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Blood Purification Device

Abstract

A blood purification device including: piping, a plurality of sensors, and a liquid chemical identification unit. The plurality of sensors of different detection types that are provided on the piping. The liquid chemical identification unit that identifies a type of a cleaning/disinfection liquid chemical flowing through the piping by using the plurality of sensors. The liquid chemical identification unit is configured to be able to identify types of the liquid chemicals of at least not less than a number of the plurality of sensors by using the plurality of sensors. The liquid chemical identification unit selects all or part of the plurality of sensors according to the type of the liquid chemical which should be used for cleaning/disinfection and, based on detection results from the selected all or part of sensors, identifies whether or not it is a liquid chemical which should be used for the cleaning/disinfection.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) [0001] This application is a continuation of 17/610,295, filed on Nov. 10, 2021, which claims priority to International Application No. PCT/JP2020/018464, filed on May 1, 2020, which claims priority to Japanese Application Nos. 2019-097205, filed on May 23, 2019 and 2019-102813, filed May 31, 2019, the entire disclosures of which are hereby incorporated by reference.

FIELD

[0002] The teachings herein relate to a blood purification device.

BACKGROUND

[0003] For blood purification devices, a cleaning/disinfecting process for cleaning/disinfecting the inside of piping is performed after blood purification therapy. In the cleaning/disinfecting process, a cleaning/disinfection liquid chemical is introduced into the piping and the inside of the piping is cleaned/disinfected (see, e.g., Patent Document 1).

CITATION LIST

Patent Literature

[0004] Patent Document **1**: JP2014-097197A

SUMMARY

Technical Problem

[0005] In the cleaning/disinfecting process, different liquid chemicals are used depending on how dirty inside the piping is or how frequently the device is used, etc. Time required for cleaning/disinfection and the control details, etc., are different when using different liquid chemicals. Therefore, if, e.g., a wrong liquid chemical is used, cleaning/disinfection may be performed excessively which causes the liquid chemical to be wasted, or cleaning/disinfection may not be sufficiently performed which adversely affects the subsequent therapy.

[0006] For example, a blood purification device into which a liquid chemical is introduced from an external device could receive data of the type of liquid chemical used from the external device by communication, etc. However, even in such a case, to further increase safety, it is desired that each blood purification device identifies the type of the actually supplied liquid chemical and determines whether the correct liquid chemical is supplied.

[0007] Therefore, it is an object of the invention to provide a blood purification device that is capable of identifying types of cleaning/disinfection liquid chemicals and allows an appropriate cleaning/disinfecting process according to the type of liquid chemical to be performed.

Solution to Problem

[0008] To solve the problem mentioned above, the application according to the teachings herein provides a blood purification device for blood purification therapy performed through a blood purifier, the blood purification device including: piping; a plurality of sensors of different detection types that are provided on the piping; and a liquid chemical identification unit that identifies a type of a cleaning/disinfection liquid chemical flowing through the piping by using the plurality of

sensors, wherein the liquid chemical identification unit is configured to be able to identify types of the liquid chemicals of at least not less than the number of the plurality of sensors by using the plurality of sensors.

[0009] The application according to the teachings herein is the blood purification device taught herein, wherein the liquid chemical identification unit selects all or part of the plurality of sensors according to the type of the liquid chemical which should be used for cleaning/disinfection and, based on detection results from the selected all or part of sensors, identifies whether or not it is a liquid chemical which should be used for the cleaning/disinfection.

[0010] The application according to the teachings herein is the blood purification device taught herein, wherein the liquid chemical identification unit is configured to be able to identify types of the liquid chemicals of more than the number of the plurality of sensors based on a combination of the detection results from the plurality of sensors.

[0011] The application according to the teachings herein is the blood purification device taught herein, further including: a cleaning/disinfection control unit to detect whether the piping is filled with the cleaning/disinfection liquid chemical at the time of cleaning/disinfecting the piping, based on a detection result from at least one of the plurality of sensors.

[0012] The application according to the teachings herein is the blood purification device as taught herein, wherein the cleaning/disinfection control unit is configured to be able to detect whether a dialysate or the liquid chemical in the piping has been replaced with dialysis water, based on a detection result from at least one of the plurality of sensors.

[0013] The application according to the teachings herein is the blood purification device taught herein, wherein the plurality of sensors comprise a conductivity sensor to measure conductivity of a liquid flowing through the piping, and an absorbance sensor to measure absorption of ultraviolet light by the liquid flowing through the piping.

[0014] The application according to the teachings herein is the blood purification device taught herein, wherein the liquid chemical identification unit identifies a type of the liquid chemical by comparing a threshold for a detection value of the conductivity sensor and a threshold for a detection value of the absorbance sensor, which are set for each type of the liquid chemical, with the detection values of the conductivity sensor and the absorbance sensor.

Advantageous Effects

[0015] According to the teachings herein, it is possible to identify the type of the cleaning/disinfection liquid chemical and possible to perform an appropriate cleaning/disinfecting process according to the type of the liquid chemical.

