(12) UK Patent (19) GB (11) 2582049 (13) B

(45) Date of B Publication **22.03.2023**

(54) Title of the Invention: Method for operating an electrolysis system and electrolysis system

(51) INT CL: ***C25B 1/02*** (2006.01) ***C25B 1/04*** (2021.01) ***C25B 15/00*** (2006.01) ***C25B 15/02*** (2021.01)

(21) Application No: **1918555.2**

(22) Date of Filing: **16.12.2019**

(30) Priority Data:
(31) **102018222388** (32) **20.12.2018** (33) **DE**

(43) Date of A Publication **09.09.2020**

(56) Documents Cited:
EP 3460104 A1
WO 2015/185039 A1
US 20200002822 A1
US 20120325654 A1
WO 2019/181004 A1
JP 2009289681 A
US 20170175277 A1

(58) Field of Search:
As for published application 2582049 A viz:
INT CL **C25B, H01M**
Other: **WPI, EPODOC, INTERNET**
updated as appropriate

Additional Fields
Other: **None**

(72) Inventor(s):
Peter Schuetzbach
Dietmar Steiner
Michael Stauch

(73) Proprietor(s):
Robert Bosch GmbH
(Incorporated in the Federal Republic of Germany)
Postfach 30 02 20, 70442 Stuttgart, Germany

(74) Agent and/or Address for Service:
AA Thornton IP LLP
Octagon Point, 5 Cheapside, London, EC2V 6AA,
United Kingdom

