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## (54) ELECTROLYSIS ARRANGEMENT AND METHOD

(57) Electrolysis arrangement (1) comprising:
- a pump unit (2),
- multiple stacks (3),
- an anode separator (9),
- a cathode separator (13),
- a primary cooler (22) for cooling the medium arranged between the pump unit (2) and the stack inlets (4a,4b), and
- a bypass (18) from between the pump unit (2) and the primary cooler (22) to the anode separator (9) and/or to the cathode separator (13).

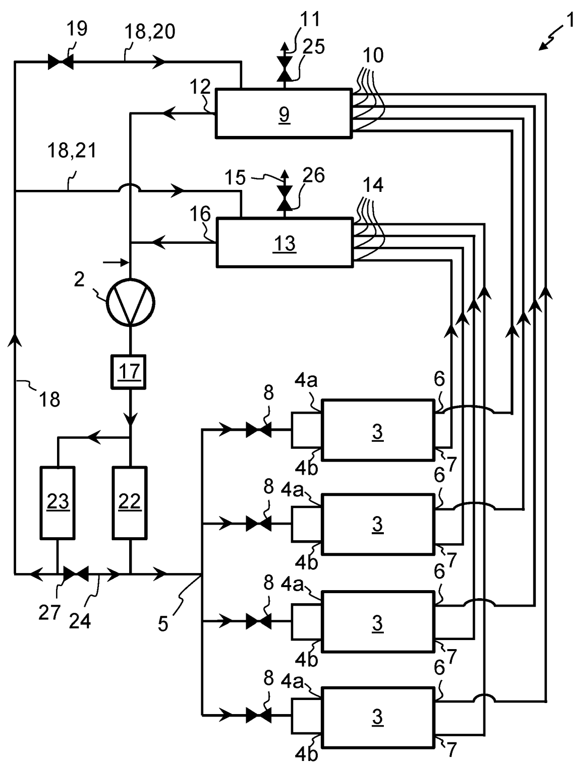


Fig. 1

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## Description

**[0001]** The invention is directed to an electrolysis arrangement and a method for performing an electrolysis.

**[0002]** Electrolysis processes consume a significant amount of energy. For this reason, electrolysis plants favour low cost renewable power generation from solar photovoltaic installations in areas of high solar incident radiation. Unfortunately, these locations are also lacking significiant quanities of clean water. In known electrolysis processes, a large amount of energy is converted to low grade heat, which is removed from the process by means of cooling water. It is, therefore, desired to reduce the consumption of cooling water.

**[0003]** The object of the invention is to improve the prior art so that consumption of cooling water can be reduced in a particularly efficient manner.

**[0004]** The object is solved with the electrolysis arrangement and the method according to the independent claims. Advantageous refinements are presented in the dependent claims. The features described in the claims and in the description can be combined with each other in any technologically reasonable manner.

**[0005]** According to the invention an electrolysis arrangement is presented that comprises:

- a pump unit for driving a medium,
- multiple stacks of electrolysis cells, wherein each stack comprises a respective stack inlet connected to the pump unit, a respective anode outlet and a respective cathode outlet, wherein the stacks are configured to obtain by electrolysis of the medium introduced into the respective stack inlet an anode product provided together with the medium at the respective anode outlet and a cathode product provided together with the medium at the respective cathode outlet,
- an anode separator having an anode separator medium outlet that is connected to the pump unit, wherein each of the anode outlets of the stacks is connected to a respective anode separator inlet of the anode separator, and wherein the anode separator is configured to separate the anode product from the medium introduced into the anode separator inlets such that the anode product is provided at an anode separator product outlet and the medium is provided at the anode separator medium outlet and,
- a cathode separator having a cathode separator medium outlet that is connected to the pump unit, wherein each of the cathode outlets of the stacks is connected to a respective cathode separator inlet of the cathode separator, and wherein the cathode separator is configured to separate the cathode product from the medium introduced into the cathode separator inlets such that the cathode product is provided at a cathode separator product outlet and the medium is provided at the cathode separator medium outlet,
- a primary cooler for cooling the medium arranged between the pump unit and the stack inlets,
- a bypass from between the pump unit and the primary cooler to the anode separator and/or to the cathode separator.