[0016] According to the teachings herein, it is possible to identify whether or not the liquid chemical used currently is a liquid chemical which should be used for cleaning/disinfection.

[0017] According to the teachings herein, it is possible to detect whether the piping is filled with the cleaning/disinfection liquid chemical, and possible to perform an appropriate cleaning/disinfecting process.

[0018] According to the teachings herein, it is possible to suppress insufficient cleaning/disinfection due to the dialysate remaining after pre-cleaning or problems in blood purification therapy due to the liquid chemical remaining after post-cleaning.

[0019] According to the teachings herein, since the sensors respectively detect conductivity and absorbance, it is possible to detect liquid chemicals having different compositions and possible to identify more types of cleaning/disinfection liquid chemicals.

[0020] According to the teachings herein, it is possible to identify an acid cleaning solution, a peracetic acid-based disinfectant and a hypochlorite disinfectant, which are typical liquid chemicals used for the cleaning/disinfecting process.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0021] FIG. **1** is a schematic configuration diagram illustrating a blood purification system using blood purification devices in an embodiment of the present invention.

[0022] FIG. **2** is a schematic configuration diagram illustrating the blood purification device.

[0023] FIG. **3**A is a flowchart showing a cleaning/sterilization process.

[0024] FIG. **3**B is a flowchart of Step S**2** in FIG. **3**A.

DESCRIPTION OF EMBODIMENTS

Embodiment

[0025] An embodiment of the invention will be described below in conjunction with the appended drawings.

[0026] FIG. **1** is a schematic configuration diagram illustrating a blood purification system using blood purification devices in the present embodiment. As shown in FIG. **1**, a blood purification system **10** includes a dialysate supply device **11** and plural blood purification devices **1**.

[0027] The dialysate supply device **11** prepares a dialysate with a predetermined concentration using dialysis water supplied from a water treatment device (not shown) and an undiluted dialysate fluid supplied from a dissolving device (not shown), and supplies the prepared dialysate to each blood purification device **1**. The dialysate prepared by the dialysate supply device **11** is supplied to each blood purification device **1** via a dialysate supply line **12**.

[0028] Each blood purification device **1** is connected to a blood purifier (a dialyzer, not shown) for providing blood purification therapy (dialysis therapy) to a patient and supplies the dialysate supplied from the dialysate supply device **11** to the blood purifier. The details of the blood purification device **1** will be described later.

[0029] The blood purification system **10** is configured such that the dialysate supply device **11** can communicate with each blood purification device **1** via a signal line **13**. The dialysate supply device **11** can detect an operating status of each blood purification device **1** and control each blood purification device **1**. The form of communication between the dialysate supply device **11** and each blood purification device **1** is not limited thereto and may be, e.g., wireless communication instead of wired communication.

[0030] In the blood purification system **10**, a cleaning/disinfecting process for cleaning/disinfecting the inside of piping is performed after blood purification therapy. The cleaning/disinfecting process here includes a case where only cleaning is performed, a case where only disinfection is performed, and a case where both cleaning and disinfection are performed. When performing the cleaning/disinfecting process, the dialysate supply device **11** prepares a liquid chemical used for cleaning/disinfection and supplies the prepared liquid chemical to each blood purification device **1** via the dialysate supply line **12**. The dialysate supply device **11** also has a function of notifying each blood purification device **1** of the type, etc., of liquid chemical to be used when performing the cleaning/disinfecting process. When a worker operates the dialysate supply device **11** to start the cleaning/disinfecting process, the cleaning/disinfecting process for the dialysate supply device **11** and each blood purification device **1** is automatically performed according to a program preset in the dialysate supply device **11**.

Blood Purification Device **1**

[0031] FIG. **2** is a schematic configuration diagram illustrating the blood purification device **1**. FIG. **2** schematically shows piping arrangement during cleaning/disinfection. As shown in FIG. **2**, the blood purification device **1** has a pair of connectors **2***a*, **2***b* to which the blood purifier (not shown) is connected. During cleaning/disinfection, the two connectors **2***a*, **2***b* are connected via a bypass connector **2***c*.

[0032] Piping **3** inside the blood purification device **1** has a supply-side flow path **31** including a liquid supply port **3***a* connected to the dialysate supply line **12** and the connector **2***a*, and a discharge-side flow path **32** including the other connector **2***b* and a liquid discharge port **3***b*.