Fig. 1

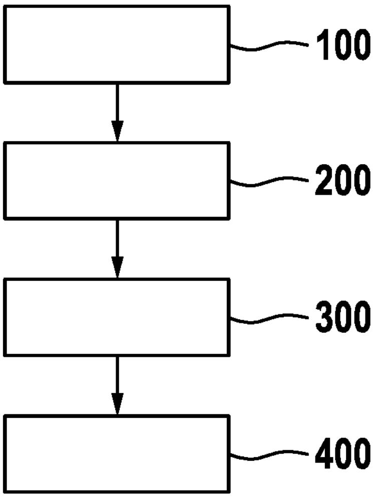

100
200
300
400

Fig. 2

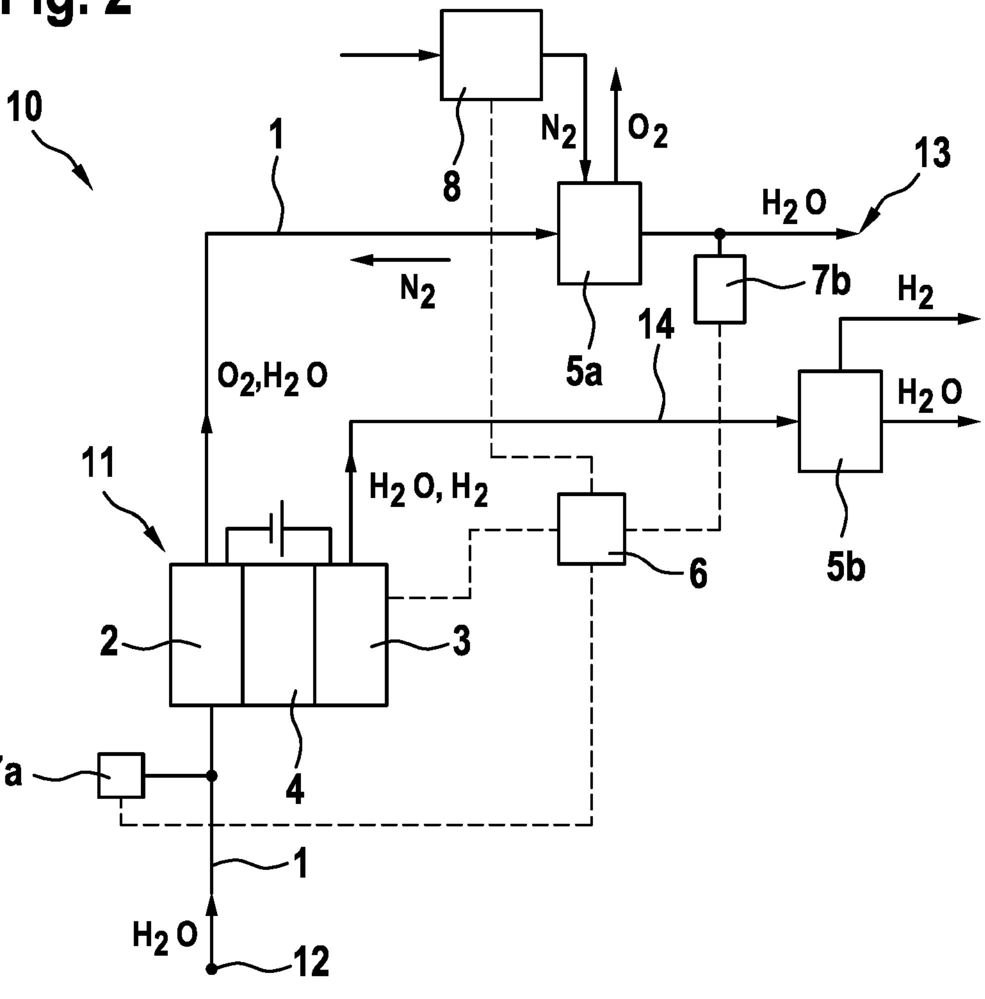

10
8
1
N_2
O_2
13
H_2O
N_2
7b
H_2
14
5a
O_2,H_2O
H_2O
11
H_2O, H_2
6
5b
2
3
4
7a
1
H_2O
12

Fig. 3

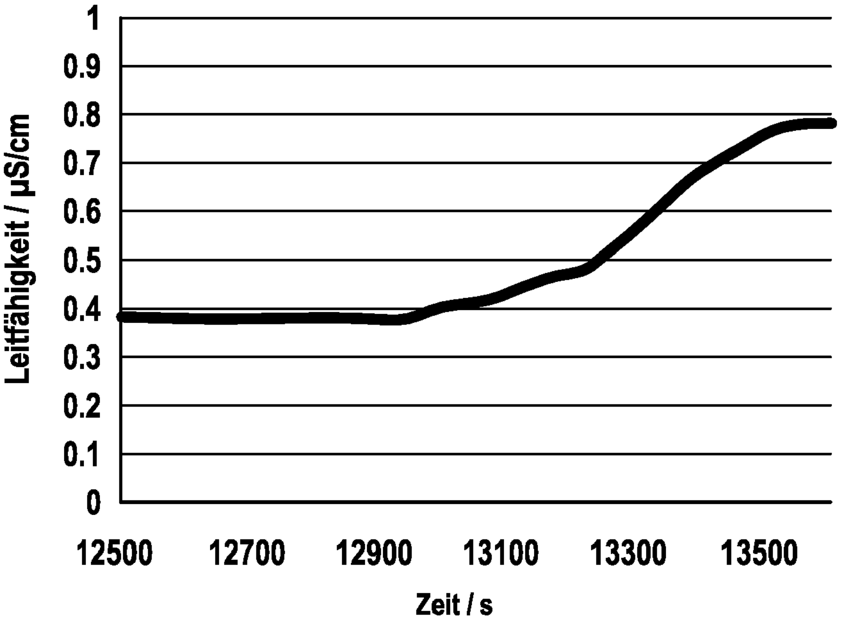
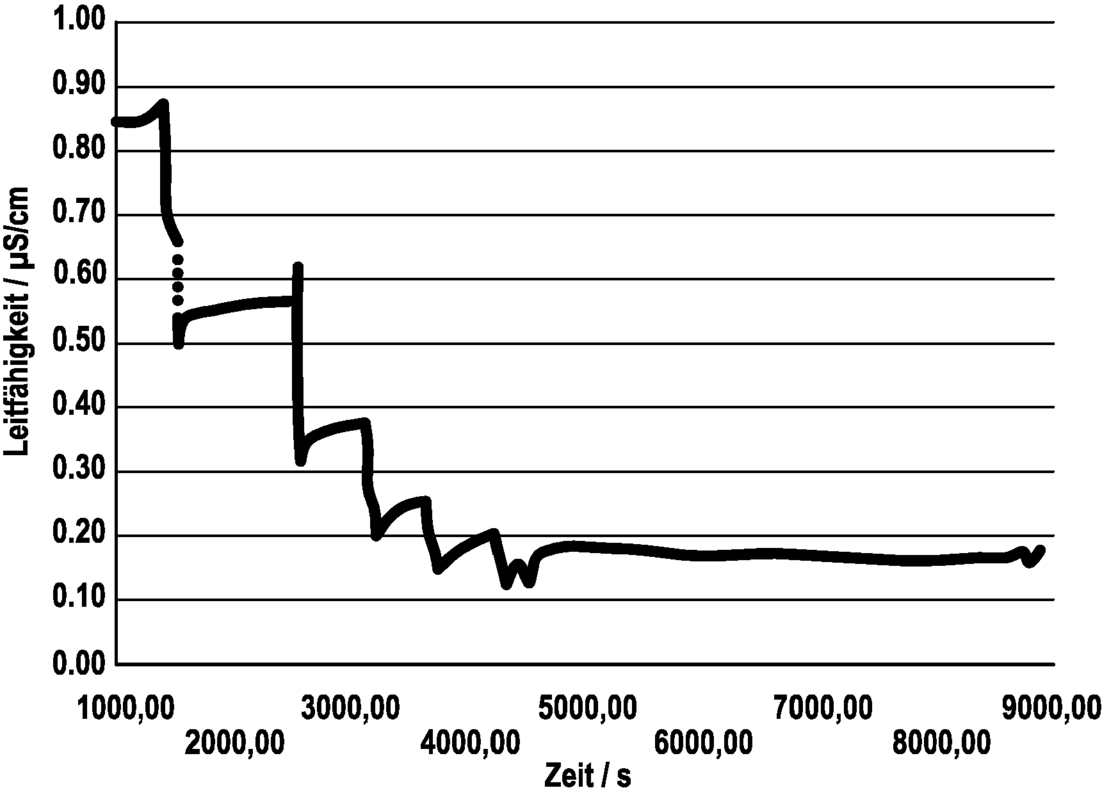