**[0006]** The electrolysis arrangement can be used for electrolysis of a medium. Instead of the term "electrolysis arrangement" also the term "electrolyser" could be used. Preferably, the medium is water. In that case hydrogen and oxygen can be obtained as electrolysis products. The electrolysis arrangement is intended to be used for an industrial scale electrolysis. For example, it is preferred that at least one of the electrolysis products is obtained at a rate of 250 to 1500 $Nm^3$ per hour per stack. This applies, in particular, to the production of hydrogen in the case of water electrolysis. The electrolysis is preferably performed in an automated way.

**[0007]** The electrolysis arrangement comprises multiple stacks. Preferably, the electrolysis arrangement comprises 2 to 16 stacks, in particular 2, 4 or 8 stacks. The stacks can also be referred to as electrolysis stacks. Each of the stacks comprises several electrolysis cells. Each stack has at least one stack inlet, an anode outlet and a cathode outlet. The medium can be provided to the stack via the stack inlet(s). Within the stack the electrolysis of the medium can be performed using the electrolysis cells. Thereby, an anode product and a cathode product are obtained. In the case of water as the medium the anode product is oxygen and the cathode product is hydrogen. The anode product can be extracted from the stack via the anode outlet. Thereby, however, the anode product will be mixed with the medium. Analogously, a mixture of the cathode product and the medium can be extracted from the stack via the cathode outlet.

**[0008]** Each of the electrolysis cells preferably comprises an anode, an anode space adjacent to the anode, a cathode and a cathode space adjacent to the cathode. The cathode space is preferably separated from the anode space by a membrane and, optionally also by the anode and the cathode. The anode outlet is preferably connected to the anode space. The cathode outlet is preferably connected to the cathode space. The membrane is preferably permeable for certain ions. For example, in the case of PEM electrolysis cells the membrane is preferably permeable for hydrogen ions ($H^+$). In that case the anode and the cathode are permeable and arranged adjacent to the membrane. Also in this case it is preferred that each stack has only one stack inlet, which is connected to the cathode space. As a further example, in the case of alkaline electrolysis cells, the membrane is preferably permeable for hydroxide ions (OH). In that case each of the stacks has preferably two stack inlets: a respective anode stack inlet and a respective cathode stack inlet. The anode stack inlet is preferably connected to the anode space. The cathode stack inlet is preferably connected to the cathode space.

**[0009]** The electrolysis arrangement further comprises an anode separator and a cathode separator. The following description applies to both the anode separator and the cathode separator. The separators are configured for separating the electrolysis products from the medium. The separators have a respective separator inlet, a respective separator product outlet and a respective separator medium outlet. If a mixture of the product and the medium is provided at the separator inlet, the mixture is separated within the separator such that only the majority of the medium (that is >99%mol) is provided at the separator medium outlet and only the majority of the product (that is >99%mol) is provided at the separator product outlet. The medium is preferably liquid, while the products are preferably gaseous. The separators are hence preferably configured as gas/liquid separators.

**[0010]** The anode outlets of the stacks are connected to the anode separator inlets. That is, the anode outlets of all stacks are connected to the anode separator inlets of the same anode separator. Preferably, there is only one cathode separator. The cathode outlets of the stacks are connected to the cathode separator inlets. That is, the cathode outlets of all stacks are connected to the cathode separator inlets of the same cathode separator. Preferably, there is only one cathode separator.

**[0011]** The medium is driven by the pump unit. The pump unit preferably has a variable flow. That is, the flow of the medium generated by the pump unit can be controlled, for example, by controlling the rotation speed of at least one pump of the pump unit. In case there are multiple pump units, it is preferred that the flows of the medium generated by the pump unit can be controlled independently of each other. The pump unit can comprise one or more pumps. In the case of more than one pump, the pumps of a pump unit are configured such that one, some or all of the pumps of this pump unit can contribute to the flow generated by this pump unit. For example, a pump unit can have two pumps, of which one pump can be active, while the other pump is used as a backup. Alternatively, both pumps of the pump unit can be used simultaneously to avoid that one of the pumps has to be operated at its maximum power. It should be noted that the electrolysis arrangement can comprise multiple pump units, each comprising multiple pumps. To that end, the electrolysis arrangement can have, for example, four pumps, of which two form a first pump unit and the other two form a second pump unit.