[0033] The blood purification device **1** also has a dual pump **5** which is configured to operate so that an amount of liquid supplied to the blood purifier and an amount of liquid discharged from the blood purifier are mechanically equivalent. In the present embodiment, the dual pump **5** is used to control a flow rate of the liquid flowing through the piping **3**. In addition, a removed water flow path **33** is provided on the discharge-side flow path **32** so as to bypass the dual pump **5**, and a water removal pump **6** to control an amount of water removed from blood is provided on the removed water flow path **33**. In addition, a liquid supply valve **7** composed of a solenoid valve capable of shutting off liquid supply is provided on the supply-side flow path **31**. The configuration diagram in FIG. **2** is simplified, and a flow path for bypassing each part, a solenoid valve, a filter unit, a pressure sensor for measuring liquid pressure, a temperature sensor for measuring liquid temperature, etc., may be appropriately provided.
[0034] The blood purification device **1** also includes a control device **8** that controls the dual pump **5**, the water removal pump **6**, the liquid supply valve **7**, etc. The control device **8** controls each part during blood purification therapy or during cleaning/disinfection.
[0035] The blood purification device **1** in the present embodiment includes plural sensors of different detection types provided on the piping **3** inside the device, and a liquid chemical identification unit **81** that identifies a type of cleaning/disinfection liquid chemical flowing through the piping **3** by using the plural sensors **4**.
[0036] The plural sensors **4** are provided on the piping **3** and can detect that a cleaning/disinfection liquid chemical is flowing through the piping **3**. In the present embodiment, these plural sensors **4** are used to determine the type of the cleaning/disinfection liquid chemical. In the present embodiment, a conductivity sensor **41** to measure conductivity of a liquid flowing through the piping **3** and an absorbance sensor **42** to measure absorption of ultraviolet light in the 280-nm band by the liquid flowing through the piping **3** are used as the plural sensors **4**. However, the sensors **4** are not limited thereto, and, e.g., a pH sensor to measure pH of the liquid flowing through the pipe **3**, etc., may be included.
[0037] The conductivity sensor **41** is used to monitor a dialysate concentration during blood purification therapy and is provided on the supply-side flow path **31**. When the dialysate concentration exceeds a threshold during blood purification therapy, an alarm is issued and is visually or audibly notified via a user interface, such as a display unit (not shown). Meanwhile, the absorbance sensor **42** is used to measure absorbance of waste liquid from the blood purifier, detect an amount of urea nitrogen contained in the waste liquid and monitor the progress of dialysis during blood purification therapy, and is provided on the discharge-side flow path **32**. That is, in the present embodiment, the conductivity sensor **41** and the absorbance sensor **42**, which are conventionally used in blood purification therapy, are used for a different purpose and are used to determine the type of cleaning/disinfection liquid chemical. As a result, it is not necessary to separately provide a sensor for determining the type of cleaning/disinfection liquid chemical, the system configuration is simplified, and it is possible to reduce the cost.
[0038] Typical liquid chemicals used for cleaning/disinfection include an acid cleaning solution, a peracetic acid-based disinfectant and a hypochlorite disinfectant. Of those, the acid cleaning solution and the hypochlorite disinfectant have different conductivities from that of the dialysis water and thus can be detected by the conductivity sensor **41**. Meanwhile, of the liquid chemicals mentioned above, the peracetic acid-based disinfectant and the hypochlorite disinfectant exhibit different UV absorbances (ultraviolet light in the 280-nm band) from that of the dialysis water and thus can be detected by the absorbance sensor **42**. As such, in the present embodiment, two or more types (three types in this example) of liquid chemicals can be detected by using two sensors **4**.
[0039] Since conductivity detected by the conductivity sensor **41** and absorbance detected by the absorbance sensor **42** depend on the concentration of the liquid chemical flowing through the piping **3**, the concentration of the liquid chemical can also be detected by detecting conductivity or absorbance. That is, in the present embodiment, the sensors **4** are configured to be able to detect the

concentration of the liquid chemical flowing through the piping **3**.

[0040] The liquid chemical identification unit **81** is mounted on the control device **8** and is realized by appropriately combining an arithmetic element such as CPU, a storage device such as memory, a software, and an interface, etc. The liquid chemical identification unit **81** is configured to be able to identify types of the liquid chemicals of at least not less than the number of the sensors **4** based on detection results from the plural sensors **4**. In the present embodiment, the liquid chemical identification unit **81** is configured to be able to identify types of the liquid chemicals of more than the number of the plural sensors **4** based on a combination of the detection results from the plural sensors **4**.

[0041] In more particular, the liquid chemical identification unit **81** identifies the type of the liquid chemical by comparing a threshold (within a reference value range) for a detection value of the conductivity sensor **41** and a threshold (within a reference value range) for a detection value of the absorbance sensor **42**, which are set for each type of liquid chemical, with the detection values of the conductivity sensor **41** and the absorbance sensor **42**. For example, when the detection values of the conductivity sensor **41** and the absorbance sensor **42** are respectively within the reference value ranges for an acid cleaning solution, it is identified that the liquid chemical is the acid cleaning solution. However, it is not limited thereto. Based the detection results from the conductivity sensor **41** and the absorbance sensor **42**, the liquid chemical identification unit **81** may identify that the liquid chemical is the acid cleaning solution when only the detection value of the conductivity sensor **41** changes as compared to measurement result of the dialysis water (when the amount of change is not less than a predetermined threshold), the liquid chemical is the peracetic acid-based disinfectant when only the detection value of the absorbance sensor **42** changes (when the amount of change is not less than a predetermined threshold), and the liquid chemical is the hypochlorite disinfectant when the detection values of the conductivity sensor **41** and the absorbance sensor **42** both change (when the amount of change is not less than a predetermined threshold).

