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(54) **WATER ELECTROLYSIS SYSTEM AND ENERGY SYSTEM**

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(57) **ABSTRACT**

A water electrolysis system includes: a water electrolysis device including a membrane electrode assembly formed by sandwiching an electrolyte membrane between an anode and a cathode, the water electrolysis device being configured to generate oxygen gas at the anode by supplying water to the cathode and electrolyzing the water; and a water supply device configured to supply, to the anode, water generated in association with power generation of a fuel cell stack.

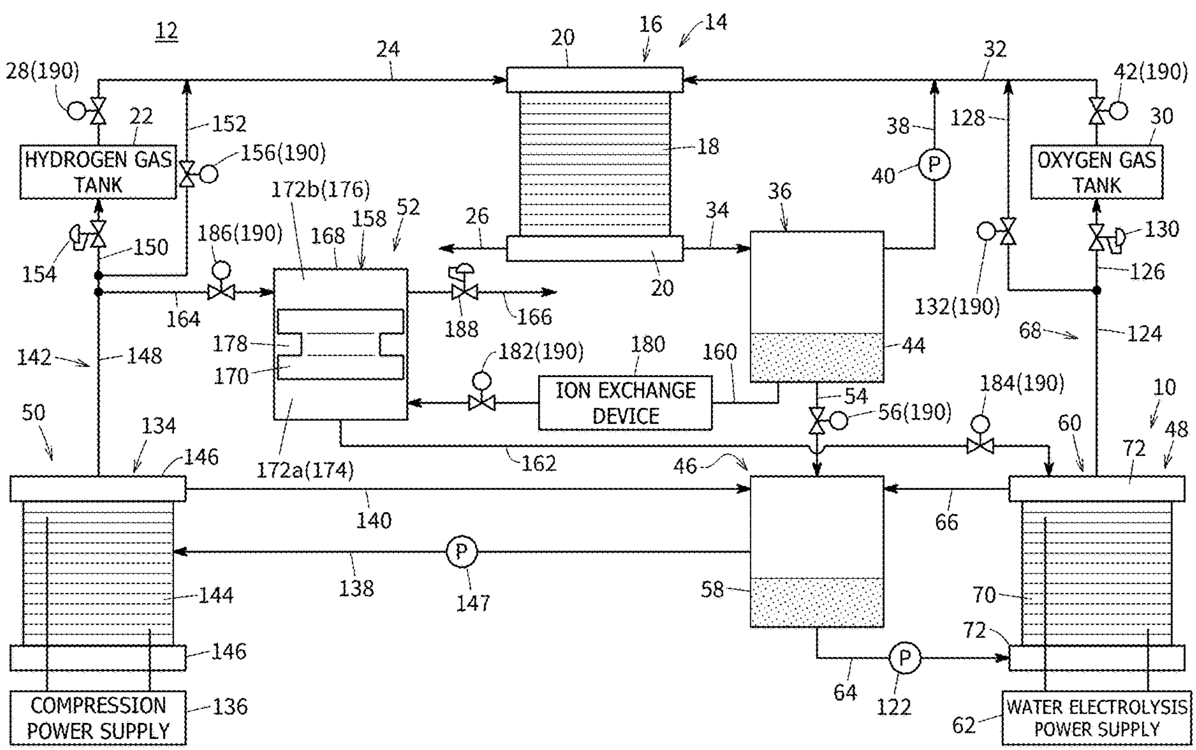


FIG. 1

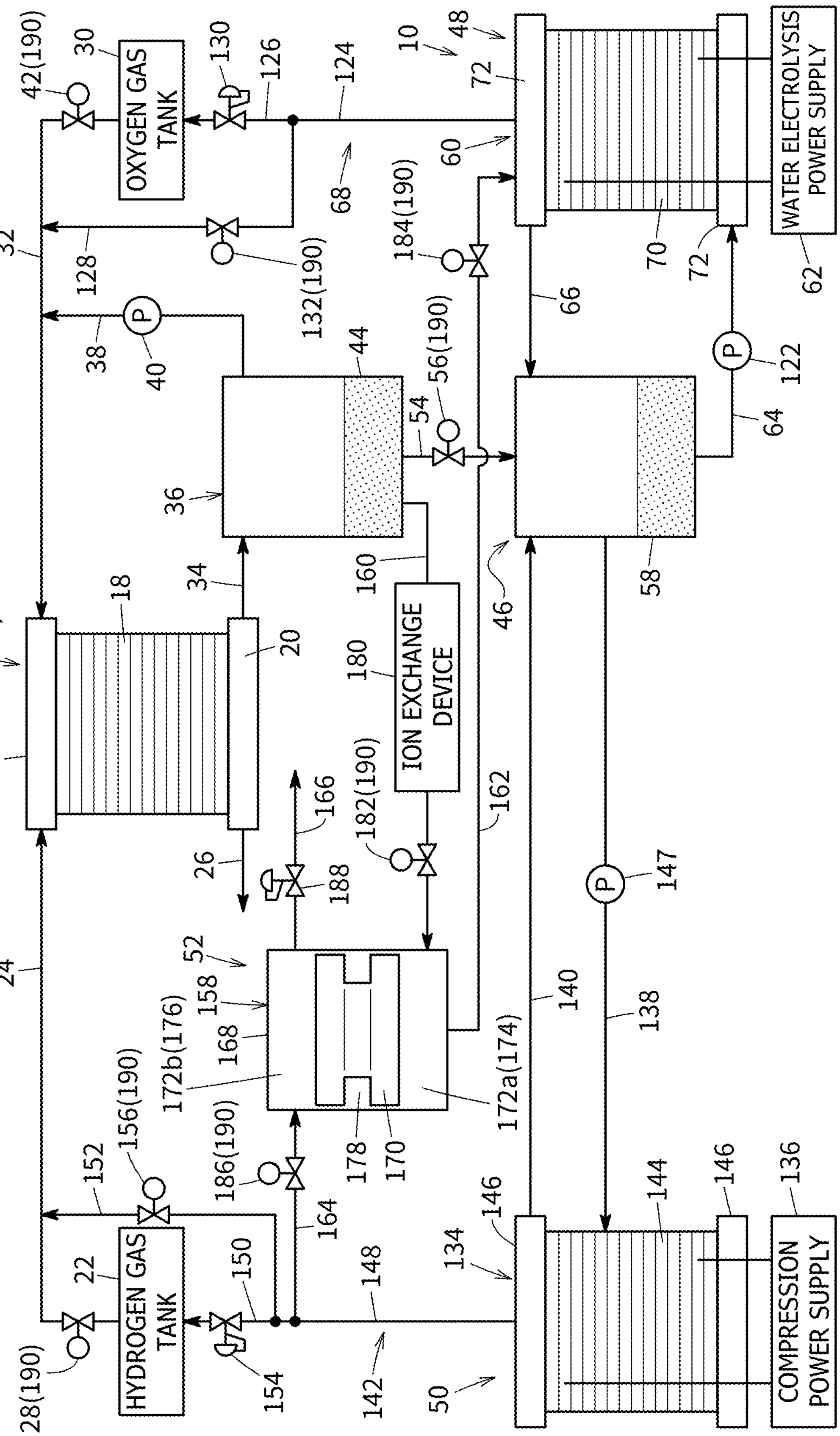

OXYGEN GAS TANK
HYDROGEN GAS TANK
ION EXCHANGE DEVICE
WATER ELECTROLYSIS POWER SUPPLY
COMPRESSION POWER SUPPLY

FIG. 2

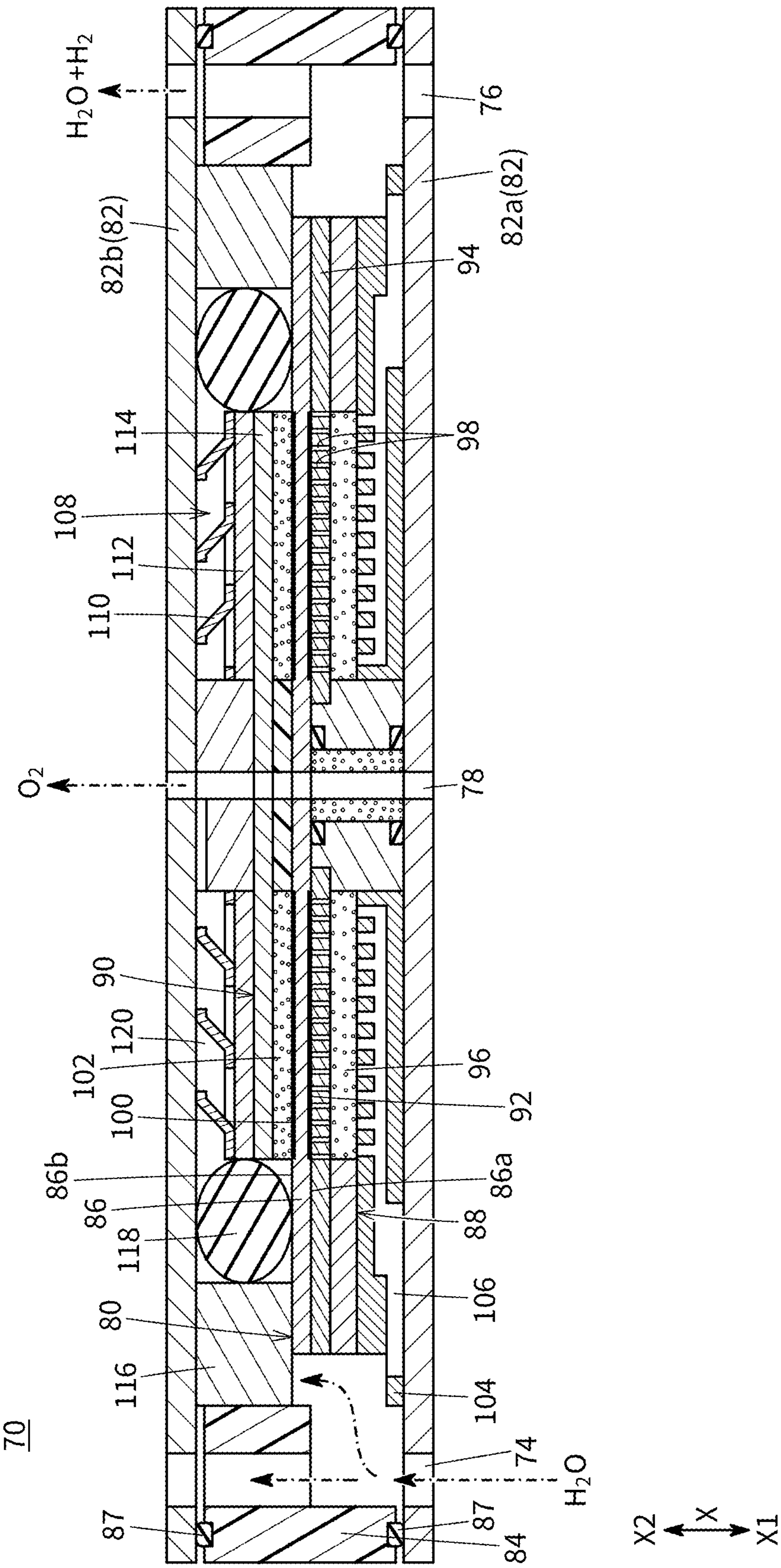

70
H_2O+H_2
76
82a(82)
82b(82)
94
98
114
108
112
110
O_2
78
90
120
102
100
96
92
86b
86a
86
88
118
106
80
116
104
74
H_2O
87
87
84
X2
X
X1

FIG. 3

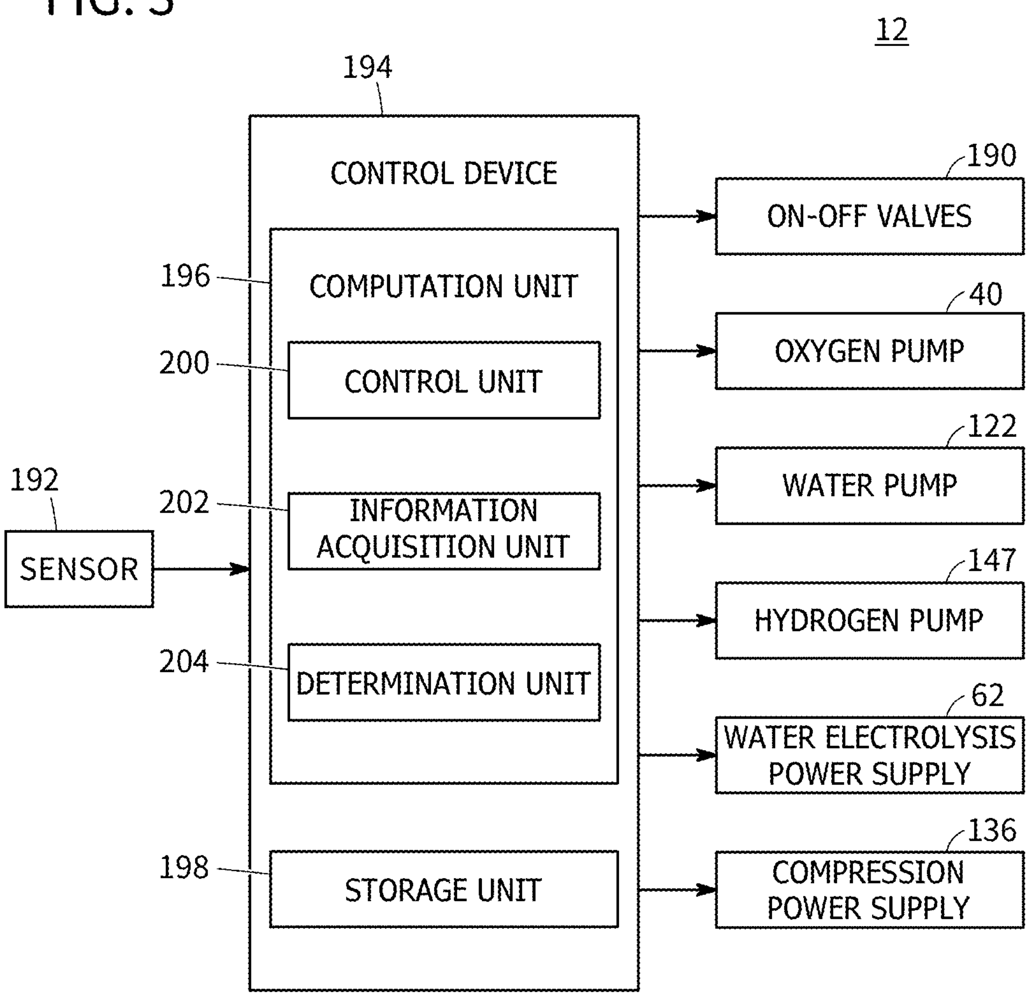
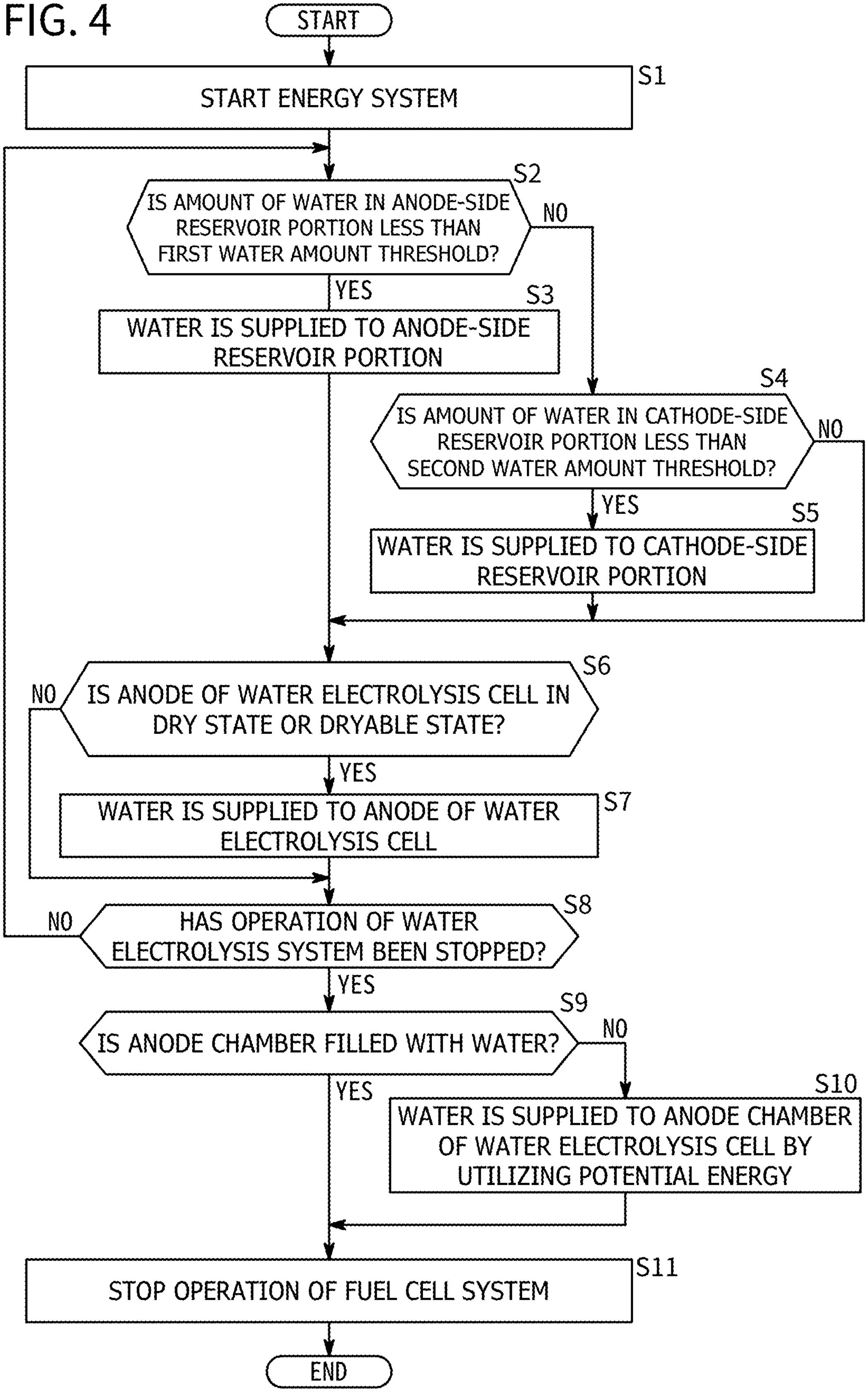