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Leitfähigkeit / µS/cm
12500
12700
12900
13100
13300
13500
Zeit / s

Fig. 4


1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Leitfähigkeit / µS/cm
1000,00
2000,00
3000,00
4000,00
5000,00
6000,00
7000,00
8000,00
9000,00
Zeit / s

Description

Title

Method for operating an electrolysis system and electrolysis system

Prior art

Various options for circulating gas inside a water electrolysis system are known from the prior art.

EP 3 336 947 A1 discloses flushing a water electrolysis system with nitrogen during operation if a leak occurs.

Disclosure of the invention

Based on a first aspect, this invention relates to a method for operating an electrolysis system having an electrolysis block based on a proton exchange membrane (PEM). In particular, an electrolysis block should be understood as meaning an arrangement having an anode, which may comprise nickel and/or iridium and/or platinum and/or palladium for example, the cathode and a proton exchange membrane which is disposed between the anode and a cathode. For example, an electrolysis block may also comprise an anode/proton exchange membrane/cathode arrangement as described above, stacked one above the other. The metals which may be used for the cathode are the same metals (e.g. nickel and/or iridium) as those already specified for the anode. The proton exchange membranes used may be known Nafion membranes in particular. The cathode respectively anode metals may also be applied to a base material. Carbon black and/or activated carbon and/or carbon nanotubes and/or graphene and/or graphite in particular may be used as base materials. In particular, an "electrolysis system" should be understood as having, in addition to an electrolysis block, a peripheral system which feeds deionized water having a low conductivity, for example < 0.2 µS/cm, to the electrolysis block, for example, and a system for processing resultant gases connected downstream of the electrolysis block. An electrolysis system may also comprise a cooling circuit as well as a gas-liquid separator configured to separate water from the resultant H_2 and/or O_2 gases, as well as a system for processing waste heat. In particular, the deionized water fed to the electrolysis block on the anode side respectively via an anode-side flow path is oxidised at the anode and converted to oxygen. In particular, the protons thus generated migrate through the proton exchange membrane to the cathode and the protons are reduced to hydrogen gas at the cathode. The method proposed by the invention comprises flushing an anode-side flow path of the electrolysis system with nitrogen and/or an inert gas up to an instant of electrochemical activation of the electrolysis block. By "flushing" in this context is meant that the gas atmosphere in contact with the deionized water within the anode-side flow path is flushed with a gaseous nitrogen volume flow and/or an inert gas volume flow, in particular comprising helium, argon and/or xenon, in order to remove atmospheric air containing carbon dioxide from the anode-side flow path, thereby preventing an increase in conductivity due to an introduction of CO_2 and due to corresponding chemical balances of resultant $H^+_{(aq)}$ and $carbonate_{(aq)}$ ions. An "instant of electrochemical activation of the electrolysis block" in this context may be understood as meaning the instant at which a voltage enabling the electrochemical reaction of the water electrolysis described above is applied inside the electrolysis block between the cathode and anode in order to obtain hydrogen gas and oxygen gas. An "anode-side flow path" in this context may be understood as meaning a flow route upstream of the electrolysis block across which a volume flow of deionized water is fed to an anode side of the electrolysis block. The anode-side flow path further comprises an anode chamber comprising a proton exchange membrane and an anode, the deionized water being fed through the anode chamber as it is subjected to an oxidation reaction. Furthermore, the anode-side flow path may be understood as also being a flow path connected downstream of the electrolysis block which is configured in particular to feed the oxygen gas generated at the anode and the excess deionized water to a gas separator in which oxygen is separated from the deionized water. In particular, up to the instant of electrochemical activation, an air atmosphere in contact with the deionized water within the anode-side flow path of the electrolysis system is flushed with gaseous nitrogen in order to prevent an increase in conductivity due to carbonate$_{(aq)}$ ions and $H^+_{(aq)}$ ions that would occur as a result of a balance reaction of carbon dioxide in the deionized water. In this manner, carbon dioxide can be substantially removed from the anode-side flow path before electrochemical activation of the electrolysis block, as a result of which an electrical conductivity measurement of the deionized water is not impaired by carbonate$_{(aq)}$ ions and/or $H^+_{(aq)}$ ions that would result from the balance reaction of CO_2 with the deionized water. In this manner, it can be accurately assumed that an increase in the electrical conductivity of the deionized water can only come about due to the introduction of metal. As already described above, such introduction of metal can lead to contamination of the cathode and/or anode catalyst metals. In this manner, activation in the presence of a metal contaminating one of the anode- and/or cathode catalysts can be detected as rapidly as possible, thereby ultimately increasing the service life of the electrolysis system by implementing other preventive measures. For example, if metal ions were introduced into the deionized water, activation could be put off to allow the deionized water and/or parts of the electrolysis system to be replaced. In addition, CO_2 adsorber cartridges can be dispensed with, these being an additional part susceptible to wear. Moreover, in the event of a leak within the electrolysis system, the method proposed by the invention enables CO_2 to be efficiently removed, regardless of the location of its occurrence. In this connection, this invention satisfies the stipulation that modern electrolysis systems based on proton exchange membranes require extremely deionized (DI) water as a reactant for the electrochemical water splitting process. The electrical conductivity of the water σ is largely linearly correlated to its ion concentration (see formula 1), as the skilled person knows. σ is therefore applied as a measure of the quality of the (DI) water.