[0042] In the present embodiment, the control device **8** is configured to communicate with the dialysate supply device **11** and acquire information indicating the liquid chemical used in the cleaning/disinfecting process from the dialysate supply device **11**. The liquid chemical identification unit **81** is configured to specify the liquid chemical based on the acquired information indicating the liquid chemical and select the sensor corresponding to the specified liquid chemical from the plural sensors **4**.

[0043] As such, in the present embodiment, the liquid chemical identification unit **81** selects all or part of the plural sensors **4** according to the type of the liquid chemical which should be used for cleaning/disinfection. The liquid chemical identification unit **81** is also configured to identify whether or not the liquid chemical used currently is a liquid chemical which should be used for cleaning/disinfection, based on the detection results from the selected all or part of sensors **4**. The reference value ranges mentioned above are set within a range in which the type of the liquid chemical can be identified. Therefore, by determining whether or not the concentration of the liquid chemical is within the reference value range, it is possible to determine whether or not the type of the liquid chemical is appropriate in addition to whether or not the concentration of the liquid chemical is appropriate. As a result, it is possible to avoid cleaning/disinfection with an inappropriate type of liquid chemical even when a user puts a wrong type of liquid chemical instead of the liquid chemical which should be supplied and a liquid chemical of a different type from the controlled liquid chemical is sent from the dialysate supply device **11** due to the control.

[0044] The blood purification device **1** also includes a cleaning/disinfection control unit **82** to cause the cleaning/disinfection liquid chemical to flow through the piping **3** inside the device and perform the cleaning/disinfecting process for the piping **3**. The cleaning/disinfection control unit **82** performs the cleaning/disinfecting process according to the instruction from the dialysate supply device **11**. The cleaning/disinfection control unit **82** is mounted on the control device **8** and is

realized by appropriately combining an arithmetic element such as CPU, a storage device such as memory, a software, and an interface, etc. The cleaning/disinfection control unit **82** has a liquid chemical replacement detection unit **821** and a liquid chemical flow rate control unit **822**.

[0045] The liquid chemical replacement detection unit **821** is configured to detect, during cleaning/disinfecting the piping **3**, that the piping **3** is filled with the cleaning/disinfection liquid chemical (the other liquid is replaced with the liquid chemical), based on the detection result from at least one sensor **4**. The liquid chemical replacement detection unit **821** uses the detection result from the sensor **4** corresponding to the liquid chemical identified by the liquid chemical identification unit **81**, compares the detection value of the sensor **4** with the threshold corresponding to the identified liquid chemical, and thereby detects that the liquid chemical is flowing through the piping **3** at a position where the sensor **4** is provided. In other words, when the concentration of the liquid chemical detected by the sensor **4** exceeds a predetermined reference value, the liquid chemical replacement detection unit **821** detects that the liquid chemical is flowing through the piping **3** at the position where the sensor **4** is provided.

[0046] When the liquid chemical identification unit **81** identifies that the liquid chemical used is, e.g., an acid cleaning solution, the liquid chemical replacement detection unit **821** compares the detection value of the conductivity sensor **41** with a preset threshold for the acid cleaning solution and detects that the liquid chemical is flowing through the piping **3** at the position where the conductivity sensor **41** is provided. In case of the hypochlorite disinfectant, the flow of the liquid chemical may be detected by using only one of the conductivity sensor **41** and the absorbance sensor **42** or the flow of the liquid chemical may be detected by using both sensors **41**, **42**.

[0047] During cleaning/disinfection, the entire piping **3** including the downstream side of the sensor **4** need to be filled with the liquid chemical. Therefore, when a delay time preset according to a piping capacity of the piping **3** on the downstream side of the sensor **4** used to detect flow of a liquid chemical has elapsed after detection of the flow of the liquid chemical, the liquid chemical replacement detection unit **821** detects that the piping **3** is filled with the cleaning/disinfection liquid chemical. For example, in case that the conductivity sensor **41** detects the liquid chemical, the delay time is set longer since it is arranged on the upstream side of the absorbance sensor **42** in a direction of sending the liquid chemical.

[0048] As such, the threshold (the reference value of the concentration) for detection of the flow of the liquid chemical and length of the delay time are different depending on the liquid chemical to be used. By providing the liquid chemical identification unit **81**, it is possible to perform an appropriate cleaning/disinfecting process according to the type of the liquid chemical actually used even when there is a human error such as, e.g., using a liquid chemical which is different from the intended liquid chemical. The liquid chemical identification unit **81** may be configured to issue an alarm by, e.g., sending an alert signal to the dialysate supply device **11** when the liquid chemical notified by the dialysate supply device **11** is different from the identified liquid chemical.