12
194
CONTROL DEVICE
196
COMPUTATION UNIT
200
CONTROL UNIT
202
INFORMATION ACQUISITION UNIT
204
DETERMINATION UNIT
198
STORAGE UNIT
192
SENSOR
190
ON-OFF VALVES
40
OXYGEN PUMP
122
WATER PUMP
147
HYDROGEN PUMP
62
WATER ELECTROLYSIS POWER SUPPLY
136
COMPRESSION POWER SUPPLY

FIG. 4


START
S1
START ENERGY SYSTEM
S2
IS AMOUNT OF WATER IN ANODE-SIDE RESERVOIR PORTION LESS THAN FIRST WATER AMOUNT THRESHOLD?
NO
YES
S3
WATER IS SUPPLIED TO ANODE-SIDE RESERVOIR PORTION
S4
IS AMOUNT OF WATER IN CATHODE-SIDE RESERVOIR PORTION LESS THAN SECOND WATER AMOUNT THRESHOLD?
NO
YES
S5
WATER IS SUPPLIED TO CATHODE-SIDE RESERVOIR PORTION
S6
NO
IS ANODE OF WATER ELECTROLYSIS CELL IN DRY STATE OR DRYABLE STATE?
YES
S7
WATER IS SUPPLIED TO ANODE OF WATER ELECTROLYSIS CELL
S8
NO
HAS OPERATION OF WATER ELECTROLYSIS SYSTEM BEEN STOPPED?
YES
S9
IS ANODE CHAMBER FILLED WITH WATER?
NO
YES
S10
WATER IS SUPPLIED TO ANODE CHAMBER OF WATER ELECTROLYSIS CELL BY UTILIZING POTENTIAL ENERGY
S11
STOP OPERATION OF FUEL CELL SYSTEM
END

WATER ELECTROLYSIS SYSTEM AND ENERGY SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2024-022662 filed on Feb. 19, 2024, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present disclosure relates to a water electrolysis system and an energy system.

Description of the Related Art

[0003] In recent years, technological development has been conducted on energy systems that contribute to energy efficiency in order to ensure that more people have access to affordable, reliable, sustainable and modern energy.

[0004] JP 2022-083098 A describes an energy system including a water electrolysis system, a compression (pressurizing) device, and a fuel cell. The water electrolysis system includes a water electrolysis device including a membrane electrode assembly formed by sandwiching an electrolyte membrane between an anode and a cathode. The water electrolysis device supplies water to the cathode and electrolyzes the water to generate oxygen gas at the anode.

SUMMARY OF THE INVENTION

[0005] There has been a demand for a more satisfactory water electrolysis system and a more satisfactory energy system.

[0006] The present disclosure has the object of solving the above-described problem.

[0007] According to a first aspect of the present disclosure, there is provided a water electrolysis system comprising: a water electrolysis device including a membrane electrode assembly formed by sandwiching an electrolyte membrane between an anode and a cathode, the water electrolysis device being configured to generate oxygen gas at the anode by supplying water to the cathode and electrolyzing the water; and a water supply device configured to supply, to the anode, water generated in association with power generation of a fuel cell stack.

[0008] According to a second aspect of the present disclosure, there is provided an energy system comprising: the water electrolysis system according to the first aspect; and a fuel cell system including the fuel cell stack.

[0009] According to the present disclosure, a more satisfactory water electrolysis system and a more satisfactory energy system can be provided.

[0010] The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings, in which a preferred embodiment of the present invention is shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a schematic configuration diagram of an energy system according to an embodiment of the present disclosure;

[0012] FIG. **2** is an explanatory cross-sectional view of a water electrolysis cell;

[0013] FIG. **3** is a block diagram of a control device of the energy system; and

[0014] FIG. **4** is a flowchart showing an example of a method for controlling the energy system.

DETAILED DESCRIPTION OF THE INVENTION

[0015] In a water electrolysis device, the anode may be corroded by oxygen gas generated at the anode. The present disclosure has been made in view of such a problem, and can provide a water electrolysis system and an energy system capable of suppressing corrosion of an anode.

[0016] FIG. **1** is a schematic configuration diagram of an energy system **12** according to an embodiment of the present disclosure. The energy system **12** is a circulative renewable energy system. Specifically, the energy system **12** is a system in which a fuel cell system **14** that generates electricity and water by an electrochemical reaction between oxygen gas and hydrogen gas, and a water electrolysis system **10** that generates oxygen gas and hydrogen gas by electrolyzing water, are combined. In the energy system **12**, the water electrolysis system **10** generates, by using water generated in the fuel cell system **14**, oxygen gas and hydrogen gas required for power generation of the fuel cell system **14**.

[0017] Such an energy system **12** can be installed, for example, on the ground or on the moon's surface. Further, the energy system **12** can also be mounted on a satellite such as an International Space Station (ISS).

[0018] The fuel cell system **14** includes a fuel cell stack **16**. The fuel cell stack **16** includes a plurality of power generation cells **18** and a pair of end plates **20**. The plurality of power generation cells **18** are stacked on each other. The pair of end plates **20** sandwich the plurality of power generation cells **18** in the stacking direction of the power generation cells **18**.

[0019] The detailed illustration of the power generation cells **18** will be omitted. The power generation cells **18** each include a membrane electrode assembly and a pair of separators. The membrane electrode assembly is sandwiched between the pair of separators. The membrane electrode assembly includes an electrolyte membrane, an anode, and a cathode. The power generation cells **18** generate power by an electrochemical reaction between hydrogen gas and oxygen gas. Water is generated at the cathodes when power is generated by the power generation cells **18**.

[0020] The fuel cell system **14** further includes a hydrogen gas tank **22**, a hydrogen gas supply path **24**, and a hydrogen gas discharge path **26**. The hydrogen gas tank **22** is filled with high-pressure hydrogen gas. The hydrogen gas supply path **24** is configured to supply the hydrogen gas filled in the hydrogen gas tank **22** to the fuel cell stack **16**. The hydrogen gas supply path **24** is provided with an on-off valve **28**. The on-off valve **28** opens and closes the hydrogen gas supply path **24**. A hydrogen exhaust gas discharged from the fuel cell stack **16** flows through the hydrogen gas discharge path

26. The hydrogen exhaust gas contains unreacted hydrogen gas that has not reacted in the power generation cells **18**.

[0021] The fuel cell system **14** further includes an oxygen gas tank **30**, an oxygen gas supply path **32**, an oxygen gas discharge path **34**, a gas-liquid separator **36**, a circulation flow path **38**, and an oxygen pump **40**. The oxygen gas tank **30** is filled with high-pressure oxygen gas. The pressure of the oxygen gas in the oxygen gas tank **30** is lower than the pressure of the hydrogen gas in the hydrogen gas tank **22**. The oxygen gas supply path **32** is configured to supply the oxygen gas filled in the oxygen gas tank **30** to the fuel cell stack **16**. The oxygen gas supply path **32** is provided with an on-off valve **42**. The on-off valve **42** opens and closes the oxygen gas supply path **32**. An oxygen exhaust gas discharged from the fuel cell stack **16** flows through the oxygen gas discharge path **34**. The oxygen exhaust gas contains unreacted oxygen gas that has not reacted in the power generation cells **18**. The oxygen exhaust gas also contains water (water vapor) generated at the cathodes of the power generation cells **18**.

[0022] The gas-liquid separator **36** is connected to the oxygen gas discharge path **34**. The gas-liquid separator **36** separates the oxygen exhaust gas into gas and liquid. Specifically, the gas-liquid separator **36** removes water vapor from the oxygen exhaust gas. The gas-liquid separator **36** includes a reservoir portion **44** that stores water (liquid water) separated from the oxygen exhaust gas. The circulation flow path **38** connects the gas-liquid separator **36** and the oxygen gas supply path **32** to each other. The circulation flow path **38** guides the oxygen exhaust gas from which water vapor has been removed by the gas-liquid separator **36**, to the oxygen gas supply path **32**. The oxygen pump **40** is provided in the circulation flow path **38**. The oxygen pump **40** sends the oxygen exhaust gas flowing through the circulation flow path **38**, to the oxygen gas supply path **32**.

[0023] The fuel cell system **14** may include components other than the above-described components. That is, the fuel cell system **14** may include, for example, a cooling device for circulating a coolant to the fuel cell stack **16**.

[0024] The water electrolysis system **10** includes a gas-liquid separator **46**, a water electrolysis device **48**, a compression device **50**, and a water supply device **52**. The gas-liquid separator **46** of the water electrolysis system **10** and the gas-liquid separator **36** of the fuel cell system **14** are connected to each other by a connecting passage **54**. The connecting passage **54** is provided with an on-off valve **56**. The on-off valve **56** opens and closes the connecting passage **54**. The water stored in the reservoir portion **44** of the gas-liquid separator **36** of the fuel cell system **14** is supplied to the gas-liquid separator **46** via the connecting passage **54**. The gas-liquid separator **46** includes a cathode-side reservoir portion **58** that stores water. The water stored in the cathode-side reservoir portion **58** is supplied to a cathode **88** (described later) of the water electrolysis device **48**.