$1\ \mu S/cm \sim 5.34\ \mu mol/l$ (formula 1)

Electrolysis systems available on the market today must be operated with DI water having an electrical conductivity of $\sigma < 0.2\ \mu S/cm$. Such an electrical conductivity is therefore close to the threshold of the autoprotolysis of water which, in the case of water totally free of ions at 25 ° C, causes a conductivity of $\sigma = 0.055\ \mu S/cm$. Due to the nitrogen flushing proposed by the invention, it is possible to operate below the electrical conductivity threshold of $\sigma = 0.2\ \mu S/cm$. The DI water cannot be circulated in a closed circuit because the DI water has to be separated from electrochemically produced oxygen and/or hydrogen in a gas-liquid separator, for example. The DI water may therefore be exposed to an atmosphere containing CO_2 (e.g. ambient air). Due to the ambient air, CO_2 molecules can be introduced into the DI water, thereby enabling carbonic acid

($H_2CO_{3(aq)}$) to form which allows the ion concentration and hence the electrical conductivity of the deionized water to rise due to splitting into 2 $H^+_{(aq)}$ and the carbonate ion, $CO_3^{2-}{}_{(aq)}$. If DI water is exposed to the ambient atmosphere in the gas-liquid separator of an electrolysis system (which contains 400 ppm CO_2, for example) the conductivity of the DI water will rise, in particular to $\sigma = 0.8$ to 1.1 µS/cm. However, by flushing with nitrogen until electrochemical activation of the electrolysis block as proposed by the invention, CO_2 can be eliminated from the electrolysis system, in particular from the anode-side flow path. In this manner, due to corresponding balance reactions, the ions resulting from the carbonic acid can also be removed, which results in a drop in conductivity. The quality of the DI water in water electrolysis systems is monitored using electrical conductivity measurements. Due to conductivity measurements, therefore, it is possible as proposed by the invention, to rule out carbonate$_{(aq)}$ ions and $H^+_{(aq)}$ ions and detect contaminants such as metal$_{(aq)}$ ions which put the system at risk. Due in particular to the low pH value of the deionized water, metal ions can become detached from the pipework of the electrolysis system and be transported with the deionized water to electrodes. Since electrodes of a PEM water electrolysis system typically contain nickel and/or iridium, the electrodes can be contaminated, i.e. deactivated, by such contaminants, such as iron$_{(aq)}$ ions for example. This is one of the most frequent causes of reduced service life of present-day water electrolysis systems. To prevent carbonate$_{(aq)}$ ions from being mistaken for metal$_{(aq)}$ ions during the electrical conductivity measurement, the atmosphere above the DI water in current systems is kept free of CO_2 by directing ambient air flowing downstream through a CO_2 adsorber cartridge as the produced oxygen is drawn off. However, these cartridges constitute a part that is susceptible to wear. Furthermore, CO_2 can also get into the DI water circuit of an electrolysis system through small leakage points. As proposed by the invention, therefore, it can be reliably ascertained whether damaging metal ions are present in the DI water circuit, in particular in the anode-side flow path, without using additional parts that are susceptible to wear. Accordingly, the advantage of this invention is that damaging metal ions can be detected at an early stage prior to activation. Appropriate steps can therefore be taken to remove the metal ions. For example, the DI water can be replaced. As a result of the method proposed by the invention, the service life of the electrolysis system overall can be significantly increased. Based on the invention, one of the most frequent causes of shorter service life in modern electrolysis systems can therefore be significantly reduced.