**[0012]** Preferably, the electrolysis arrangement has only one pump unit. In that case the pump unit outlet is connected to all stack inlets. This does not mean that the pump unit has to be connected directly to the stack inlets. In particular, a means for returning excess flow to the separators to balance the feed medium flow can be arranged in between the pump unit and the stack inlets. Between the pump unit and the stack inlets a header is preferably provided for separating a flow of the medium provided by the pump unit into a respective flow of for each of the stacks. That is, by means of the header the flow of the medium is distributed to the stack inlets. Further, the anode separator medium outlet and the cathode separator medium outlet are connected to a pump unit inlet. This may be via an intermediate common vessel. This way, the medium can be circulated by the pump unit through the stacks and the separators. This embodiment can be referred to as a single feed or as a common feed because the medium is fed to the stacks via only one feed line that is distributed to the stacks. In particular in this embodiment it is possible that each of the stacks has only one stack inlet. This is particularly preferred in the case of PEM electrolysis cells. Alternatively, each of the stacks can have a respective anode stack inlet and a respective cathode stack inlet. This is particularly preferred in the case of alkaline electrolysis cells. The anode stack inlet and the cathode stack inlet of a certain stack can be jointly connected to the header. That is, a respective header outlet assigned to the respective stack can be connected to both the anode stack inlet and the cathode stack inlet of this stack. To this end, the single feed does not only fan out to the individual stacks by means of the header, but further to the anode stack inlet and the cathode stack inlet.

**[0013]** The electrolysis arrangement comprises a primary cooler for cooling the medium. The primary cooler is arranged between the pump unit and the stack inlets. Preferably, the primary cooler is an air cooler. Using an air cooler as the primary cooler reduces the consumption of cooling water. If only the primary cooler is active, there is no cooling duty and hence cooling water flows can be reduced. In case the electrolysis arrangement is supposed to be operated at partial load, fans of the primary cooler can also be switched off.

**[0014]** Further, the electrolysis arrangement comprises a bypass. The bypass extends from a point between the pump and the primary cooler to the anode separator and/or to the cathode separator. The "and" case is preferred. The bypass preferably comprises an anode branch that is connected to the anode separator and a cathode branch that is connected to the cathode separator. Splitting the bypass into the anode branch and the cathode branch facilitates the enhanced level control of the separators. The anode separator and the cathode separator are preferably not connected to each other except for indirect connections via the separator outlets, via the separator inlets and/or via the bypass.

**[0015]** Via the bypass the medium can flow from the pump unit outlet to the pump unit inlet without passing through the stacks. Thereby, the pump unit can generate a flow that is higher than required. Preferably, the bypass comprises a bypass valve. By means of the bypass valve the flow through the bypass and, in consequence, through the stacks can be adjusted particularly quickly, in particular compared to adjusting the rotation speed of one or more pumps of the pump unit. Hence, the flow control is particularly fast. The bypass can be used to balance the medium level in the anode separator and the cathode separator. The anode separator and the cathode separator are preferably connected to each other only via the separator outlets, the separator inlets and/or via the bypass.

**[0016]** According to a preferred embodiment of the electrolysis arrangement the bypass comprises a secondary cooler for cooling the medium.

**[0017]** The secondary cooler is preferably a water cooler. In case the bypass comprises an anode branch and a cathode branch, it is preferred that the secondary cooler is arranged upstream of where the bypass is split into the anode branch and the cathode branch. That way, the secondary cooler can cool the entire medium that flows through the bypass.

**[0018]** With the secondary cooler the temperature of the medium can be controlled particularly well. The secondary cooler can be used in addition or alternatively to the primary cooler. For example, in the case of an air cooler as the primary cooler, the primary cooler might have to be switched off at nighttime for noise protection. In such a situation the secondary cooler can be used alone, which may be sufficient in particular due to lower environmental temperatures at night.

**[0019]** According to a further preferred embodiment the electrolysis arrangement further comprises a return path from the bypass downstream of the secondary cooler to the stack inlets.

