodic flow channel 211. This allows for separate, counter-current flows of oxygen gas and water, thereby avoiding mutual interference of the two. This can also reduce the air pressure in the anodic flow channel 211, allowing oxygen gas to smoothly enter the anodic flow channel 211 from the anode side gas diffusion layer 14 and water to smoothly flow from the anodic flow channel 211 into the anode side gas diffusion layer 14. In addition, the supply flow rate of water may also be increased accordingly. This can significantly improve the electrolysis efficiency of the electrolytic cell, achieve the drying of the product oxygen gas to some extent, and minimize mass transfer losses as much as possible.

[0031] Exemplarily, as shown in FIGS. 1 and 2, the anodic flow channel 211 of the anode plate 21 is defined by two sidewalls 213 spaced apart from one another in the transverse direction Y and a top wall 214 arranged between the two sidewalls 213, wherein, in the thickness direction Z or viewed from the direction of gravity, the through holes 212 of the anode plate 21 are arranged in the upper portion of at least one of the two sidewalls 213 adjacent to the top wall 214. This prevents water in the anodic flow channel 211 from flowing into the inter-cell channel 23 through the through holes 212, thereby maximizing the drying of oxygen gas in the inter-cell channel 23.

[0032] Exemplarily, as shown in FIGS. 1 and 2, the through holes 212 of the anode plate 21 are arranged on the two sidewalls 213 of the anodic flow channel 211, which increases the flow rate of oxygen gas through the through holes 212. In particular, the through holes 212 are symmetrically arranged on the sidewalls 213 with respect to a central plane T of the anodic flow channel 21 perpendicular to the transverse direction Y. The central plane extends in the longitudinal direction X and the thickness direction Z, thereby enabling simple and cost-effective manufacturing of the anode plate 21.

[0033] Exemplarily, the through holes 212 of the anode plate 21 are distributed evenly spaced along the longitudinal direction X, which allows oxygen gas in the anodic flow channel 21 to flow evenly to the inter-cell channel 23.

[0034] Exemplarily, the through holes 212 of the anode plate 21 are configured as elongate holes extending along the longitudinal direction X. This allows for a relatively large flow area in the through holes 212, thereby increasing the flow rate of oxygen gas and also avoiding adverse impact on the strength of the anode

plate 21. Of course, other configurations of the through hole 212 that are considered meaningful by those skilled in the art can also be considered.

[0035] Exemplarily, the anode plate 21 and the cathode plate 22 are constructed as an integrally molded metal stamping piece, thereby achieving cost-effective manufacturing of the anode plate 21 and the cathode plate 22. Here, the anode plate 21 and the cathode plate 22 may be made of the same metal material, which should have high strength, good chemical stability, and electrical conductivity, such as stainless steel. However, it is also contemplated that the anode plate 21 and the cathode plate 22 are made of different materials.

[0036] Exemplarily, the anode plate 21 and the cathode plate 22 are fixed to each other by welding. However, it may also be considered that the anode plate 21 and the cathode plate 22 are fixed to each other by bonding through a bonding agent or by shape-locking.

[0037] Exemplarily, as shown in FIG. 1, the electrolytic cell unit 100 further includes a sealing structure 30 that encloses the membrane electrode assembly 10 in a circumferential direction. The sealing structure is clamped between the anode plate 21 and the cathode plate 22. The sealing structure 30 can effectively prevent the product gas from leaking from the gas diffusion layer to the outside.

[0038] FIG. 3 shows a schematic cross-sectional view of an electrolytic cell system 1000 according to an exemplary embodiment of the present invention.

[0039] As shown in FIG. 3, the electrolytic cell system 1000 includes a plurality of electrolytic cell units 100 that are stacked with one another in a thickness direction Z, wherein the anode plate 21 of each electrolytic cell unit 100 is arranged at the topmost of the electrolytic cell unit 100 in the direction of gravity corresponding to the thickness direction Z and is fixedly connected to a cathode plate of another adjacent electrolytic cell unit located above. For example, the anode plate 21 of the first electrolytic cell unit 100' in the electrolytic cell units 100 and the cathode plate 22 of the second electrolytic cell unit 100" located above are fixedly connected, and the anode plate and the cathode plate function together as the bipolar plate 20. Here, the first electrolytic cell unit 100' and the second electrolytic cell unit 100" are both constructed as the electrolytic cell unit 100 according to the present invention, wherein a through hole 212 is provided on the anode plate 21. The through hole communicates the anodic flow channel 211 with the inter-cell channel 23 between the anode plate 21 of the first electrolytic cell unit 100' and the cathode plate 22 of the second electrolytic cell unit 100". Similarly, the cathode plate 22 of the first electrolytic cell unit 100' is fixedly connected with the anode plate 21 of the immediately adjacent lower electrolytic cell unit 100 and the two functions together as the bipolar plate 20, while the anode plate 21 of the second electrolytic cell unit 100" is fixedly connected with the