[0049] When the liquid chemical replacement detection unit **821** detects that the piping **3** is filled with the liquid chemical, the liquid chemical flow rate control unit **822** performs a process of reducing a flow rate of the liquid chemical as compared with that before the detection. In the present embodiment, the liquid chemical flow rate control unit **822** is configured to control the flow rate of the liquid chemical by controlling the dual pump **5**.

[0050] As a result of study, the present inventors found that a cleaning/disinfecting effect is dominant during when the liquid chemical is in contact with the piping **3** and a sufficient cleaning/disinfecting effect is obtained even if the flow rate of the liquid chemical is reduced. However, to efficiently perform the cleaning/disinfecting process in a short time, the flow rate of the liquid chemical is desirably as high as possible until the piping **3** is filled with the liquid chemical. Therefore, in the present embodiment, the flow rate of the liquid chemical is reduced after the piping **3** is filled with the liquid chemical, thereby reducing the use amount of the liquid chemical while maintaining the sufficient cleaning/disinfecting effect.

[0051] To shorten the time required for the cleaning/disinfecting process, the flow rate of the liquid chemical before the piping **3** is filled with the liquid chemical is desirably as high as possible. Meanwhile, to reduce the use amount of the liquid chemical, the flow rate of the liquid chemical after the piping **3** is filled with the liquid chemical is desirably as low as possible. Thus, the flow rate of the liquid chemical after the piping **3** is filled with the liquid chemical is desirably not more than ½, more preferably not more than ¼, of the flow rate of the liquid chemical before the piping **3** is filled with the liquid chemical. In this regard, however, if the flow rate of the liquid chemical after the piping **3** is filled with the liquid chemical is excessively reduced, dirt, etc., is less likely to be washed away and the cleaning/disinfecting effect may decrease. Therefore, the flow rate of the liquid chemical after the piping **3** is filled with the liquid chemical should be set taking into account the piping capacity, etc., so that the cleaning/disinfecting effect can be maintained.
[0052] The cleaning/disinfection control unit **82** is configured to determine that cleaning/disinfection with the liquid chemical has been finished, to stop the dual pump **5** and to proceed to the next step (a post-cleaning (described later), etc.), when a predetermined disinfection/cleaning time has elapsed after detecting that the piping **3** is filled with the liquid chemical. In this regard, after the disinfection/cleaning time has elapsed, the cleaning/disinfecting process may be finished in the state in which the dual pump **5** is stopped and the cleaning/disinfection liquid chemical is enclosed in the piping **3**. The disinfection/cleaning time may be set for each liquid chemical to be used. To sufficiently clean/disinfect the solenoid valve such as the liquid supply valve **7**, the cleaning/disinfection control unit **82** should control to open and close the solenoid valve at predetermined time intervals from when detecting that the piping **3** is filled with the liquid chemical to when the predetermined disinfection/cleaning time elapses.
[0053] When the concentration of the liquid chemical decreases for some reason (e.g., insufficient liquid chemical, etc.) before the disinfection/cleaning time elapses after detecting that the piping **3** is filled with the liquid chemical, a sufficient cleaning/disinfecting effect may not be obtained. Thus, the cleaning/disinfection control unit **82** may be configured to increase the flow rate of the liquid chemical by the liquid chemical flow rate control unit **822** and detect whether the piping **3** is filled with the liquid chemical by the liquid chemical replacement detection unit **821** again when the liquid chemical replacement detection unit **821** detects that the concentration of the liquid chemical is below the reference value (when the detection value of the sensor **4** is below the threshold) before the disinfection/cleaning time elapses after detecting that the piping **3** is filled with the liquid chemical. As a result, even if the concentration of the liquid chemical decreases during cleaning/disinfection for some reason, it is possible to prevent the process from being finished without sufficient cleaning/disinfection. In addition, the cleaning/disinfection control unit **82** may be configured to issue an alarm by, e.g., sending an alert signal to the dialysate supply device **11** when a decrease in the concentration of the liquid chemical is detected.
[0054] Now, the procedure of the cleaning/disinfecting process will be described using FIGS. **3**A and **3**B. When the cleaning/disinfecting process is started, the dialysate for blood purification therapy remains in the piping **3**. Thus, in the cleaning/disinfecting process, pre-cleaning for replacing the dialysate in the piping **3** with the dialysis water is firstly performed in Step S**1**, as shown in FIG. **3**A. After that, cleaning/disinfection using the cleaning/disinfection liquid chemical is performed in Step S**2**. After that, post-cleaning for replacing the liquid chemical in the piping **3** with the dialysis water is performed in Step S**3**. Alternatively, the cleaning/disinfecting process may be finished while leaving the liquid chemical enclosed in the piping **3** as described above, without performing the post-cleaning in Step S**3**. In this case, the post-cleaning is performed before the next blood purification therapy.
[0055] As described previously, the conductivity sensor **41** used as the sensor **4** can detect the concentration of the dialysate and the absorbance sensor **42** can detect the concentration of urea nitrogen in the waste liquid. Thus, by monitoring the detection values of the conductivity sensor **41** and the absorbance sensor **42**, it is possible to detect whether the dialysate (including the waste