**[0020]** The return path is a conduit that connects the bypass to the stack inlets. Preferably, this is an indirect connection in that the return path is connected to a main conduit from the pump unit to the stack inlets. In particular, the return path can be connected to the main conduit between the primary cooler and the header. In case the electrolysis arrangement comprises a header, the header is part of the main conduit. In case the bypass has an anode branch and a cathode branch, the return path preferably begins between the secondary cooler and where the bypass splits into the anode branch and the cathode branch.

**[0021]** With the return path, in fact, the primary cooler and the secondary cooler are arranged parallel to each other. That means that the medium can be driven from the pump unit through either of the coolers to the stacks. This can be useful, in particular, on a hot day when the cooling power of the primary cooler might be insufficient.

**[0022]** In order to be able to control the flows through the main conduit, the bypass and the return path, respective control valves are preferably provided. For example, in addition to a bypass valve a control valve can be provided within the return path.

**[0023]** According to a further preferred embodiment of the electrolysis arrangement the bypass has an anode branch connected to the anode separator and a cathode branch connected to the cathode separator, wherein the anode branch and/or the cathode branch comprise a respective bypass valve. The "and" case is preferred.

**[0024]** It is sufficient for the flow through the bypass to be controlled in one of the branches. Preferably, only the anode branch comprises a control valve, wherein the cathode branch does not. In that case the cathode branch preferably comprises a flow resistance element such as an orifice.

**[0025]** According to a further preferred embodiment of the electrolysis arrangement the stack inlets are connected to the pump unit via a header for separating a flow of the medium provided by the pump unit into a respective flow for each of the stacks, wherein the electrolysis arrangement comprises for each of the stacks a respective control valve arranged between the header and the respective stack inlet.

**[0026]** In case a stack has more than one stack inlet it is preferred that a respective control valve is arranged upstream of where a common flow assigned to this stack is divided into respective flows for the stack inlets. Preferably, there is at least one control valve per stack. Thereby, it is possible to individually control the flow of the medium into the stacks. This allows multiple stacks to be used with a single anode separator and a single cathode separator. With the electrolysis arrangement a high degree of pressure control is possible. This is advantageous because it is desired to operate the electrolysis cells at precisely controlled pressures. The membrane of the electrolysis cells is preferably largely impermeable to the medium. However, a larger pressure difference between the anode space and the cathode space can drive greater amounts of the medium through the membrane. If too much of the medium is driven through the membrane, a hydrostatic imbalance between the anode separator and the cathode separator can be the result. In order to avoid this, it is desired to control the pressure difference between the anode space and the cathode space. In particular, it is preferred that for each of the stacks a respective pressure difference between the anode space and the cathode space is smaller than 0.05 bar, in particular smaller than 0.02 bar. This pressure control can be achieved in part by the afore mentioned bypass flow to minimise hydrostatic head differences between the separators.

**[0027]** In order to achieve such a precise pressure control, the electrolysis arrangement preferably comprises a respective control valve for each of the stacks. The control valve is preferably arranged between the header and the stack inlet of the respective stack.

**[0028]** It is preferred that the pump unit provides a pressure that is at least 1 bar higher than the desired pressure at the stack inlets. The control valves can be used to reduce the pressure.

**[0029]** According to a further preferred embodiment of the electrolysis arrangement the electrolysis cells are configured as PEM electrolysis cells, anion exchange membrane electrolysis cells or alkaline electrolysis cells.

**[0030]** It was found that in particular using these electrolysis cells the described advantages can be obtained. PEM electrolysis cells are particularly preferred. In this case as well as potentially in the case of anion exchange membrane electrolysis cells the medium is water, in particular de-ionised water. In case of alkaline electrolysis cells and possibly anion exchange membrane electrolysis cells the medium is an aqueous solution of potassium hydroxide (KOH).

**[0031]** According to a further aspect of the invention a method is presented for performing an electrolysis of a medium in order to obtain an anode product and a cathode product using an electrolysis arrangement as described. The method comprises driving the medium by means of the pump unit and applying a voltage to the electrolysis cells, wherein the speed of at least one pump of the pump unit is controlled.

**[0032]** The advantages and features of the described electrolysis arrangement are transferrable to the described method, and vice versa. The described electrolysis arrangement is preferably configured to be used according to the described method. The described method is preferably performed using the described electrolysis arrangement.