[0025] The water electrolysis device **48** generates oxygen gas and hydrogen gas by electrolyzing water (pure water). The water electrolysis device **48** is, for example, a solid polymer water electrolysis device. The water electrolysis device **48** may be an alkaline water electrolysis device or a solid oxide water electrolysis device.

[0026] The water electrolysis device **48** includes a water electrolysis stack **60**, a water electrolysis power supply **62**, a water electrolysis supply path **64**, a water electrolysis discharge path **66**, and an oxygen gas delivery path **68**. The water electrolysis stack **60** includes a plurality of water electrolysis cells **70** and a pair of end plates **72**. The plurality of water electrolysis cells **70** are stacked on each other. The pair of end plates **72** sandwich the plurality of water electrolysis cells **70** in the stacking direction of the water electrolysis cells **70**.

[0027] FIG. **2** is an explanatory cross-sectional view of the water electrolysis cell **70**. In FIG. **2**, an X direction is the stacking direction of the plurality of water electrolysis cells **70**. As shown in FIG. **2**, in the water electrolysis cell **70**, water is supplied to the cathode **88**. The water electrolysis cells **70** each generate oxygen gas at an anode **90** and hydrogen gas at the cathode **88** by electrolyzing water.

[0028] The water electrolysis cell **70** is a differential pressure water electrolysis cell in which the pressure of the oxygen gas in the anode **90** is higher than the pressure of the water in the cathode **88**. The water electrolysis cell **70** may be an equal pressure water electrolysis cell in which the pressure of the oxygen gas in the anode **90** is substantially equal to the pressure of the water in the cathode **88**. In the water electrolysis device **48**, for example, oxygen gas at 14.8 MPa can be generated at the anodes **90**.

[0029] The water electrolysis cells **70** each include a water supply passage **74**, a water discharge passage **76**, and an oxygen gas discharge passage **78** that are provided so as to penetrate the water electrolysis cell **70** in the X direction. The water supply passages **74** of the plurality of water electrolysis cells **70** communicate with each other. The water discharge passages **76** of the plurality of water electrolysis cells **70** communicate with each other. The oxygen gas discharge passages **78** of the plurality of water electrolysis cells **70** communicate with each other.

[0030] The water supply passage **74** and the water discharge passage **76** are provided at positions separated from each other in an outer peripheral portion of the water electrolysis cell **70**. The oxygen gas discharge passage **78** is provided in a central portion of the water electrolysis cell **70**. The oxygen gas discharge passage **78** is located between the water supply passage **74** and the water discharge passage **76**. Water is supplied to the cathode **88** through the water supply passage **74**. Water flowing through the cathode **88** and hydrogen gas generated at the cathode **88** are discharged to the outside through the water discharge passage **76**. Oxygen gas generated at the anode **90** is discharged to the outside through the oxygen gas discharge passage **78**.

[0031] The water electrolysis cells **70** each include a membrane electrode assembly **80**, a pair of separators **82**, and a frame member **84**. The membrane electrode assembly **80** is sandwiched between the pair of separators **82**. The frame member **84** is formed in an annular shape so as to surround the membrane electrode assembly **80**. A seal member **87** for preventing a fluid (water and hydrogen gas) from flowing out is provided between the frame member **84** and each of the separators **82**. Hereinafter, in FIG. **2**, one of the pair of separators **82** that is located on an X1 direction side of the membrane electrode assembly **80** may be referred to as a "first separator **82***a*", and the other of the pair of separators **82** that is located on an X2 direction side of the membrane electrode assembly **80** may be referred to as a "second separator **82***b*".

[0032] The membrane electrode assembly **80** is formed in an annular shape. The membrane electrode assembly **80** includes an electrolyte membrane **86**, the cathode **88**, and the anode **90**. The electrolyte membrane **86** is sandwiched between the cathode **88** and the anode **90**. The electrolyte membrane **86** is an ion exchange membrane. Specifically, the electrolyte membrane **86** is, for example, an anion exchange membrane (AEM). The electrolyte membrane **86** may be a proton exchange membrane (PEM). The electrolyte membrane **86** prevents the oxygen gas generated at the anode **90** from passing through to the cathode **88**.

[0033] The cathode **88** includes a cathode catalyst layer **92**, a protective sheet **94**, and a cathode current collector **96**. The cathode catalyst layer **92** is joined to a surface **86***a* (a surface facing the X1 direction) of the electrolyte membrane **86**. The cathode current collector **96** also serves as a gas diffusion layer for supplying water to the cathode catalyst layer **92**. The cathode current collector **96** includes a portion formed of a porous member. The protective sheet **94** is disposed between the cathode catalyst layer **92** and the cathode current collector **96**. The protective sheet **94** prevents the electrolyte membrane **86** from being damaged by being pressed by the cathode current collector **96** due to the high-pressure oxygen gas generated at the anode **90**. A plurality of through holes **98** are formed in the protective sheet **94**.

[0034] The outer diameter of the anode **90** is smaller than the outer diameter of the cathode **88**. The anode **90** includes an anode catalyst layer **100** and an anode current collector **102**. The anode catalyst layer **100** is joined to a surface **86***b* (a surface facing the X2 direction) of the electrolyte membrane **86**. The anode current collector **102** also serves as a gas diffusion layer for leading out oxygen gas generated in the anode catalyst layer **100**. The anode current collector **102** includes a portion formed of a porous member.

[0035] A support member **104** for supporting the membrane electrode assembly **80** is provided between the first separator **82***a* and the cathode current collector **96**. A connection channel **106** is formed in the support member **104**. The connection channel **106** guides the water introduced from the water supply passage **74** into the cathode current collector **96**. Further, the connection channel **106** guides a mixed fluid of water and hydrogen gas in the cathode current collector **96** to the water discharge passage **76**.

[0036] A load applying mechanism **108** that biases the anode current collector **102** in the X1 direction is provided between the second separator **82***b* and the anode current collector **102**. The load applying mechanism **108** includes, for example, a plate spring **110**, a plate spring holder **112**, and a conductive sheet **114**. An annular member **116** is provided between the second separator **82***b* and an outer peripheral portion of the electrolyte membrane **86**. The annular member **116** is in liquid-tight and air-tight contact with the surface **86***b* of the electrolyte membrane **86**.

[0037] An annular seal member **118** is disposed between the annular member **116** and the load applying mechanism **108**. The seal member **118** is in liquid-tight and air-tight contact with the second separator **82***b* and the electrolyte membrane **86**. A space (an anode chamber **120**) for accommodating the anode **90** is formed on the inner side of the seal member **118**. The load applying mechanism **108** is disposed in the anode chamber **120**.

[0038] As shown in FIG. **1**, the water electrolysis power supply **62** is a DC power supply. The water electrolysis power supply **62** applies a voltage between the cathode current collector **96** and the anode current collector **102** (see FIGS. **1** and **2**).

[0039] The water electrolysis supply path **64** connects the cathode-side reservoir portion **58** and the water electrolysis stack **60**. The water electrolysis supply path **64** communicates with the water supply passages **74** (see FIG. **2**) of the water electrolysis cells **70**. The water electrolysis supply path **64** guides the water stored in the cathode-side reservoir portion **58** to the water electrolysis stack **60**. The water electrolysis supply path **64** is provided with a water pump **122**. The water pump **122** sends the water flowing through the water electrolysis supply path **64**, to the water electrolysis stack **60**.

[0040] The water electrolysis discharge path **66** connects the gas-liquid separator **46** and the water electrolysis stack **60**. The water electrolysis discharge path **66** communicates with the water discharge passages **76** (see FIG. **2**) of the water electrolysis cells **70**. The water electrolysis discharge path **66** guides, to the gas-liquid separator **46**, a mixed fluid of hydrogen generated at the cathodes **88** of the water electrolysis cells **70** and water that has not been electrolyzed. The gas-liquid separator **46** separates the mixed fluid guided from the water electrolysis discharge path **66** into gas and liquid. The water separated from the mixed fluid is stored in the cathode-side reservoir portion **58**.

[0041] The oxygen gas generated in the water electrolysis stack **60** is delivered to the fuel cell system **14** through the oxygen gas delivery path **68**. The oxygen gas delivery path **68** communicates with the oxygen gas discharge passages **78** (see FIG. **2**) of the water electrolysis cells **70**. The oxygen gas delivery path **68** includes an oxygen gas lead-out path **124**, a first branch path **126**, and a second branch path **128**. The oxygen gas lead-out path **124** is connected to the water electrolysis stack **60**. The first branch path **126** and the second branch path **128** branch off from the oxygen gas lead-out path **124**. The first branch path **126** is connected to the oxygen gas tank **30** of the fuel cell system **14**. The second branch path **128** is connected to the oxygen gas supply path **32** of the fuel cell system **14**.

[0042] The first branch path **126** is provided with a back pressure valve **130**. The back pressure valve **130** opens in a case where the pressure of the oxygen gas guided from the water electrolysis stack **60** is equal to or higher than an oxygen gas pressure threshold determined in advance. The back pressure valve **130** closes in a case where the pressure of the oxygen gas guided from the water electrolysis stack **60** is less than the oxygen gas pressure threshold. The second branch path **128** is provided with an on-off valve **132**. The on-off valve **132** opens and closes the second branch path **128**.