The dependent claims specify preferred embodiments of the invention.

Based on one advantageous embodiment, the method proposed by the invention comprises the step of flushing the anode-side flow path of the electrolysis system with nitrogen and/or inert gas during a period of electrochemical operation of the electrolysis block. In other words, in addition to being flushed prior to activation, the anode-side flow path is also flushed during operation of the electrolysis block. The particular advantage of this is that contamination of the deionized water due to the occurrence of metal ions can also be reliably detected during electrochemical operation, i.e. during the water electrolysis process, because carbon dioxide is also reliably removed from the system during electrochemical operation of the electrolysis block.

Based on another advantageous embodiment of the method proposed by the invention, flushing during electrochemical operation or prior to electrochemical activation of the electrolysis block may be operated in counterflow to or in parallel flow with the volume flow of deionized water. In this connection, it goes without saying that the volume flow of deionized water within the anode-side flow path is precisely of such a size that a gas atmosphere is able to flush the deionized water and a parallel flow and/or counterflow of a nitrogen volume flow and/or of an inert gas volume flow is therefore possible. In particular, a volume flow of the deionized water may be 5 Nl/min to 20 Nl/min, in particular 8 Nl/min to 13 Nl/min. Furthermore, a volume flow of the nitrogen and/or inert gas may be 2 Nl/min to 6 Nl/min, in particular 5 Nl/min. “Nl” in the current context should be taken as meaning normal litre in accordance with the conventional physics definition. If operating in parallel flow, a flow control system, in particular a mass flow controller, may be disposed upstream of the electrolysis block for example. In this connection, the nitrogen and/or the inert gas may be fed to the anode-side flow path through a flow passage for example. If operating in counterflow in particular, a flow control system, for example a mass flow controller, may be disposed on a gas-liquid separator and connected to a flow passage directing fluid to the anode flow path for example. In particular, it should be noted in this context that a nitrogen volume flow and/or an inert gas volume flow which is directed via an anode-side flow path is not transported through the proton exchange membrane into the cathode-side flow path because high pressures, in particular 20 to 30 bar, can prevail on the side of the cathode within the electrolysis block during electrochemical operation due to the resultant hydrogen gas. In addition, the proton exchange membrane may be designed so as to be non-permeable to nitrogen and/or inert gases.

Based on one advantageous variant, the method proposed by the invention comprises a step of thinning an oxygen gas produced at the anode of the electrolysis block during electrochemical operation. For example, such thinning may take place inside the anode-side gas-liquid separator. In particular, the oxygen gas inside a gas-liquid separator can be thinned by four times the nitrogen or inert gas quantity. If thinning with the aid of nitrogen, the result in particular is artificial air with a ratio by volume of 80% nitrogen and 20% oxygen. Such a mixture can be discharged to the environment without further risk because the explosivity caused by oxygen is reduced by the thinning process.

Based on another advantageous embodiment of the method proposed by the invention, the anode-side flow path outside the electrolysis block is run through a gas-liquid separator, the gas-liquid separator being connected downstream of the electrolysis block by reference to the volume flow of deionized water. In particular, a flow passage through which nitrogen can be fed fluidically communicates with the gas-liquid separator. For the gas-liquid separator, any gas-liquid separators of the type used in water electrolysis systems known to the skilled person may be used. For example, it would be conceivable to use gas-liquid separators in which ambient air can penetrate, as a result of which the gas-liquid separators are potentially exposed to the introduction of CO_2.

Based on another advantageous embodiment, the method proposed by the invention comprises the step of measuring an electrical conductivity of the deionized water upstream of and/or downstream of and/or inside the electrolysis block, the measurement upstream and downstream being by reference to the volume flow of deionized water. The electrical conductivity may be measured by means of measuring systems that are known to the skilled person per se. The advantage of measuring the electrical conductivity prior to electrochemical activation and/or during electrochemical operation of the electrolysis system in particular is that due to the flushing operation, carbonate$_{(aq)}$ ions and/or $H^{+}_{(aq)}$ ions which might be present due to the potential introduction of CO_2 can be ruled out based on the measured electrical conductivity. Accordingly, a rise in electrical conductivity can only come about due to a metal ion that has become detached from a pipe wall or some other device of the anode-side flow path, for example. In addition to metals which can contaminate the anode or cathode in particular, leaching effects may also occur whereby metals are washed out of the anode for example. By measuring the electrical conductivity of the deionized water downstream, it can be ascertained that leaching of the anode has occurred for example, whereas a measurement upstream of the electrolysis block will not show up a rise in electrical conductivity for example.