**[0033]** According to a preferred embodiment of the method for each of the stacks and for the bypass a respective desired flow is determined, wherein the speed of at least one pump of the pump unit is controlled such that a flow of the medium provided by the pump unit is at least equal to the sum of the desired flows determined for the stacks and for the bypass.

**[0034]** Preferably, the electrolysis arrangement comprises a respective control valve for each of the stacks. Hence, the flow through each of the stacks can be controlled independently.

**[0035]** According to a further preferred embodiment of the method for each of the stacks the respective desired flow is determined based on a desired anode product output and/or a desired cathode product output. The "and" case is preferred.

**[0036]** According to a further preferred embodiment of the method the desired flow of the medium through the bypass is at least equal to a predetermined minimum flow.

**[0037]** In this embodiment there is always a desired flow through the bypass. That is, at all times the bypass is supposed to have a flow that is larger than zero. The actual flow through the bypass may deviate from the desired flow. The purpose of the bypass is, in particular, to have a flow control that can react faster than what would be possible by adjusting the rotation speed of a pump.

**[0038]** According to a further preferred embodiment of the method a cooling power of the primary cooler and a flow of the medium through the bypass are controlled based on a desired temperature of the medium at the stack inlets.

**[0039]** The temperature of the medium at the stack inlets is influenced by the distribution of the flow through the main conduit with the primary cooler, through the bypass with the secondary cooler and through the return path. Also, the temperature of the medium at the stack inlets is influenced by the cooling power of the primary cooler and/or by the cooling power of the secondary cooler. Hence, it is preferred that all these parameters are controlled based on the desired temperature of the medium at the stack inlets.

**[0040]** According to a further preferred embodiment of the method energy extracted from the medium by the primary cooler is at least partly recovered.

**[0041]** By recovering energy, the energy consumption can be reduced and the efficiency can be improved.

**[0042]** In the following the invention will be described with respect to the figure. The figure shows a preferred embodiment, to which the invention is not limited. The figure and the dimensions shown therein are only schematic. The figure shows:

Fig. 1: an electrolysis arrangement according to the invention.

**[0043]** Fig. 1 shows an electrolysis arrangement 1 that comprises multiple stacks 3 of electrolysis cells. The electrolysis cells may be configured as PEM electrolysis cells, anion exchange membrane electrolysis cells or alkaline electrolysis cells. The stacks 3 each have a maximum rated DC power consumption in the range of 1 to 20 MW. Also, the electrolysis arrangement 1 comprises a pump unit 2 for driving a medium. In the present embodiment there is only one pump unit 2. Hence, the present embodiment can be referred to as a single feed. In the embodiment of Fig. 1, the pump unit 2 comprises a single pump only.

**[0044]** The pump unit 2 comprises a centrifugal pump configured to provide an adjustable flow of the medium. Each stack 3 comprises two stack inlets 4a,4b that are connected to the pump unit 2 via a header 5 for separating a flow of the medium provided by the pump unit 2 into a respective flow for each of the stacks 3. Each stack 3 comprises a respective anode outlet 6 and a respective cathode outlet 7. The stacks 3 are configured to obtain by electrolysis of the medium introduced into the respective stack inlets 4a,4b an anode product provided together with the medium at the respective anode outlet 6 and a cathode product provided together with the medium at the respective cathode outlet 7.

**[0045]** Further, the electrolysis arrangement 1 comprises a respective control valve 8 for each of the stacks 3 arranged between the header 5 and the respective stack inlets 4a,4b, wherein the control valves 8 are configured to individually control a flow of the medium into the respective stack 3. This does not necessarily mean that the flow into the anode stack inlet 4a can be controlled independently of the flow into the cathode stack inlet 4b. In the embodiment according to Fig. 1 this is not possible because the flow assigned to a certain stack 3 is divided into separate flows for the anode stack inlet 4a and the cathode stack inlet 4b downstream of the control valve 8. Nevertheless, the flow into the stack inlets 4a,4b of one stack 3 can be controlled independently of the flow into the stack inlets 4a,4b of the other stacks 3.