liquid) in the piping **3** has been replaced with the dialysis water at the time of the pre-cleaning. Therefore, the cleaning/disinfection control unit **82** in the present embodiment is configured to be able to detect whether the dialysate in the piping **3** has been replaced with dialysis water at the time of the pre-cleaning in Step S**1**, based on the detection result from at least one sensor **4**. The cleaning/disinfection control unit **82** is configured to determine whether the inside of the piping **3** has been replaced with the dialysis water based on the detection result from the sensor **4**, and proceed to cleaning/disinfection in Step S**2** when it is determined that the inside of the piping **3** has been replaced with the dialysis water. An intended cleaning/disinfecting effect may not be obtained when the liquid chemical is introduced in the state in which the dialysate remains in the piping **3**, but such a problem can be suppressed in the present embodiment.

[0056] In addition, since the concentration of the cleaning/disinfection liquid chemical can be detected by the sensors **4**, whether the liquid chemical in the piping **3** has been replaced with the dialysis water can be detected at the time of post-cleaning by monitoring the detection values of the sensors **4**. Therefore, the cleaning/disinfection control unit **82** in the present embodiment is configured to be able to detect whether the liquid chemical in the piping **3** has been replaced with the dialysis water at the time of the post-cleaning in Step S**3**, based on the detection result from at least one sensor **4**. The cleaning/disinfection control unit **82** is configured to determine whether the inside of the piping **3** has been replaced with the dialysis water based on the detection result from the sensor **4**, and finish the cleaning/disinfecting process when it is determined that the inside of the piping **3** has been replaced with the dialysis water. The liquid chemical comes into contact with patient's blood in the next therapy and may adversely affect the blood purification therapy when the process is finished in the state in which the liquid chemical remains in the piping **3**, but such a problem can be suppressed in the present embodiment.

[0057] As shown in FIG. **3**B, in cleaning/disinfection in Step S**2**, firstly, the control unit **8** communicates with the dialysate supply device **11** and thereby acquires information indicating the liquid chemical used in the cleaning/disinfecting process from the dialysate supply device **11** in Step S**20**. Subsequently, the liquid chemical identification unit **81** specifies the liquid chemical based on the information indicating the liquid chemical and selects the sensor corresponding to the specified liquid chemical from the plural sensors **4**.

[0058] After that, in Step S**21**, the liquid chemical identification unit **81** determines whether or not the concentration of the liquid chemical is within a predetermined reference value range by using the sensor **4** selected in Step S**20**. The liquid chemical identification unit **81** also identifies the type of the liquid chemical through the determination made in Step S**21**. That is, since the reference value range is set within a range in which the type of the liquid chemical can be identified, whether or not the type of the liquid chemical is appropriate in addition to whether or not the concentration of the liquid chemical is appropriate can be determined by determining whether or not the concentration of the liquid chemical is within the reference value range. Furthermore, although the information indicating the type of the liquid chemical is acquired and the type of the liquid chemical is specified in Step S**20**, it is possible to avoid cleaning/disinfection with an inappropriate type of liquid chemical even when a user puts a wrong type of liquid chemical instead of the liquid chemical which should be supplied and a liquid chemical of a different type from the controlled liquid chemical is sent from the dialysate supply device **11** due to the control since the type of the liquid chemical is identified in step S**21**.

[0059] When the determination made in Step S**21** is NO, the process returns to Step S**21** to repeat determination. When the determination made in Step S**21** is YES, the liquid chemical replacement detection unit **821** detects whether the piping **3** is filled with the liquid chemical in Step S**22**. In particular, when a predetermined delay time has elapsed after the determination of YES is made in Step S**21**, the liquid chemical replacement detection unit **821** detects that the piping **3** is filled with the liquid chemical. When the determination made in Step S**22** is NO, the process returns to Step S**21**.

[0060] When the determination made in Step S**22** is YES, the liquid chemical flow rate control unit **822** reduces the flow rate of the liquid chemical by controlling the dual pump **5** in Step S**23**. After that, in Step S**24**, whether the concentration of the liquid chemical is within the reference value range is determined based on the detection result from the sensor **4**. When the determination made in Step S**24** is NO, the liquid chemical flow rate control unit **822** increases the flow rate of the liquid chemical by controlling the dual pump **5** in Step S**25** and the process then returns to Step S**21**. Step S**24** and Step S**25** can be omitted in case that, e.g., the concentration of the liquid chemical is monitored by an external device and there is no risk of a decrease in the concentration of the liquid chemical.

[0061] When the determination made in Step S**24** is YES, the cleaning/disinfection control unit **82** determines, in Step S**26**, whether a preset disinfection/cleaning time has elapsed after detecting that the piping **3** is filled with the liquid chemical in Step S**22**. When the determination made in Step S**26** is NO, the process returns to Step S**24**.