Based on another advantageous embodiment of the method, electrochemical activation of the electrolysis block may not take place in particular unless the electrical conductivity of the deionized water is less than 0.4 µS/cm, in particular equal to 0.2 µS/cm. In this manner, the quality of the deionized water can be guaranteed and the presence of a critical foreign metal ion concentration within the deionized water can therefore also be ruled out. A safe electrochemical activation of the electrolysis block can therefore be guaranteed without the risk of catalyst metal being contaminated. This may be used to increase service life.

Based on another advantageous embodiment, an electrochemical deactivation of the electrolysis block may take place if the electrical conductivity is greater than 0.6 µS/cm in spite of continuous flushing. Continuous flushing means that it can be specifically assumed that any introduction of CO_2 into the deionized water is out of the question. Accordingly, a rise in electrical conductivity in spite of continuous flushing can only be caused by the fact that foreign metal ions and/or ions washed out of the catalyst materials have got into the deionized water. To prevent detrimental impairment to service life, therefore, the electrolysis block can be taken out of operation.

Based on another advantageous variant of the method proposed by the invention, flushing may be interrupted as long as the electrical conductivity is less than 0.3 µS/cm. This obviates the need to run a continuous flushing operation with an inert gas and/or nitrogen gas. In this manner, a saving can be made on gas needed for flushing. This saving on materials also enables the operating costs of the electrolysis system to be reduced. However, as soon as the electrical conductivity is 0.3 µS/cm or higher, flushing is resumed during operation and/or prior to electrochemical activation.

The following aspect of the invention comprises the aforementioned advantageous embodiments as well as features and technical effects and advantages of the first inventive aspect accordingly. To avoid repetition, these will therefore not be described again.

Based on a second aspect, this invention relates to an electrolysis system. This electrolysis system comprises an electrolysis block based on a proton exchange membrane and an anode-side flow path, the course of which runs through the electrolysis block as already described above. The electrolysis system further comprises a measuring unit, in particular a conductivity measuring device known to the skilled person, and the measuring unit is configured to measure an electrical conductivity of the deionized water upstream of and/or downstream of and/or within the anode-side flow path. As described above, the measuring unit may therefore be disposed upstream of and/or downstream of and/or inside the electrolysis block. The electrolysis system further comprises a flow control system, for example a controllable needle valve and/or a mass flow controller, which is configured to control flushing of the anode-side flow path with nitrogen and/or inert gas until electrochemical activation and/or during electrochemical operation of the electrolysis block. The electrolysis system further comprises an evaluation unit, in particular a CPU and/or a microcontroller and/or an electrical control device. This evaluation unit is configured to communicate electronically with the measuring device and receive values of the measuring unit. The evaluation unit is configured to control flushing by the flow control system depending on the corresponding electrical conductivity value measured by the measuring unit. For example, the evaluation unit may prompt a flow control system to flush the anode-side flow path with nitrogen and/or an inert gas in order to reduce the electrical conductivity respectively introduction of CO_2 into the deionized water. For example, the evaluation unit may also be configured to prompt deactivation of the electrolysis system if a conductivity value rises above a value of 0.6 µS/cm in spite of continuous flushing for example. For example, deactivation may be carried out with effect from a threshold value of > 0.2 µS/cm. Furthermore, the range of ≤ 0.2 µS/cm may be suitable for an activation.

Brief description of the drawings

Examples of embodiments of the invention will be described in detail below with reference to the accompanying drawings. Of the drawings:

Figure 1	is a flow diagram based on one embodiment of the method proposed by the invention;
Figure 2	shows an embodiment of the electrolysis system proposed by the invention;

Figure 3	shows a conductivity curve after completion of a flushing operation; and
Figure 4	is a diagram plotting a conductivity curve during permanent flushing.