**[0046]** The electrolysis arrangement 1 further comprises an anode separator 9 having an anode separator medium outlet 12 that is connected to the pump unit 2. Each of the anode outlets 6 of the stacks 3 is connected to a respective anode separator inlet 10 of the anode separator 9. The anode separator 9 is configured to separate the anode product from the medium introduced into the anode separator inlets 10 such that the anode product is provided at an anode separator product outlet 11 and the medium is provided at the anode separator medium outlet 12. The pressure of the anode separator 9 is controlled by a control valve 25. The electrolysis arrangement 1 further comprises a cathode separator 13 having a cathode separator medium outlet 16 that is connected to the pump unit 2. Each of the cathode outlets 7 of the stacks 3 is connected to a respective cathode separator inlet 14 of the cathode separator 13. The cathode separator 13 is configured to separate the cathode product from the medium introduced into the cathode separator inlets 14 such that the cathode product is provided at a cathode separator product outlet 15 and the medium is provided at the cathode separator medium outlet 16. The pressure of the cathode separator 13 is controlled by a control valve 26. The operation of the control valves 25 and 26 are such that the pressure difference is minimized between the two separators 9,13.

**[0047]** The electrolysis arrangement 1 further comprises a primary cooler 22 for cooling the medium arranged between the pump unit 2 and the stack inlets 4a,4b. Also, the electrolysis arrangement 1 comprises a bypass 18 from between the pump unit 2 and the primary cooler 22 to the anode separator 9 and to the cathode separator 13. Between the pump unit 2 and where the bypass 18 begins, a filter 17 is arranged. The bypass 18 comprises a secondary cooler 23 for cooling the medium. A return path 24 connects the bypass 18 from a point downstream of the secondary cooler 23 to the header 5 and, thereby, to the stack inlets 4a,4b. By means of a control valve 27 the flow through the return path can be controlled. The bypass 18 has an anode branch 20 connected to the anode separator 9 and a cathode branch 21 connected to the cathode separator 13. The anode branch 20 comprises a bypass valve 19.

**[0048]** The described electrolysis arrangement 1 comprises:

- a pump unit 2,
- multiple stacks 3,
- an anode separator 9,
- a cathode separator 13,
- a primary cooler 22 for cooling the medium arranged between the pump unit 2 and the stack inlets 4a,4b, and
- a bypass 18 from between the pump unit 2 and the primary cooler 22 to the anode separator 9 and/or to the cathode separator 13.

**List of reference numerals**

**[0049]**

| | |
|---|---|
| 1 | Electrolysis arrangement |
| 2 | pump unit |
| 3 | stack |
| 4a | anode stack inlet |
| 4b | cathode stack inlet |
| 5 | header |
| 6 | anode outlet |
| 7 | cathode outlet |
| 8 | control valve |
| 9 | anode separator |
| 10 | anode separator inlet |
| 11 | anode separator product outlet |
| 12 | anode separator medium outlet |
| 13 | cathode separator |
| 14 | cathode separator inlet |
| 15 | cathode separator product outlet |
| 16 | cathode separator medium outlet |
| 17 | filter |
| 18 | bypass |
| 19 | bypass valve |
| 20 | anode branch |
| 21 | cathode branch |
| 22 | primary cooler |
| 23 | secondary cooler |
| 24 | return path |
| 25 | control valve |
| 26 | control valve |
| 27 | control valve |

**Claims**

**1.** Electrolysis arrangement (1) comprising:

- a pump unit (2) for driving a medium,
- multiple stacks (3) of electrolysis cells, wherein each stack (3) comprises a respective stack inlet (4a,4b) connected to the pump unit (2), a respective anode outlet (6) and a respective cathode outlet (7), wherein the stacks (3) are configured to obtain by electrolysis of the medium introduced into the respective stack inlet (4a,4b) an anode product provided together with the medium at the respective anode outlet (6) and a cathode product provided together with the medium at the respective cathode outlet (7),
- an anode separator (9) having an anode separator medium outlet (12) that is connected to the pump unit (2), wherein each of the anode outlets (6) of the stacks (3) is connected to a respective anode separator inlet (10) of the anode separator (9), and wherein the anode separator (9) is configured to separate the anode product from the medium introduced into the anode separator inlets (10) such that the anode product is provided at an anode separator product outlet (11) and the medium is provided at the anode separator medium outlet (12) and,