cathode plate 22 of the immediately adjacent upper electrolytic cell unit 100 and the two functions together as the bipolar plate 20.

[0040] Here, when a specific electrolytic cell unit 100 in the electrolytic cell system 1000 exhibits poor performance or has defects, the corresponding electrolytic cell unit can be easily disassembled from the electrolytic cell stack and replaced with a new electrolytic cell unit, thereby reducing the maintenance cost of the electrolytic cell system 1000.

[0041] Exemplarily, the electrolytic cell system 1000 includes end plates located on both sides in the thickness direction Z, and the end plates are configured to clamp and fix an electrolytic cell stack consisting of a plurality of electrolytic cell units 100.

[0042] Exemplarily, the electrolytic cell system 1000 includes a water supply manifold, an oxygen gas discharge manifold, and a hydrogen gas discharge manifold, wherein the water supply manifold is in communication with the anodic flow channel 211 of the anode plate 21 of each electrolytic cell unit 100 and is configured to supply water as a reactant and a coolant to the anode side gas diffusion layer 14. The oxygen gas discharge manifold is at least in communication with the inter-cell channel 23 of the bipolar plate 20 and is configured to discharge the product oxygen gas. It is also possible that the oxygen gas discharge manifold is also in communication with the anodic flow channel 211 of each electrolytic cell unit 100, while the hydrogen gas discharge manifold is in communication with the cathodic flow channel 221 of each electrolytic cell unit 100 to discharge the product hydrogen gas.

[0043] The foregoing description of embodiments only describes the present disclosure within the framework of the examples. Certainly, as long as it is technically meaningful, the various features of the embodiments may be freely combined with each other without departing from the framework of the present invention.

[0044] For those skilled in the art, other advantages and alternative embodiments of the present invention are apparent. Therefore, in terms of its broader significance, the present invention is not limited to the specific details, representative structures, and exemplary examples shown and described. Conversely, those skilled in the art may make various modifications and alternatives without departing from the essential spirit and scope of the present invention.

Claims

1. An electrolytic cell unit (100), wherein the electrolytic cell unit (100) comprises at least:
 - a membrane electrode assembly (10) having a proton exchange membrane (11) located in the middle, an anodic catalyst layer (12), a cathodic catalyst layer (13), an anode side

gas diffusion layer (14), and a cathode side gas diffusion layer (15);

- an anode plate (21) disposed on an anode side of the membrane electrode assembly (10), the anode plate being configured with a plurality of anodic flow channels (211) positioned between the anode plate (21) and the anode side gas diffusion layer (14), the anodic flow channels extending along a longitudinal direction (X) and spaced apart from one another in a transverse direction (Y) perpendicular to the longitudinal direction (X); and

- a cathode plate (22) disposed on a cathode side of the membrane electrode assembly (10), the cathode plate being configured with a plurality of cathodic flow channels (221) positioned between the cathode plate (22) and the cathode side gas diffusion layer (15), the cathodic flow channels extending along the longitudinal direction (X) and spaced apart from one another in the transverse direction (Y),

wherein a plurality of through holes (212) are provided on the anode plate (21), the through holes being configured to communicate the anodic flow channel (211) to an exterior of the anode plate (21) away from the anodic flow channels (211).