Embodiments of the invention

Figure 1 is a flow diagram illustrating an embodiment of the method proposed by the invention. In a first step 100, the anode-side flow path 1 of the electrolysis system is flushed with nitrogen until an instant of electrochemical activation of the electrolysis block 11. The electrolysis block 11 will be explained in more detail later. The anode-side flow path 1 runs through the electrolysis block 11 and comprises, inside the electrolysis block 11, an anode 2 and a proton exchange measuring membrane 4. Furthermore, the anode-side flow path 1 is configured to circulate a volume flow of deionized water. During the first step 100, however, a volume flow of deionized water is not generated during flushing in particular. The deionized water is typically already located in the electrolysis system 10 respectively in the anode-side flow path 1 and the ambient air likewise contained in the anode-side flow path 1 is removed by flushing with nitrogen during the first step 100. In a second step 200, an electrical conductivity of the deionized water located in the anode-side flow path 1 is measured. The measuring operation based on the second step 200 takes place during flushing, in particular to determine a conductivity at which the electrolysis block 11 can be placed in operation. In particular, an electrochemical activation takes place, i.e. a commencement of water electrolysis, by applying an electric voltage to the electrolysis block 11 when the electrical conductivity of the deionized water is less than 0.4 µS/cm. When there is a drop below this value of electrical conductivity, an electrochemical activation of the electrolysis block 11 will follow. During electrochemical operation of the electrolysis block 11 respectively during a period of electrochemical operation of the electrolysis block 11, the anode-side flow path 1 of the electrolysis system is flushed again in a third step 300. In particular, the flushing operation may be operated via a nitrogen intake line into the gas-liquid separator 5 of the anode-side flow path 1. Accordingly, flushing in the third step 300 is operated in counterflow to the volume flow of deionized water which is introduced into the anode-side flow path 1. Accordingly, in a fourth step 400, an oxygen gas produced at the anode 2 of the electrolysis block 11 during electrochemical operation is thinned inside the gas-liquid separator 5 in order to thin the oxygen that is discharged to the atmosphere to a volume ratio such as that also present in atmospheric air.

Figure 2 illustrates an embodiment of an electrolysis system 10 proposed by the invention. The electrolysis system 10 proposed by the invention may be an electrolysis system per se. Furthermore, the electrolysis system 10 proposed by the invention may also be part of a complex of electrolysis systems. The electrolysis system 10 proposed by the invention comprises an electrolysis block 11 which comprises an anode 2 as well as a proton exchange membrane 4 and a cathode 3. Iridium and/or nickel on carbon nanotubes in particular may be used as the cathode material. The same materials may also be used for the anode 2. The proton exchange membrane 4 may be a Nafion membrane, for example. Nafion in this instance is a perfluorinated copolymer having sulphonic acid groups in particular. Also illustrated is an anode side flow path 1 which is configured to circulate a volume flow of deionized water. The deionized water H_2O is fed via an inlet 12 to the anode-side flow path 1. The anode-side flow path 1 runs upstream by reference to a deionized water flow through the anode side of the electrolysis block 11 and downstream of the electrolysis block 11 through to a gas-liquid separator 5 by means of which the oxygen gas which occurs during electrochemical operation of the electrolysis system 10 and generated at the anode 2 is discharged to the environment. Deionized water is also fed out from the gas-liquid separator 5 after having been separated from the oxygen gas. The deionized water which leaves via an outlet 13 can be fed via a closed-loop back to the inlet 12. During electrochemical operation of the electrolysis block 11, O_2 gas is generated at the anode 2 due to oxidation of the deionized water. The protons generated during this oxidation migrate through the proton exchange membrane 4 to the cathode 3. During this migration, water molecules of the deionized water H_2O likewise migrate to the cathode side to the cathode 3. This phenomenon is referred to "osmotic drag" in particular. At the cathode 3, therefore, hydrogen gas is generated by the reduction of the $protons_{(aq)}$. Hydrogen and the deionized water H_2O are fed via a cathode-side flow path 14 into a second gas-liquid separator 5b where hydrogen gas H_2 is separated from the deionized water H_2O. A first measuring unit 7a for measuring the electrical conductivity of the deionized water H_2O is disposed upstream by reference to a volume flow of the deionized water H_2O in the anode-side flow path 1. A second measuring unit 7b for measuring electrical conductivity is disposed downstream of the first gas-liquid separator 5a. The electrolysis system 10 proposed by the invention further comprises a mass flow controller 8 which is configured to control a nitrogen volume flow into the gas-liquid separator 5a and upstream of the cathode-side flow path 1 by reference to a volume flow of the deionized water. The first and second measuring units 7a, 7b as well as the mass flow controller 8 are controlled by an evaluation unit 6, e.g. a CPU and/or a microcontroller and/or an electronic control unit. For example, if too high an electrical conductivity prevails at one of the first and second measuring units 7a, 7b, the evaluation unit 6 can prompt activation of the mass flow controller 8, causing a nitrogen flow opposite the flow direction of the deionized water in order to remove CO_2 from the electrolysis system 10 and/or to prepare the electrolysis system 10 for activation. If too high an electrical conductivity value is measured at one of the measuring units 7a, 7b in spite of continuously flushing the anode-side flow path 1 with nitrogen gas, the evaluation unit 6 may also control a deactivation of the electrolysis block 11 because foreign metal ions have got into the deionized water in such a case.