[0062] When the determination made in Step S**26** is YES, the cleaning/disinfection control unit **82** stops the flow of the liquid chemical by stopping the dual pump **5** in Step S**27**. After that, it returns (proceeding to Step S**3** in FIG. **3**A).

Modifications

[0063] In the present embodiment, the example in which the information indicating the liquid chemical to be used is acquired in advance from the dialysate supply device **11** has been described. However, this process (the process in Step S**20** described above) may be omitted, and the liquid chemical may be identified by the plural sensors **4**. In this case, preferably, all of the plural sensors **4** are used and the liquid chemical is identified based on the detection results from the plural sensors **4**, instead of selecting the sensor to be used from the plural sensors **4** and identifying the liquid chemical based on the detection result from only this sensor.

[0064] Although the blood purification device **1** supplied with the dialysate or the cleaning/disinfection liquid chemical from the external dialysate supply device **11** has been described in the present embodiment, the blood purification device **1** may include a mechanism for preparing the dialysate or the cleaning/disinfection liquid chemical. Alternatively, the blood purification device **1** may have a built-in tank, etc., for supplying the cleaning/disinfection liquid chemical or may be supplied with the cleaning/disinfection liquid chemical from a tank, etc., which is separately provided.

[0065] In addition, although the description is omitted in FIG. **3**A, it is obviously possible to continuously perform cleaning/sterilization using different liquid chemicals such as, e.g., performing cleaning/sterilization using a disinfectant in a low oxidation after cleaning/sterilization using an acid cleaning solution. In this case, it is desirable to prevent mixing of the liquid chemicals by performing the pre-cleaning to replace the inside of the piping **3** with the dialysis water after finishing cleaning/sterilization with a given liquid chemical, and then performing cleaning/sterilization with another liquid chemical. This is because if different liquid chemicals are mixed, a toxic substance such as chlorine gas may be produced depending on a combination of the liquid chemicals. In such a case, the cleaning/disinfection control unit **82** should be configured to determine whether the inside of the piping **3** has been replaced with the dialysis water at the time of the cleaning step based on the detection result from the sensor **4**, and proceed to cleaning/disinfection using the next liquid chemical when it is determined that the inside of the piping **3** has been replaced with the dialysis water. It is thereby possible to further suppress mixing of the liquid chemicals.

[0066] Furthermore, although it is detected that the piping **3** is filled with the liquid chemical based on the detection result from the sensor **4** in the present embodiment, it is not limited thereto. It is also possible to determine that the piping **3** is filled with the liquid chemical based on time elapsed since the start of liquid chemical supply. In this case, however, since the liquid chemical is not physically detected, reliability is slightly poor. That is, by determining whether the piping **3** is filled

with the liquid chemical based on the detection result from the sensor **4** as in the present embodiment, it is possible to more accurately detect that the piping **3** is filled with the liquid chemical.

Functions and Effects of the Embodiment

[0067] As described above, the blood purification device **1** in the present embodiment is configured to be able to identify types of the liquid chemicals of at least not less than the number of the sensors **4** by using the plural sensors **4** of different detection types.

[0068] For example, in case of using one sensor, it is difficult to determine typical liquid chemicals used for the cleaning/disinfecting process. If, e.g., a very expensive and large-scale equipment such as a spectrophotometer is used, it is possible to determine the liquid chemical by one equipment, but it is not realistic. When using plural sensors **4** of different detection types as in the present embodiment, it is possible to determine the typical liquid chemicals used for the cleaning/disinfecting process by using the sensors **4** which are relatively inexpensive and conventionally used for monitoring blood purification therapy. That is, in the present embodiment, it is possible to identify many types of cleaning/disinfection liquid chemicals with an inexpensive and simple system configuration and possible to perform an appropriate cleaning/disinfecting process according to the type of the liquid chemical.