- a cathode separator (13) having a cathode separator medium outlet (16) that is connected to the pump unit (2), wherein each of the cathode outlets (7) of the stacks (3) is connected to a respective cathode separator inlet (14) of the cathode separator (13), and wherein the cathode separator (13) is configured to separate the cathode product from the medium introduced into the cathode separator inlets (14) such that the cathode product is provided at a cathode separator product outlet (15) and the medium is provided at the cathode separator medium outlet (16),
- a primary cooler (22) for cooling the medium arranged between the pump unit (2) and the stack inlets (4a,4b),
- a bypass (18) from between the pump unit (2) and the primary cooler (22) to the anode separator (9) and/or to the cathode separator (13).

**2.** Electrolysis arrangement (1) according to claim 1, wherein the bypass (18) comprises a secondary cooler (23) for cooling the medium

**3.** Electrolysis arrangement (1) according to claim 2, further comprising a return path (24) from the bypass (18) downstream of the secondary cooler (23) to the stack inlets (4a,4b).

**4.** Electrolysis arrangement (1) according to any of the preceding claims, wherein the bypass (18) has an anode branch (20) connected to the anode separator (9) and a cathode branch (21) connected to the cathode separator (13), and wherein the anode branch (20) and/or the cathode branch (21) comprise a respective bypass valve (19).

**5.** Electrolysis arrangement (1) according to any of the preceding claims, wherein the stack inlets (4a,4b) are connected to the pump unit (2) via a header (5) for separating a flow of the medium provided by the pump unit (2) into a respective flow for each of the stacks (3), and wherein the electrolysis arrangement (1) comprises for each of the stacks (3) a respective control valve (8) arranged between the header (5) and the respective stack inlet (4a,4b).

**6.** Electrolysis arrangement (1) according to any of the preceding claims, wherein the electrolysis cells are configured as PEM electrolysis cells, anion exchange membrane electrolysis cells or alkaline electrolysis cells.

**7.** Method for performing an electrolysis of a medium in order to obtain an anode product and a cathode product using an electrolysis arrangement (1) according to any of the preceding claims, the method comprising driving the medium by means of the pump unit (2) and applying a voltage to the electrolysis cells, wherein the speed of at least one pump of the pump unit (2) is controlled.

**8.** Method according to claim 7, wherein for each of the stacks (3) and for the bypass (18) a respective desired flow is determined, and wherein the speed of at least one pump of the pump unit (2) is controlled such that a flow of the medium provided by the pump unit (2) is at least equal to the sum of the desired flows determined for the stacks (3) and for the bypass (18).

**9.** Method according to claim 8, wherein for each of the stacks (3) the respective desired flow is determined based on a desired anode product output and/or a desired cathode product output.

**10.** Method according to claim 8 or 9, wherein the desired flow of the medium through the bypass (18) is at least equal to a predetermined minimum flow.

**11.** Method according to any one of claims 7 to 10, wherein a cooling power of the primary cooler (22) and a flow of the medium through the bypass (18) are controlled based on a desired temperature of the medium at the stack inlets (4a,4b).

**12.** Method according to any one of claims 7 to 11, wherein energy extracted from the medium by the primary cooler (22) is at least partly recovered.