Figure 3 is a diagram plotting the electrical conductivity of the deionized water (ordinate) over a measuring time (abscissa). The diagram relates to an operating mode of the electrolysis system 10 proposed by the invention. During electrochemical operation of the electrolysis system 10 proposed by the invention, nitrogen flushing takes place until second 12500. At the end of the nitrogen flushing operation, the electrical conductivity of the deionized water rises due to the introduction of carbon dioxide gas from the ambient air, in particular via the gas-liquid separator 5a of the cathode-side flow path 1.

Figure 4 is a diagram illustrating an achievable deionized water quality in the case of permanent flushing with nitrogen gas. In particular, the electrical conductivity (ordinate) is plotted over the measuring time (abscissa). At the start of a nitrogen flushing operation, in particular prior to electrochemical activation, the electrical conductivity of the deionized water is virtually 1.00 µS/cm due to carbonate and protons$_{(aq)}$ resulting from the introduction of carbon dioxide. During a permanent nitrogen flushing operation with effect from second 1000, the electrical conductivity of the deionized water is further reduced due to the removal of CO_2. Similarly, due to the corresponding balances familiar to the skilled person, the $\text{carbonate}_{(aq)}$ and $H^+_{(aq)}$ ions dissolved in the deionized water are converted back to CO_2 which is also removed. In this manner, a conductivity of less than 0.2 µS/cm is achieved due to the permanent nitrogen flushing operation, in particular until second 9000 as illustrated. The electrical conductivity values of the deionized water, shown in Figures 3 and 4, were measured respectively at 300 K. In particular, the flushing duration may depend on the volume of liquid in the system. In a laboratory system having a 10 kW electrolyser, this may typically be 1 to 5 minutes per cycle.

Claims

1. Method for operating an electrolysis system (10) having an electrolysis block (11) based on a proton exchange membrane comprising the step:
   - flushing (100) an anode-side flow path (1) of the electrolysis system with nitrogen and/or an inert gas up to an instant of electrochemical activation of the electrolysis block (11), the anode-side flow path (1) running through the electrolysis block (11) and having an anode (2) and a proton exchange membrane (4) inside the electrolysis block (11), and the anode-side flow path (1) is configured to circulate a volume flow of deionized water and further comprising the step of flushing the anode-side flow path (1) of the electrolysis system with nitrogen and/or inert gas during a period of an electrochemical operation of the electrolysis block (11).

2. Method as claimed in claim 1, whereby flushing takes place in counterflow to or in parallel flow with the volume flow of the deionized water.

3. Method as claimed in claim 1 further comprising the step of
   - thinning an oxygen gas produced at the anode (2) of the electrolysis block (11) during electrochemical operation.

4. Method as claimed in one of the preceding claims, whereby the anode-side flow path (1)

outside the electrolysis block (11) runs through
a gas-liquid separator (5) connected downstream of the electrolysis block (11) by reference to the volume flow of deionized water.

5. Method as claimed in one of the preceding claims further comprising the step of measuring (200) an electrical conductivity of the deionized water upstream of and/or downstream of and/or inside the electrolysis block (11), the measurement upstream and downstream being by reference to the volume flow of deionized water.

6. Method as claimed in claim 5, whereby electrochemical activation of the electrolysis block (11) takes place when the electrical conductivity of the deionized water is less than 0.4 µS/cm.

7. Method as claimed in claim 5 or 6, whereby an electrochemical deactivation of the electrolysis block (11) takes place if the electrical conductivity is greater than 0.6 µS/cm in spite of continuous flushing.

8. Method as claimed in claim 7, whereby flushing is interrupted whilst the electrical conductivity is less than 0.3 µS/cm.

9. Electrolysis system (10) comprising:

- an electrolysis block (11) based on a proton exchange membrane having an anode (2) and a proton exchange membrane (4) inside the electrolysis block (11),
- an anode-side flow path (1)
- a measuring unit (7a, 7b) configured to measure an electrical conductivity of deionized water within the anode-side flow path (1), and
- a flow control system configured to control flushing of the anode-side flow path (1) with nitrogen and/or an inert gas until electrochemical activation and during electrochemical operation of the electrolysis block (11), and
- an evaluation unit (6) configured to communicate electronically with the measuring unit (7a, 7b) and control flushing by the flow control system depending on the electrical conductivity, wherein the anode-side flow path (1) of the electrochemical system is flushed with nitrogen and/or inert gas during a period of an electrochemical operation of the electrolysis block (11).