2. The electrolytic cell unit (100) according to claim 1, wherein:
the anodic flow channel (211) is defined by two sidewalls (213) spaced apart from one another in the transverse direction (Y) and a top wall (214), wherein, in a thickness direction (Z), the through holes (212) are arranged in an upper portion of at least one of the sidewalls (213) adjacent to the top wall (214).
3. The electrolytic cell unit (100) according to claim 2, wherein:
the through holes (212) are symmetrically arranged on the sidewalls (213) with respect to a central plane (T) of the anodic flow channel (211) perpendicular to the transverse direction (Y).
4. The electrolytic cell unit (100) according to any one of claims 1 to 3, wherein, the through holes (212) are distributed evenly spaced along the longitudinal direction (X); and/or the through holes (212) are configured as elongate holes extending along the longitudinal direction (X).
5. The electrolytic cell unit (100) according to any one of the preceding claims, wherein the electrolytic cell unit (100) further comprises a sealing structure (30) that encloses the membrane electrode assembly (10) in a circumferential direction; and/or

the anode plate (21) and the cathode plate (22) are configured as an integrally molded metal stamping piece; and/or

the anode plate (21) is bonded and fixed on the anode side gas diffusion layer (14), and the cathode plate (22) is bonded and fixed on the cathode side gas diffusion layer (15).

6. The electrolytic cell unit (100) according to any one of the preceding claims, wherein:

the proton exchange membrane (11), the anodic catalyst layer (12), and the cathodic catalyst layer (13) are collectively constructed in the form of a catalyst coating film; and/or

the anodic catalyst layer (12) is made of a noble metal catalyst, and the cathodic catalyst layer (13) is made of a non-noble metal catalyst; and/or

viewed in the direction of gravity, the anode plate (21) is positioned at the topmost of the electrolytic cell unit (100).

7. A bipolar plate (20) for an electrolytic cell, wherein the bipolar plate (20) comprises at least:

- an anode plate (21), configured to be arranged on an anode side gas diffusion layer (14) of a first electrolytic cell unit (100'), the anode plate (21) being configured with a plurality of anodic flow channels (211) extending along a longitudinal direction (X) and spaced apart from one another in a transverse direction (Y) perpendicular to the longitudinal direction (X); and

- a cathode plate (22) in fixed connection with the anode plate (21), the cathode plate being configured to be suitably arranged on a cathode side gas diffusion layer (15) of a second electrolytic cell unit (100''), the first electrolytic cell unit (100') and the second electrolytic cell unit (100'') being arranged stacked in a thickness direction (Z), the cathode plate (22) being configured with a plurality of cathodic flow channels (221), the cathodic flow channels extending along the longitudinal direction (X) and spaced apart from one another in the transverse direction (Y), wherein a plurality of inter-cell channels (23) are formed between the anode plate (21) and the cathode plate (22), the inter-cell channels being arranged alternately with the anodic flow channels (211) and the cathodic flow channels (221) in the transverse direction (Y), respectively,

wherein a plurality of through holes (212) are disposed on the anode plate (21), the through holes being configured to communicate the various ano-

dic flow channels (211) with at least one adjacent inter-cell channel (23), wherein at least the first electrolytic cell unit (100') is constructed as the electrolytic cell unit (100) according to any one of claims 1 to 6.

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8. The electrolytic cell unit (100) according to claim 7, wherein:

the anode plate (21) and the cathode plate (22) are fixed to each other by welding or bonding.

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9. An electrolytic cell system (1000), wherein the electrolytic cell system comprises at least a plurality of electrolytic cell units (100) according to any one of claims 1 to 6 that are stacked with one another, wherein an anode plate (21) of one electrolytic cell unit and a cathode plate (22) of an adjacent additional electrolytic cell units of the electrolytic cell units (100) are securely connected and collectively function as the bipolar plate (20) according to claim 7 or 8.

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10. The electrolytic cell system (1000) according to claim 9, wherein

the electrolytic cell system (1000) includes a water supply manifold in communication with an anodic flow channel (211) of the anode plate (21) of the electrolytic cell unit (100), an oxygen gas discharge manifold in communication with an inter-cell channel (23) of the bipolar plate (20), and a hydrogen gas discharge manifold in communication with a cathodic flow channel (221) of the electrolytic cell unit (100).