[0043] The water electrolysis device **48** may include components other than the above-described components.

[0044] The compression device **50** includes a compression stack **134**, a compression power supply **136**, a compression supply path **138**, a compression discharge path **140**, and a hydrogen gas delivery path **142**. The compression stack **134** compresses the hydrogen gas generated in the water electrolysis device **48**. The compression stack **134** includes a plurality of compression cells **144** and a pair of end plates **146**. The plurality of compression cells **144** are stacked on each other. The pair of end plates **146** sandwich the plurality of compression cells **144** in the stacking direction of the compression cells **144**.

[0045] The detailed illustration of the compression cells **144** will be omitted. In each of the compression cells **144**, a voltage is applied between an anode current collector of an anode and a cathode current collector of a cathode by the compression power supply **136** in a state where humidified hydrogen gas is supplied to the anode. Consequently, hydrogen ions are generated at the anode, and the hydrogen ions pass through the electrolyte membrane (the ion exchange membrane) of the compression cell **144** and are guided to the cathode. At the cathode, hydrogen ions are combined to generate hydrogen gas. The electrolyte membrane of the compression cell **144** prevents the hydrogen gas generated at the cathode from passing through to the anode. In the compression device **50**, high-pressure hydrogen gas can be generated at the cathodes. The compression device **50** can compress the hydrogen gas to, for example, **70** MPa. That is, the pressure of the hydrogen gas compressed by the compression device **50** is higher than the pressure of the oxygen gas generated by the water electrolysis device **48**.

[0046] The compression supply path **138** connects the gas-liquid separator **46** and the compression stack **134**. The compression supply path **138** guides the hydrogen gas from which water is removed by the gas-liquid separator **46**, to the compression stack **134**. The compression supply path **138** is provided with a hydrogen pump **147**. The hydrogen pump **147** sends the hydrogen gas flowing through the compression supply path **138**, to the compression stack **134**. It should be noted that the hydrogen gas supplied from the compression supply path **138** to the compression stack **134** contains an appropriate amount of water vapor. As a result, the electrolyte membranes of the compression cells **144** are humidified by the water vapor.

[0047] The compression discharge path **140** connects the gas-liquid separator **46** and the compression stack **134**. The compression discharge path **140** guides the unreacted hydrogen gas in the compression stack **134** to the gas-liquid separator **46** together with the water vapor.

[0048] The hydrogen gas generated at the cathodes of the compression cells **144** is delivered to the fuel cell system **14** through the hydrogen gas delivery path **142**. The hydrogen gas delivery path **142** includes a hydrogen gas lead-out path **148**, a first branch path **150**, and a second branch path **152**. The hydrogen gas lead-out path **148** is connected to the compression stack **134**. The first branch path **150** and the second branch path **152** branch off from the hydrogen gas lead-out path **148**. The first branch path **150** is connected to the hydrogen gas tank **22** of the fuel cell system **14**. The second branch path **152** is connected to the hydrogen gas supply path **24** of the fuel cell system **14**.

[0049] The first branch path **150** is provided with a back pressure valve **154**. The back pressure valve **154** opens the first branch path **150** in a case where the pressure of the hydrogen gas guided from the compression stack **134** is equal to or higher than a hydrogen gas pressure threshold determined in advance. The back pressure valve **154** closes the first branch path **150** in a case where the pressure of the hydrogen gas guided from the compression stack **134** is less than the hydrogen gas pressure threshold. The second branch path **152** is provided with an on-off valve **156**. The on-off valve **156** opens and closes the second branch path **152**.

[0050] The compression device **50** may include components other than the above-described components.

[0051] The water supply device **52** supplies water generated in association with power generation of the fuel cell stack **16**, to the anodes **90** of the water electrolysis device **48**. It should be noted that the pressure in the anode **90** to which the generated water is supplied is higher than the pressure in the cathode **88**. The water supply device **52** includes a pressing device **158**, a water introduction path **160**, a water supply path **162**, a hydrogen gas introduction path **164**, and a discharge path **166**. The pressing device **158** includes a cylindrical portion **168** and a piston **170**. The piston **170** is provided in the cylindrical portion **168** so as to be slidable on an inner peripheral surface of the cylindrical portion **168**. The piston **170** partitions an internal space of the cylindrical portion **168** into a first chamber **172*a*** and a second chamber **172*b***. The first chamber **172*a*** is an anode-side reservoir portion **174** capable of storing water to be supplied to the anodes **90** of the water electrolysis cells **70**. The second chamber **172*b*** is a pressurizing chamber **176** into which the hydrogen gas compressed by the compression device **50** can be introduced.

[0052] An outer peripheral surface of the piston **170** is in liquid-tight and air-tight contact with the inner peripheral surface of the cylindrical portion **168**. An annular groove **178** is formed in the outer peripheral surface of the piston **170**. An inert gas such as nitrogen gas is sealed in the annular groove **178**. This can suppress mixing of the water in the anode-side reservoir portion **174** with the hydrogen gas in the pressurizing chamber **176**.

[0053] The water introduction path **160** connects the reservoir portion **44** of the fuel cell system **14** and the cylindrical portion **168**. The water introduction path **160** introduces water stored in the reservoir portion **44** of the fuel cell system **14** into the anode-side reservoir portion **174**. In a case where water is introduced into the anode-side reservoir portion **174**, the water may be pressure-fed by a pump (not shown).

[0054] Alternatively, the water may be introduced while increasing the space of the anode-side reservoir portion **174** by moving the piston **170** toward the pressurizing chamber **176** by discharging the gas in the pressurizing chamber **176** through a discharge valve **188** to reduce the pressure in the pressurizing chamber **176**. The water introduction path **160** is provided with an ion exchange device **180** and an on-off valve **182**. The ion exchange device **180** removes impurities from the water guided from the reservoir portion **44** of the fuel cell system **14**. The on-off valve **182** opens and closes the water introduction path **160**.

[0055] The water supply path **162** connects the cylindrical portion **168** and the water electrolysis stack **60**. The water supply path **162** communicates with the anode chamber **120** (see FIG. **2**) of each of the water electrolysis cells **70**. Specifically, the water supply path **162** can guide the water (pure water) stored in the anode-side reservoir portion **174** to the anode **90** (see FIG. **2**) of each of the water electrolysis cells **70**. The water supply path **162** is provided with an on-off valve **184**. The on-off valve **184** opens and closes the water supply path **162**.

[0056] The hydrogen gas introduction path **164** connects the hydrogen gas delivery path **142** (the hydrogen gas lead-out path **148**) and the cylindrical portion **168**. The hydrogen gas introduction path **164** guides the hydrogen gas flowing through the hydrogen gas delivery path **142**, to the pressurizing chamber **176** of the cylindrical portion **168**. The hydrogen gas introduction path **164** is provided with an on-off valve **186**. The on-off valve **186** opens and closes the hydrogen gas introduction path **164**.

[0057] The hydrogen gas inside the pressurizing chamber **176** is discharged to the outside through the discharge path **166**. The discharge path **166** is provided with the discharge valve **188**. The discharge valve **188** opens and closes the discharge path **166**. The discharge valve **188** opens in a case where the pressure in the pressurizing chamber **176** is equal to or higher than a pressure threshold determined in advance. The discharge valve **188** closes in a case where the pressure in the pressurizing chamber **176** is less than the pressure threshold.

[0058] The water supply device **52** may include components other than the above-described components.

[0059] In the water electrolysis system **10**, the water supply device **52** and the water electrolysis stack **60** are arranged such that the potential energy of the anode-side reservoir portion **174** is higher than the potential energy of the anode **90** of each of the water electrolysis cells **70**. Specifically, the height of the anode-side reservoir portion **174** in the gravity direction is greater than the height of the water electrolysis cells **70** in the gravity direction. As a result, the water stored in the anode-side reservoir portion **174** can be introduced to the anodes **90** of the water electrolysis cells **70** by using the potential energy.

[0060] In the following description, the on-off valves **28**, **42**, **56**, **132**, **156**, **182**, **184**, and **186** described above may be simply referred to as an "on-off valve **190**".

[0061] FIG. **3** is a block diagram of a control device **194** of the energy system **12**. As shown in FIG. **3**, the energy system **12** further includes a sensor **192** and the control device **194**. The sensor **192** detects various kinds of information about the energy system **12**. Detection signals of the sensor **192** are sequentially transmitted to the control device **194**. The sensor **192** includes, for example, a water level sensor for measuring the amount of water in the anode-side reservoir portion **174**. Further, the sensor **192** includes a voltage sensor for measuring the voltage between the cathode current collector **96** and the anode current collector **102** of each of the water electrolysis cells **70**.

[0062] The control device **194** includes a computation unit **196** and a storage unit **198**. The computation unit **196** is constituted by a processor such as a central processing unit (CPU) or a graphics processing unit (GPU). That is, the computation unit **196** is constituted by processing circuitry.

[0063] The computation unit **196** includes a control unit **200**, an information acquisition unit **202**, and a determination unit **204**. The control unit **200**, the information acquisition unit **202**, and the determination unit **204** can be realized by the computation unit **196** executing programs stored in the storage unit **198**.