Summary of the Embodiment

[0069] Technical ideas understood from the embodiment will be described below citing the reference numerals, etc., used for the embodiment. However, each reference numeral, etc., described below is not intended to limit the constituent elements in the claims to the members, etc., specifically described in the embodiment. [0070] [1] A blood purification device (**1**) for blood purification therapy performed through a blood purifier, the blood purification device (**1**) comprising: piping (**3**); a plurality of sensors (**4**) of different detection types that are provided on the piping (**3**); and a liquid chemical identification unit (**81**) that identifies a type of a cleaning/disinfection liquid chemical flowing through the piping (**3**) by using the plurality of sensors (**4**), wherein the liquid chemical identification unit (**81**) is configured to be able to identify types of the liquid chemicals of at least not less than the number of the plurality of sensors (**4**) by using the plurality of sensors (**4**). [0071] [2] The blood purification device described in [1], wherein the liquid chemical identification unit (**81**) selects all or part of the plurality of sensors (**4**) according to the type of the liquid chemical which should be used for cleaning/disinfection and, based on detection results from the selected all or part of sensors (**4**), identifies whether or not it is a liquid chemical which should be used for the cleaning/disinfection. [0072] [3] The blood purification device (**1**) described in [1] or [2], wherein the liquid chemical identification unit (**81**) is configured to be able to identify types of the liquid chemicals of more than the number of the plurality of sensors (**4**) based on a combination of the detection results from the plurality of sensors (**4**). [0073] [4] The blood purification device (**1**) described in any one of [1] to [3], comprising: a cleaning/disinfection control unit (**82**) to detect whether the piping (**3**) is filled with the cleaning/disinfection liquid chemical at the time of cleaning/disinfecting the piping (**3**), based on a detection result from at least one of the plurality of sensors (**4**). [0074] [5] The blood purification device (**1**) described in [4], wherein the cleaning/disinfection control unit (**82**) is configured to be able to detect whether a dialysate or the liquid chemical in the piping (**3**) has been replaced with dialysis water, based on a detection result from at least one of the plurality of sensors (**4**). [0075] [6] The blood purification device (**1**) described in any one of [1] to [5], wherein the plurality of sensors (**4**) comprise a conductivity sensor (**4**) to measure conductivity of a liquid flowing through the piping (**3**), and an absorbance sensor (**42**) to measure absorption of ultraviolet light by the liquid flowing through the piping (**3**). [0076] [7] The blood purification device (**1**) described in [6], wherein the liquid chemical identification unit (**81**) identifies the type of the liquid chemical by comparing a threshold for a detection value of the conductivity sensor (**41**) and a threshold for a detection value of the absorbance sensor (**42**), which are set for each type of the liquid chemical,

with the detection values of the conductivity sensor (**41**) and the absorbance sensor (**42**).
[0077] Although the embodiment of the invention has been described, the invention according to claims is not to be limited the embodiment described above. In addition, not all combinations of the features described in the embodiment are necessary to solve the problem of the invention.
[0078] In addition, the invention can be appropriately modified and implemented without departing from the gist thereof. For example, although the example in which the liquid chemical flow rate control unit **822** is provided has been described in the embodiment, the liquid chemical flow rate control unit **822** can be omitted.
REFERENCE SIGNS LIST
[0079] **1**: blood purification device [0080] **3**: piping [0081] **4**: sensor [0082] **41**: conductivity sensor [0083] **42**: absorbance sensor [0084] **5**: dual pump [0085] **8**: control device [0086] **81**: liquid chemical identification unit [0087] **82**: cleaning/disinfection control unit [0088] **821**: liquid chemical replacement detection unit [0089] **822**: liquid chemical flow rate control unit

Claims

1. A blood purification device for blood purification therapy performed through a blood purifier, the blood purification device comprising: piping; a plurality of sensors of different detection types that are provided on the piping; a liquid chemical identification unit that identifies a type of a cleaning/disinfection liquid chemical flowing through the piping by using the plurality of sensors, wherein the liquid chemical identification unit is configured to be able to identify types of the liquid chemicals of at least not less than a number of the plurality of sensors by using the plurality of sensors; and wherein the liquid chemical identification unit selects all or part of the plurality of sensors according to the type of the liquid chemical which should be used for cleaning/disinfection and, based on detection results from the selected all or part of sensors, identifies whether or not it is a liquid chemical which should be used for the cleaning/disinfection.
2. The blood purification device according to claim 1, wherein the liquid chemical identification unit is configured to be able to identify types of the liquid chemicals of more than the number of the plurality of sensors based on a combination of the detection results from the plurality of sensors.
3. The blood purification device according to claim 1, comprising: a cleaning/disinfection control unit to detect whether the piping is filled with the cleaning/disinfection liquid chemical at a time of cleaning/disinfecting the piping, based on a detection result from at least one of the plurality of sensors.
4. The blood purification device according to claim 3, wherein the cleaning/disinfection control unit is configured to be able to detect whether a dialysate or the liquid chemical in the piping has been replaced with dialysis water, based on a detection result from at least one of the plurality of sensors.
5. The blood purification device according to claim 1, wherein the plurality of sensors comprise a conductivity sensor to measure conductivity of a liquid flowing through the piping, and an absorbance sensor to measure absorption of ultraviolet light by the liquid flowing through the piping.
6. The blood purification device according to claim 5, wherein the liquid chemical identification unit identifies the type of the liquid chemical by comparing a conductivity threshold for a detection value of the conductivity sensor and an absorbance threshold for a detection value of the absorbance sensor, which are set for each type of the liquid chemical, with the detection values of the conductivity sensor and the absorbance sensor.
7. The blood purification device according to claim 1, wherein some of the plurality of sensors is used to monitor progress of dialysis during blood purification therapy.
8. The blood purification device according to claim 3, wherein the cleaning/disinfection control

unit detects that the piping is filled with the cleaning/disinfection liquid chemical, when a delay time preset according to a piping capacity of the piping on a downstream side of the at least one of the plurality of sensors has elapsed after detection of the flow of the liquid chemical.