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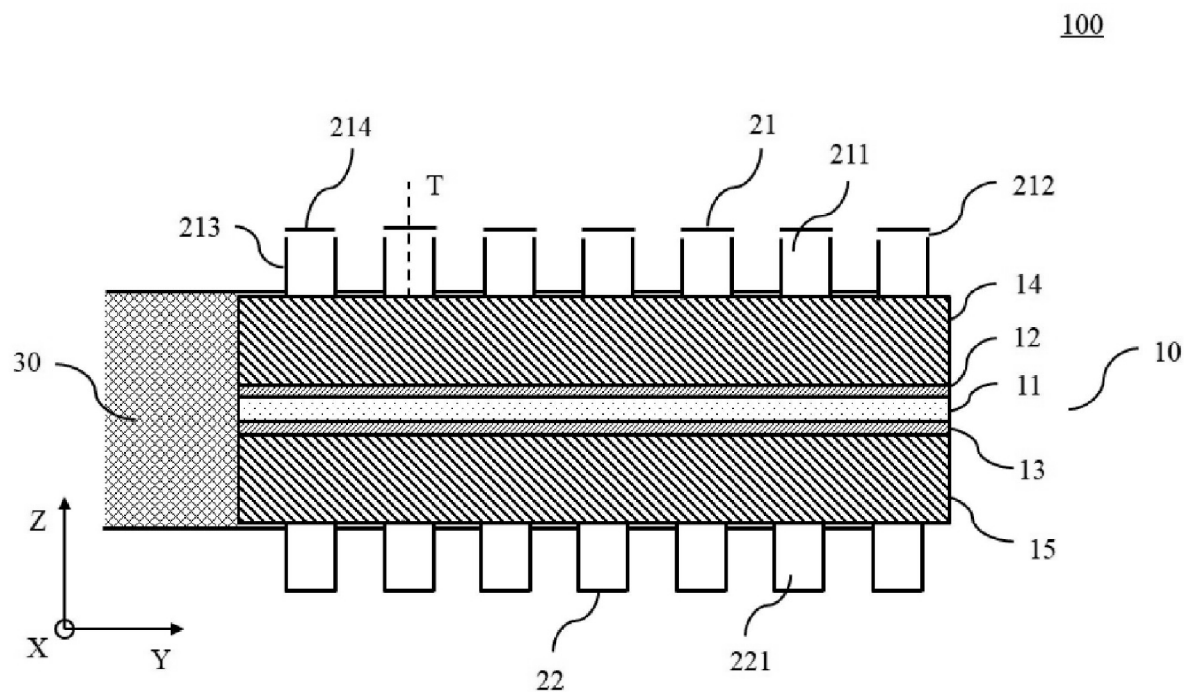