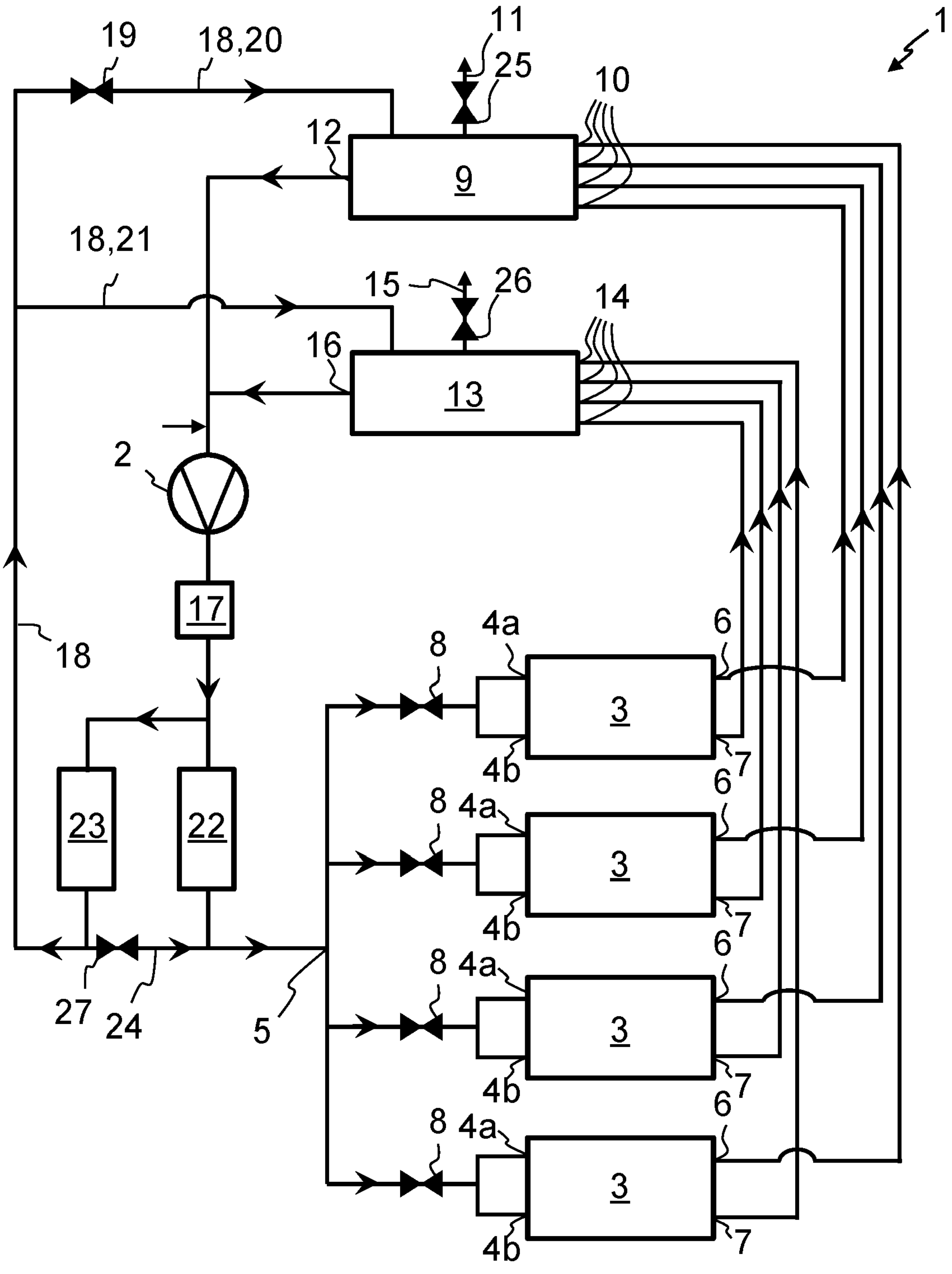
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Fig. 1

Europäisches Patentamt
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Office européen des brevets

# EUROPEAN SEARCH REPORT

Application Number
EP 20 20 7791

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X<br>A | US 2005/121315 A1 (BALTRUCKI JUSTIN D [US] ET AL) 9 June 2005 (2005-06-09)<br>* paragraph [0030] - paragraph [0037]; figures 2-4 *<br>* paragraphs [0006], [0007] *<br>----- | 1,2,4-12<br>3 | INV.<br>C25B1/04<br>C25B15/025<br>C25B15/08 |
| A | WO 2020/160424 A1 (AQUAHYDREX INC [US]) 6 August 2020 (2020-08-06)<br>* paragraphs [0327], [0330], [0331], [0333], [0340], [0341], [0342]; figure 14B *<br>* paragraph [0164] *<br>* paragraph [0346] *<br>* paragraph [0357]; figure 1 *<br>----- | 1,6,7,9 | |

TECHNICAL FIELDS SEARCHED (IPC)

C25B

The present search report has been drawn up for all claims

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| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 19 April 2021 | Desbois, Valérie |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
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