[0064] At least part of the control unit **200**, the information acquisition unit **202**, and the determination unit **204** may be realized by an integrated circuit such as an application specific integrated circuit (ASIC) or a field-programmable gate array (FPGA). Further, at least part of the control unit **200**, the information acquisition unit **202**, and the determination unit **204** may be constituted by an electronic circuit including a discrete device.

[0065] The storage unit **198** is constituted by a volatile memory (not shown) and a non-volatile memory (not shown). Examples of the volatile memory include, for example, a random access memory (RAM) or the like. The volatile memory is used as a working memory of the processor and temporarily stores data and the like required for processing or computation. Examples of the non-volatile memory include, for example, a read only memory (ROM), a flash memory, or the like. The non-volatile memory is used as a storage memory and stores programs, tables, maps, and the like. At least part of the storage unit **198** may be included in the processor, the integrated circuit, or the like described above.

[0066] The control unit **200** controls the entire energy system **12**. The control unit **200** controls the on-off valves **190**, the oxygen pump **40**, the water pump **122**, the hydrogen pump **147**, the water electrolysis power supply **62**, and the compression power supply **136**. The information acquisition unit **202** acquires information measured by the sensor **192**.

[0067] Next, the operation of the energy system **12** will be described. FIG. **4** is a flowchart showing an example of a method for controlling the energy system **12**.

[0068] As shown in FIG. **4**, in step S1, the control unit **200** starts the energy system **12**. Specifically, the control unit **200** starts the fuel cell system **14**. More specifically, the control unit **200** controls the on-off valve **42** to open the oxygen gas supply path **32**, and controls the on-off valve **28** to open the hydrogen gas supply path **24**. When the on-off valve **42** is opened, the oxygen gas filled in the oxygen gas tank **30** is introduced into the fuel cell stack **16** through the oxygen gas supply path **32**. When the on-off valve **28** is opened, the hydrogen gas filled in the hydrogen gas tank **22** is introduced into the fuel cell stack **16** through the hydrogen gas supply path **24**.

[0069] In the fuel cell stack **16**, each of the power generation cells **18** generates electric power by an electrochemical reaction between oxygen gas and hydrogen gas. Unreacted hydrogen gas that has not been used for power generation is led out to the hydrogen gas discharge path **26** as hydrogen exhaust gas. Unreacted oxygen gas that has not been used for power generation is led out to the oxygen gas discharge path **34** as oxygen exhaust gas together with water generated in association with the power generation. The oxygen exhaust gas led out to the oxygen gas discharge path **34** is separated into gas and liquid by the gas-liquid separator **36**. The water (liquid water) separated from the oxygen exhaust gas is stored in the reservoir portion **44**. Moreover, the control unit **200** drives the oxygen pump **40** to guide the oxygen exhaust gas, from which water has been removed, from the gas-liquid separator **36** to the oxygen gas supply path **32**.

[0070] The control unit **200** also starts the water electrolysis system **10**. Specifically, the control unit **200** drives the water pump **122** and controls the water electrolysis power supply **62** to apply a voltage between the cathode current collector **96** and the anode current collector **102** of each of the water electrolysis cells **70**. When the water pump **122** is driven, the water stored in the cathode-side reservoir portion **58** is supplied to the water supply passages **74** of the water electrolysis stack **60** via the water electrolysis supply path **64**. The water supplied to each of the water supply passages **74** is guided to the cathode catalyst layer **92** through the connection channel **106** of the support member **104**, the inside of the cathode current collector **96**, and the through holes **98** of the protective sheet **94**.

[0071] In a case where the electrolyte membrane **86** is an anion exchange membrane, hydrogen gas and hydroxide ions are generated in the cathode catalyst layer **92** by electrolysis of water. The hydroxide ions pass through the anion exchange membrane and are guided to the anode catalyst layer **100**. In the anode catalyst layer **100**, the hydroxide ions are combined to generate oxygen gas and water.

[0072] In a case where the electrolyte membrane **86** is a proton exchange membrane, the water guided to the cathode catalyst layer **92** passes through the proton exchange membrane and is guided to the anode catalyst layer **100**. In the anode catalyst layer **100**, oxygen gas and hydrogen ions are generated by electrolysis of water. The hydrogen ions pass through the proton exchange membrane and are guided to the cathode catalyst layer **92**. In the cathode catalyst layer **92**, hydrogen ions are combined to generate hydrogen gas.

[0073] The oxygen gas generated in the anode catalyst layer **100** is guided to the oxygen gas delivery path **68** through the oxygen gas discharge passage **78**. It should be noted that, in the oxygen gas delivery path **68**, the first branch path **126** is closed by the back pressure valve **130**, and the second branch path **128** is closed by the on-off valve **132**. Consequently, since the oxygen gas can be stored in the closed space, the pressure of the oxygen gas generated in the water electrolysis stack **60** can be increased. When the pressure of the oxygen gas generated in the water electrolysis stack **60** becomes equal to or higher than the oxygen gas pressure threshold, the back pressure valve **130** opens and the oxygen gas tank **30** is filled with the oxygen gas. It should be noted that the control unit **200** may supply the oxygen gas generated in the water electrolysis stack **60** to the oxygen gas supply path **32** by opening the on-off valve **132**.

[0074] The mixed fluid of the hydrogen gas generated in the cathode catalyst layers **92** and the water that has not been electrolyzed is returned to the gas-liquid separator **46** via the water discharge passages **76** and the water electrolysis discharge path **66**. The gas-liquid separator **46** separates the mixed fluid into gas and liquid. The water separated from the mixed fluid is stored in the cathode-side reservoir portion **58**.

[0075] Further, the control unit **200** drives the hydrogen pump **147** and controls the compression power supply **136** to apply a voltage between the cathode current collector and the anode current collector of each of the compression cells **144**. When the hydrogen pump **147** is driven, the hydrogen gas in the gas-liquid separator **46** is supplied to the anodes of the compression cells **144** via the compression supply path **138**. In each of the compression cells **144**, hydrogen ions generated at the anode pass through the electrolyte membrane and are guided to the cathode, and the hydrogen ions are combined at the cathode to generate hydrogen gas.

[0076] The hydrogen gas generated at the cathode is guided to the hydrogen gas delivery path **142**. It should be noted that, in the hydrogen gas delivery path **142**, the first branch path **150** is closed by the back pressure valve **154**, and the second branch path **152** is closed by the on-off valve **156**. Further, the hydrogen gas introduction path **164** is closed by the on-off valve **186**. Consequently, since the hydrogen gas can be stored in the closed space, the pressure of the hydrogen gas generated in the compression stack **134** can be increased. When the pressure of the hydrogen gas generated in the compression cells **144** becomes equal to or higher than the hydrogen gas pressure threshold, the back pressure valve **154** opens and the hydrogen gas tank **22** is filled with the hydrogen gas. It should be noted that the control unit **200** may supply the hydrogen gas compressed by the compression stack **134** to the hydrogen gas supply path **24** by opening the on-off valve **156**.

[0077] In the energy system **12**, water is present at each of the anodes **90** during operation of the water electrolysis device **48**. However, depending on the operation state of the water electrolysis cell **70**, the anode **90** may be dried due to a shortage of water. In particular, in the differential pressure water electrolysis cell **70**, the water in the anode **90** is pushed by the high-pressure oxygen gas and flows to the cathode **88** via the electrolyte membrane **86**, and therefore, the anode **90** is likely to be dried. When the anode **90** is dried, the anode **90** (the anode current collector **102**) may be corroded by the oxygen gas. In addition, a member provided in the anode chamber **120** (for example, the load applying mechanism **108**) may be corroded. In the present embodiment, such corrosion of the anode **90** and the like is suppressed.

[0078] After the startup of the energy system **12** is finished, the process proceeds to step S**2**.

[0079] In step S**2**, the determination unit **204** determines whether or not the amount of water in the anode-side reservoir portion **174** is less than a first water amount threshold determined in advance. The amount of water in the anode-side reservoir portion **174** is acquired by the information acquisition unit **202** based on the detection signal of the sensor **192**. The first water amount threshold is appropriately set based on the total capacity obtained by summing the capacities of the anode chambers **120** of the plurality of water electrolysis cells **70**. In a case where the determination unit **204** determines that the amount of water in the anode-side reservoir portion **174** is less than the first water amount threshold (YES in step S**2**), the process proceeds to step S**3**.

[0080] In step S**3**, water is supplied to the anode-side reservoir portion **174**. Specifically, the control unit **200** controls the on-off valve **182** to open the water introduction path **160**. Then, the water stored in the reservoir portion **44** of the fuel cell system **14** is pushed by the oxygen exhaust gas in the gas-liquid separator **36** and is guided to the anode-side reservoir portion **174** via the water introduction path **160**. It should be noted that the water guided to the anode-side reservoir portion **174** is pure water from which impurities have been removed by the ion exchange device **180**. When the water is introduced into the anode-side reservoir portion **174**, the hydrogen gas in the pressurizing chamber **176** is pushed by the piston **170** and discharged to the outside via the discharge path **166**. It should be noted that the hydrogen gas flowing through the discharge path **166** is discharged in a state of being diluted with nitrogen gas. For example, when the amount of water in the anode-side reservoir portion **174** reaches the first water amount threshold, the control unit **200** controls the on-off valve **182** to close the water introduction path **160**. This allows the amount of water in the anode-side reservoir portion **174** to be equal to or greater than the first water amount threshold. Thereafter, the process proceeds to step S**6**.