FIG. 1

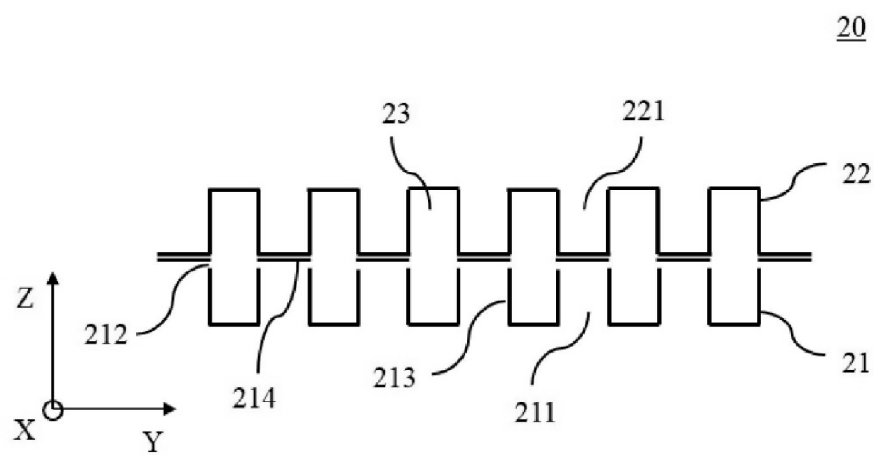


FIG. 2

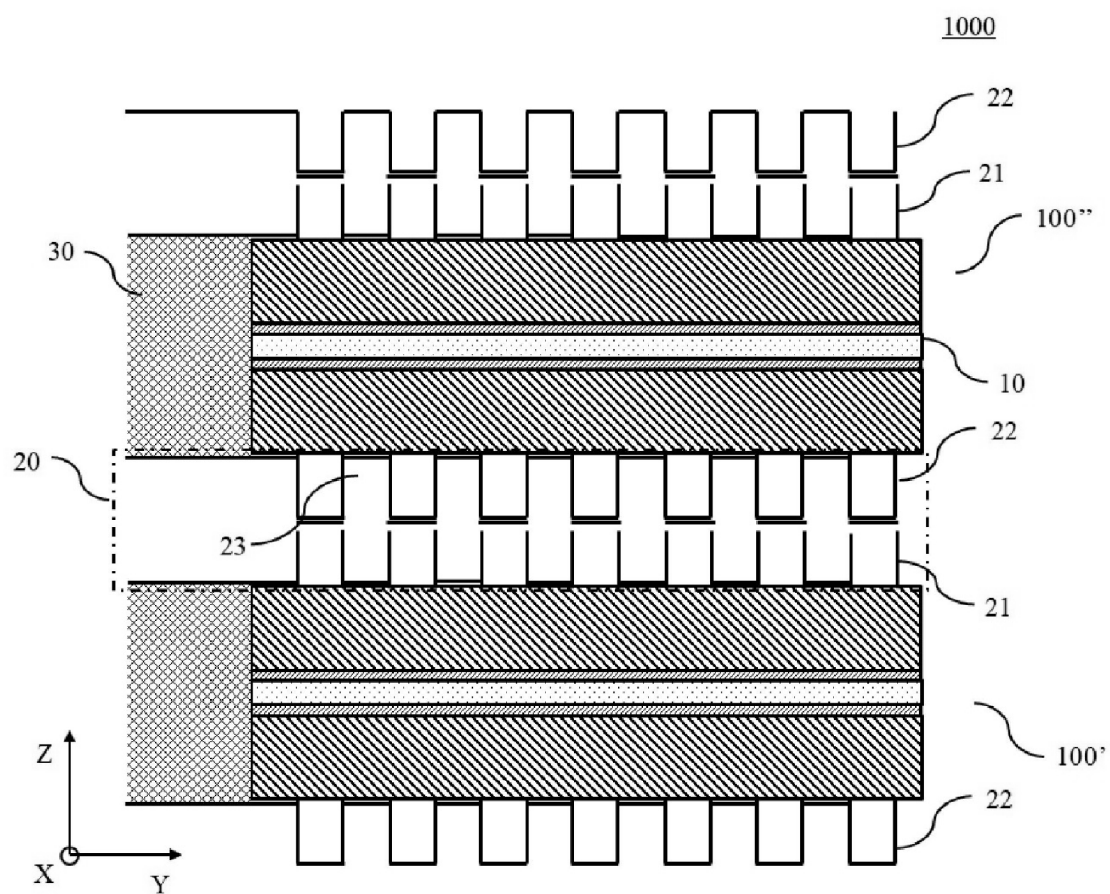


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/138127

A. CLASSIFICATION OF SUBJECT MATTER

C25B9/23(2021.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNXTX, VEN, CJFD, CNKI, ENTXT, PATENTICS, 超星读秀, DUXIU, 万方, WANFANG, ISI-WebofScience: 博世有限公司, 郝小罡, 谢旭, 电解, 流体, 流动, 氧气, O2, 通道, 通路, 路径, 膜, 电极, 孔, 阻塞, 阻碍, 堵塞, 排放, 排出, 引导, 阻力, 引流, electroly+, liquid+, water+, oxygen+, channel+, passag+, access+, path??, rout??, membran+, film+, electroad+, pore??, hole??, barrag+, block+, discharg+, eject+, lead+, conduct+, resistan+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 116892032 A (TOYOTA MOTOR CORP.) 17 October 2023 (2023-10-17) description, paragraphs [0016]-[0062], and figures 1-5	1-10
A	CN 113991136 A (SHANGHAI JIAO TONG UNIVERSITY) 28 January 2022 (2022-01-28) entire document	1-10
A	CN 114262909 A (QINGHONG (HANGZHOU) TECHNOLOGY CO., LTD.) 01 April 2022 (2022-04-01) entire document	1-10
A	CN 105951118 A (CHUNHUA HYDROGEN ENERGY TECHNOLOGY CO., LTD.) 21 September 2016 (2016-09-21) entire document	1-10
A	CN 106011914 A (CHUNHUA HYDROGEN ENERGY TECHNOLOGY CO., LTD.) 12 October 2016 (2016-10-12) entire document	1-10

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

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Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)
China No. 6, Xitucheng Road, Jimenqiao, Haidian District,
Beijing 100088

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/138127

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 113235120 A (TSINGHUA UNIVERSITY) 10 August 2021 (2021-08-10) entire document	1-10

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