[0081] In a case where the determination unit **204** determines that the amount of water in the anode-side reservoir portion **174** is equal to or greater than the first water amount threshold (NO in step S**2**), the process proceeds to step S**4**.

[0082] In step S**4**, the determination unit **204** determines whether or not the amount of water in the cathode-side reservoir portion **58** is less than a second water amount threshold. The amount of water in the cathode-side reservoir portion **58** is acquired by the information acquisition unit **202** based on the detection signal of the sensor **192**. The second water amount threshold is appropriately set based on the size of the water electrolysis stack **60**, the size of the reservoir portion **44**, and the like. In a case where the determination unit **204** determines that the amount of water in the cathode-side reservoir portion **58** is less than the second water amount threshold (YES in step S**4**), the process proceeds to step S**5**.

[0083] In step S**5**, water is supplied to the cathode-side reservoir portion **58**. Specifically, the control unit **200** controls the on-off valve **56** to open the connecting passage **54**. Then, the water stored in the reservoir portion **44** of the fuel cell system **14** is pushed by the oxygen exhaust gas in the gas-liquid separator **36** and is guided to the cathode-side reservoir portion **58** via the connecting passage **54**. For example, when the amount of water in the cathode-side reservoir portion **58** reaches the second water amount threshold, the control unit **200** controls the on-off valve **56** to close the connecting passage **54**. This allows the amount of water in the cathode-side reservoir portion **58** to be equal to or greater than the second water amount threshold. Thereafter, the process proceeds to step S**6**.

[0084] In step S**6**, the determination unit **204** determines whether or not the anode **90** of each of the water electrolysis cells **70** is in a dry state or a dryable state. Specifically, the determination unit **204** determines whether or not the anode **90** of each of the water electrolysis cells **70** is in a dry state or a dryable state, for example, based on a voltage value or a resistance value between the cathode current collector **96** and the anode current collector **102** of the water electrolysis cell **70**. In a case where water is not introduced into the anode-side reservoir portion **174**, then, in each of the water electrolysis cells **70**, water is easily supplied to the cathode **88**, whereas only water that has permeated through the electrolyte membrane **86** is supplied to the anode **90**. Therefore, the anode **90** is a factor that increases the voltage value or the resistance value between the cathode current collector **96** and the anode current collector **102** of each of the water electrolysis cells **70**. Therefore, it is possible to easily determine whether or not the anode **90** of each of the water electrolysis cells **70** is in a dry state or a dryable state. Further, the determination unit **204** may determine whether or not the anode **90** of each of the water electrolysis cells **70** is in a dry state or a dryable state based on, for example, the operation time of the water electrolysis stack **60**. It should be noted that the dry state of the anode **90** refers to a state where the amount of water in the anode **90** is less than a water amount threshold determined in advance.

[0085] In a case where the determination unit **204** determines that the anode **90** of each of the water electrolysis cells **70** is in a dry state or a dryable state (YES in step S**6**), the process proceeds to step S**7**. On the other hand, in a case where the determination unit **204** determines that the anode **90** of each of the water electrolysis cells **70** is not in a dry state or a dryable state (NO in step S**6**), the process proceeds to step S**8**.

[0086] In step S**7**, water is supplied to the anode **90** of each of the water electrolysis cells **70**. Specifically, the control unit **200** controls the on-off valve **186** to open the hydrogen gas introduction path **164**, and controls the on-off valve **184** to open the water supply path **162**. Then, the high-pressure hydrogen gas compressed by the compression stack **134** flows into the pressurizing chamber **176** from the hydrogen gas introduction path **164**, and presses the piston **170** toward the anode-side reservoir portion **174**. The water pushed by the piston **170** flows from the anode-side reservoir portion **174** into the anode chamber **120** of each of the water electrolysis cells **70** via the water supply path **162**. Consequently, water is supplied to the anode **90**. That is, the anode chamber **120** is filled with water. It should be noted that, in a case where the pressure of the hydrogen gas compressed by the compression stack **134** is higher than the pressure of the oxygen gas in the anode chamber **120** of each of the water electrolysis cells **70**, the piston **170** can be moved by the pressure of the hydrogen gas in the pressurizing chamber **176**. Moreover, in a case where the pressure of the hydrogen gas compressed by the compression stack **134** and the pressure of the oxygen gas in each of the water electrolysis cells **70** are close to each other, a differential pressure can be generated by reducing the electrolysis rate of the water electrolysis cell **70**.

[0087] When the supply of water to the anode **90** of each of the water electrolysis cells **70** is finished, the control unit **200** controls the on-off valve **186** to close the hydrogen gas introduction path **164**, and controls the on-off valve **184** to close the water supply path **162**. Thereafter, the process proceeds to step S**8**.

[0088] In step S**8**, the determination unit **204** determines whether or not the operation of the water electrolysis system **10** has been stopped. The control unit **200** stops the operation of the water electrolysis system **10** in a case of receiving a shutdown signal for the water electrolysis system **10**. In a case where the determination unit **204** determines that the operation of the water electrolysis system **10** has not been stopped (NO in step S**8**), the process proceeds to step S**2**. In a case where the determination unit **204** determines that the operation of the water electrolysis system **10** has been stopped (YES in step S**8**), the process proceeds to step S**9**.

[0089] In step S**9**, the determination unit **204** determines whether or not the anode chamber **120** is filled with water. Specifically, based on the voltage value or the resistance value between the cathode current collector **96** and the anode current collector **102** of each of the water electrolysis cells **70**, the determination unit **204** determines whether or not the anode chamber **120** of the water electrolysis cell **70** is filled with water. Further, the determination unit **204** may determine whether or not the anode chamber **120** of the water electrolysis cell **70** is filled with water based on, for example, the operation time of the water electrolysis stack **60**. It should be noted that a state where the anode chamber **120** is not filled with water refers to a state where the amount of water in the anode chamber **120** is less than a water amount threshold determined in advance.

[0090] In a case where the determination unit **204** determines that the anode chamber **120** is not filled with water (NO in step S**9**), the process proceeds to step S**10**. On the other hand, in a case where the determination unit **204** determines that the anode chamber **120** is filled with water (YES in step S**9**), the process proceeds to step S**11**.

[0091] In a case where the operation of the water electrolysis system **10** is being stopped, the hydrogen gas cannot be compressed by the compression device **50**, and therefore, the water stored in the anode-side reservoir portion **174** cannot be pressed by the piston **170** in some cases. It should be noted that no oxygen gas is generated in the anode chamber **120** of each of the water electrolysis cells **70**. In such a case, in step S**10**, water is supplied to the anode chamber **120** of the water electrolysis cell **70** by utilizing the potential energy. Specifically, the control unit **200** controls the on-off valve **184** to open the water supply path **162**. As a result, the water stored in the anode-side reservoir portion **174** can be dropped to the anode chamber **120** via the water supply path **162** by the potential energy (gravity). Thus, the anode chamber **120** can be filled with water. Thereafter, the process proceeds to step S**11**.

[0092] In step S**11**, the control unit **200** stops the operation of the fuel cell system **14**. According to this configuration, the state in which the anode **90** contacts with the oxygen gas during shutdown can be suppressed, and therefore, even during the shutdown, corrosion of the anode **90** of each of the water electrolysis cells **70** by the oxygen gas can be suppressed. Thereafter, the process shown in FIG. **4** is completed.

[0093] According to the present embodiment, the water generated in association with the power generation of the fuel cell stack **16** is supplied to the anodes **90** of the water electrolysis cells **70**, and the contact area of the water with the anodes **90** can therefore be increased. In other words, the contact area of the oxygen gas with the anodes **90** can be reduced. This can suppress corrosion of the anodes **90** of the water electrolysis cells **70** by the oxygen gas. Therefore, a more satisfactory water electrolysis system **10** and a more satisfactory energy system **12** can be provided.

[0094] The following supplementary notes are further disclosed in relation to the above-described embodiment.

Supplementary Note 1

[0095] The water electrolysis system (**10**) of the present disclosure includes: the water electrolysis device (**48**) including the membrane electrode assembly (**80**) formed by sandwiching the electrolyte membrane (**86**) between the anode (**90**) and the cathode (**88**), the water electrolysis device being configured to generate oxygen gas at the anode by supplying water to the cathode and electrolyzing the water; and the water supply device (**52**) configured to supply, to the anode, water generated in association with power generation of the fuel cell stack (**16**).

[0096] According to such a configuration, since the water generated in association with the power generation of the fuel cell stack is supplied to the anode of the water electrolysis device, the contact area of the water with the anode can be increased. In other words, the contact area of the oxygen gas with the anode can be reduced. This can suppress corrosion of the anode of the water electrolysis device by the oxygen gas. Therefore, a more satisfactory water electrolysis system can be provided.

Supplementary Note 2

[0097] In the water electrolysis system according to Supplementary Note 1, the pressure of the oxygen gas in the anode may be higher than the pressure of the water in the cathode.

[0098] According to such a configuration, hydrogen generated on the cathode side is less likely to permeate through the electrolyte membrane and move to the anode side, and thus oxygen with higher purity can be generated.

Supplementary Note 3

[0099] In the water electrolysis system according to Supplementary Note 1 or 2, the water supply device may include the anode-side reservoir portion (**174**) configured to store the water generated in association with the power generation of the fuel cell stack, and may supply the water stored in the anode-side reservoir portion to the anode during operation of the water electrolysis device.

[0100] According to such a configuration, it is possible to suppress deterioration due to an increase in resistance value associated with a shortage of the amount of water in the anode, which is caused by the water that has permeated through the electrolyte membrane being pushed back to the cathode side due to the differential pressure between the anode side and the cathode side during operation of the water electrolysis device.

Supplementary Note 4

[0101] In the water electrolysis system according to Supplementary Note 3, the water supply device may include the water introduction path (**160**) configured to connect the anode-side reservoir portion with the reservoir portion (**44**) configured to store water obtained by gas-liquid separation of the oxygen exhaust gas discharged from the fuel cell stack.

[0102] According to such a configuration, since the water stored in the reservoir portion of the fuel cell stack is guided to the anode-side reservoir portion via the water introduction path, it is possible to suppress flowing of the oxygen exhaust gas of the fuel cell stack into the anode-side reservoir portion together with the water.

Supplementary Note 5

[0103] The water electrolysis system according to Supplementary Note 3 or 4 may further include the compression device (**50**) including the compression cell (**144**) into which the hydrogen gas generated at the cathode is introduced, the compression cell being configured to compress the introduced hydrogen gas, wherein, during the operation of the water electrolysis device, the water supply device may pressure-feed the water stored in the anode-side reservoir portion to the anode using the pressure of the hydrogen gas compressed by the compression device.

[0104] According to such a configuration, the water stored in the anode-side reservoir portion can be supplied to the anode of the water electrolysis device by using the pressure of the hydrogen gas compressed by the compression device.

Supplementary Note 6

[0105] In the water electrolysis system according to Supplementary Note 5, the pressure of the hydrogen gas that is increased by the compression device may be higher than the pressure of the oxygen gas that is generated at the anode.

[0106] According to such a configuration, the water stored in the anode-side reservoir portion can be smoothly pressure-fed to the anode of the water electrolysis device by the pressure of the hydrogen gas compressed by the compression device.

Supplementary Note 7

[0107] In the water electrolysis system according to Supplementary Note 5 or 6, the water supply device may include the cylindrical portion (**168**) including the anode-side reservoir portion, the piston (**170**) provided in the cylindrical portion and configured to press the water stored in the anode-side reservoir portion, and the water supply path (**162**) configured to guide the water stored in the anode-side reservoir portion to the anode, and the hydrogen gas compressed by the compression device may press the piston to thereby pressure-feed the water stored in the anode-side reservoir portion to the anode via the water supply path.

[0108] According to such a configuration, the configuration of the water supply device can be simplified.

Supplementary Note 8

[0109] The water electrolysis system according to any one of Supplementary Notes 3 to 7 may further include the cathode-side reservoir portion (**58**) configured to store the water to be supplied to the cathode, wherein, in a case where the amount of water in the anode-side reservoir portion is less than a water amount threshold determined in advance, the water generated in association with the power generation of the fuel cell stack may be supplied to the anode-side reservoir portion without being supplied to the cathode-side reservoir portion, and in a case where the amount of water in the anode-side reservoir portion is equal to or greater than the water amount threshold, the water generated in association with the power generation of the fuel cell stack may be supplied to the cathode-side reservoir portion.

[0110] According to such a configuration, the water generated in association with the power generation of the fuel cell stack can be used for water electrolysis of the water electrolysis device. Further, the water generated in association with the power generation of the fuel cell stack is supplied to the anode-side reservoir portion in preference to the cathode-side reservoir portion, and therefore, the shortage of the water to be supplied to the anode of the water electrolysis device can be suppressed.

Supplementary Note 9

[0111] In the water electrolysis system according to any one of Supplementary Notes 3 to 8, the water supply device may supply the water stored in the anode-side reservoir portion to the anode during shutdown of the water electrolysis device.

[0112] According to such a configuration, it is possible to suppress corrosion of the anode by the oxygen gas during the shutdown of the water electrolysis device.

Supplementary Note 10

[0113] In the water electrolysis system according to any one of supplementary Notes 5 to 7, during the shutdown of the water electrolysis device, the water supply device may supply the water stored in the anode-side reservoir portion to the anode by using potential energy.

[0114] According to such a configuration, even in a case where hydrogen gas cannot be generated due to the shutdown of the water electrolysis device, the water stored in the anode-side reservoir portion can be supplied to the anode by using the potential energy.

Supplementary Note 11

[0115] In the water electrolysis system according to Supplementary Note 9 or 10, during the shutdown of the water electrolysis device, the water supply device may supply the water stored in the anode-side reservoir portion to the anode chamber (**120**) configured to accommodate the anode, to thereby fill the anode chamber with the water.

[0116] According to such a configuration, it is possible to suppress corrosion of the anode and the like accommodated in the anode chamber by the oxygen gas during the shutdown of the water electrolysis device.

Supplementary Note 12

[0117] The energy system (**12**) of the present disclosure includes the water electrolysis system according to any one of Supplementary Notes 1 to 11, and the fuel cell system (**14**) including the fuel cell stack.

[0118] According to such a configuration, a more satisfactory energy system can be provided.

[0119] Although the present disclosure has been described in detail, the present disclosure is not limited to the above-described individual embodiments. Various additions, replacements, modifications, partial deletions, and the like can be made to these embodiments without departing from the gist of the present disclosure or without departing from the gist of the present disclosure derived from the claims and equivalents thereof. Further, these embodiments can also be implemented in combination. For example, in the above-described embodiments, the order of operations and the order of processes are shown as examples, and are not limited to these. Furthermore, the same applies to a case where numerical values or mathematical expressions are used in the description of the above-described embodiments.

1. A water electrolysis system comprising:

a water electrolysis device including a membrane electrode assembly formed by sandwiching an electrolyte membrane between an anode and a cathode, the water electrolysis device being configured to generate oxygen gas at the anode by supplying water to the cathode and electrolyzing the water; and

a water supply device configured to supply, to the anode, water generated in association with power generation of a fuel cell stack.

2. The water electrolysis system according to claim **1**, wherein

a pressure of the oxygen gas in the anode is higher than a pressure of the water in the cathode.

3. The water electrolysis system according to claim **1**, wherein

the water supply device includes an anode-side reservoir portion configured to store the water generated in association with the power generation of the fuel cell stack, and supplies the water stored in the anode-side reservoir portion to the anode during operation of the water electrolysis device.

4. The water electrolysis system according to claim **3**, wherein

the water supply device includes a water introduction path configured to connect the anode-side reservoir portion with a reservoir portion configured to store water obtained by gas-liquid separation of an oxygen exhaust gas discharged from the fuel cell stack.

5. The water electrolysis system according to claim **3**, further comprising

a compression device including a compression cell into which hydrogen gas generated at the cathode is introduced, the compression cell being configured to compress the introduced hydrogen gas, wherein

during the operation of the water electrolysis device, the water supply device pressure-feeds the water stored in the anode-side reservoir portion to the anode using a pressure of the hydrogen gas compressed by the compression device.

6. The water electrolysis system according to claim **5**, wherein

the pressure of the hydrogen gas that is increased by the compression device is higher than a pressure of the oxygen gas that is generated at the anode.

7. The water electrolysis system according to claim **5**, wherein

the water supply device includes:

a cylindrical portion including the anode-side reservoir portion;

a piston provided in the cylindrical portion and configured to press the water stored in the anode-side reservoir portion; and

a water supply path configured to guide the water stored in the anode-side reservoir portion to the anode, and

the hydrogen gas compressed by the compression device presses the piston to thereby pressure-feed the water stored in the anode-side reservoir portion to the anode via the water supply path.

8. The water electrolysis system according to claim **3**, further comprising

a cathode-side reservoir portion configured to store the water to be supplied to the cathode, wherein

in a case where an amount of the water in the anode-side reservoir portion is less than a water amount threshold determined in advance, the water generated in association with the power generation of the fuel cell stack is supplied to the anode-side reservoir portion without being supplied to the cathode-side reservoir portion, and

in a case where the amount of the water in the anode-side reservoir portion is equal to or greater than the water amount threshold, the water generated in association with the power generation of the fuel cell stack is supplied to the cathode-side reservoir portion.

9. The water electrolysis system according to claim **3**, wherein

the water supply device supplies the water stored in the anode-side reservoir portion to the anode during shutdown of the water electrolysis device.

10. The water electrolysis system according to claim **5**, wherein

during shutdown of the water electrolysis device, the water supply device supplies the water stored in the anode-side reservoir portion to the anode by using potential energy.

11. The water electrolysis system according to claim **9**, wherein

during the shutdown of the water electrolysis device, the water supply device supplies the water stored in the anode-side reservoir portion to an anode chamber configured to accommodate the anode, to thereby fill the anode chamber with the water.

12. An energy system comprising:

the water electrolysis system according to claim **1**; and

a fuel cell system including the fuel cell stack.

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