

CLAIMS

1. A water quality analyzer, comprising a first disk system, a second disk system, a colorimetric system, a cleaning system, a mechanical sampling system, an analysis system and a center control display, the first disk system and the second disk system being axially rotatable, the first disk system being provided with a plurality of sample installation sites and chemical installation sites at a periphery, the second disk system being provided with a plurality of colorimetric cell installation sites, the colorimetric system being disposed at a peripheral edge of the second disk system, the cleaning system and the mechanical sampling system being disposed between the first disk system and the second disk system, and the analysis system being connected with the colorimetric system and used for analyzing water quality parameters and transmitting the same to the center control display;
wherein the mechanical sampling system comprises an up-and-down control motor, a rotation control motor, a sampling arm, a sampling probe, a control panel, a mixing tube and a plunger pump; and the up-and-down control motor and the rotation control motor are installed below the sampling arm and used for controlling up-and-down and rotation motions of the sampling arm respectively, the sampling probe is installed at an end of the sampling arm, the control panel is connected with the sampling probe, and the mixing tube has one end connected with the sampling probe and one end connected with the plunger pump.
2. The water quality analyzer of Claim 1, further comprising an online water sample system, which is disposed beside the mechanical sampling system and comprises a peristaltic pump, a delivery tube and online sample sites, which are connected in sequence.
3. The water quality analyzer of Claim 1, wherein the sampling arm comprises a rotation shaft and an arm plate, the arm plate is connected with an end of the rotation shaft, and the middle of the rotation shaft is provided with a hollow through hole allowing a pipeline to pass.
4. The water quality analyzer of Claim 1, wherein the control panel is provided with a liquid level sensor of the sampling probe.
5. The water quality analyzer of Claim 1 or 4, wherein the cleaning system comprises a cleaning tank on an upper part, and a cleaning pump, a cleaning fluid barrel as well as a waste fluid barrel on a lower part; the cleaning tank is disposed between the first disk system and the second disk system, the cleaning tank is provided with a cleaning post of a hollow structure in the middle and a waste fluid outlet at the bottom, the cleaning pump is connected with the mixing tube of the mechanical sampling system, the cleaning fluid barrel is connected with the cleaning pump, and the waste fluid barrel is connected with the waste fluid outlet.
6. The water quality analyzer of Claim 5, wherein the bottom of the cleaning fluid barrel and the upper part of the waste fluid barrel are further provided with liquid level sensors, which are in signal connection with the center control display.
7. The water quality analyzer of Claim 1 or 6, further comprising a cleaning workstation, which is disposed beside the colorimetric system.
8. A water quality analyzing method, using the water quality analyzer of any one of Claims 1 to 7, and comprising the following steps for water quality analysis,
 - S1. pumping of a water sample, wherein the sampling arm rotates to the online sample sites or sample installation sites, and the plunger pump pumps a water sample at the sample installation sites or online sample sites from the sampling probe into the mixing tube;

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- S2. injecting of the water sample, wherein the sampling arm rotates to the colorimetric cell installation sites, and the plunger pump controls the injecting of the water sample in the mixing tube from the sampling probe to the plurality of colorimetric cells of the quantity desired;
- S3. cleaning, wherein the sampling arm rotates to the cleaning system to clean the sampling probe and the mixing tube;
- S4. pumping of a chemical, wherein the sampling arm rotates to the chemical installation sites, and the plunger pump controls the injecting of the chemical in a chemical test tube at the chemical installation sites from the sampling probe to the mixing tube;
- S5. injecting of the chemical, wherein the sampling arm rotates to the colorimetric cell installation sites, the plunger pump controls the injecting of the chemical in the mixing tube from the sampling probe to the colorimetric cells with the water sample injected, and the sampling arm mixes the chemical and the water sample;
- S6. cleaning, wherein the sampling arm rotates to the cleaning system to clean the sampling probe and the mixing tube; and
- S7. colorimetric analysis, wherein the second disk system rotates to conduct data analysis on the plurality of colorimetric cells from S5 through the colorimetric system in sequence, and resulting data is transmitted to the analysis system for outputting water quality analysis data to the center control display.
9. The water quality analysis method of Claim 8, further comprising S8, in which the colorimetric cells are rotated to the cleaning working station for cleaning.
10. The water quality analysis method of Claim 8, wherein in S3 and S6, a cleaning process for the sampling probe and the mixing tube is as follows: the sampling arm rotates to be above the cleaning tank so that the sampling probe is located at a drainage site outside the cleaning post, the cleaning pump pumps a cleaning fluid in the cleaning fluid barrel to clean the mixing tube, the sampling arm rotates after the cleaning is completed so that the sampling probe is lowered and inserted into the cleaning post, and the cleaning pump is started to pump the cleaning fluid in the cleaning fluid barrel to the sampling probe via the mixing tube and then into the cleaning post; and the cleaning fluid in the cleaning post overflows to the outside of the sampling probe for cleaning, the control panel senses a liquid level of the cleaning fluid and sends a signal to close the cleaning pump, and the cleaning fluid flows into the waste fluid barrel via the waste fluid outlet at the bottom of the cleaning tank.
11. The water quality analysis method of Claim 10, wherein liquid level sensors are installed at the bottom of the cleaning fluid barrel and on the upper part of the waste fluid barrel for sensing a drainage condition of the cleaning fluid barrel and a waste fluid overflow condition respectively and sending signals indicating both abnormal conditions to the center control display.
12. The water quality analysis method of Claim 8, wherein in S5, the sampling arm mixes the chemical and the water sample with methods as follows:
- a. the plunger pump controls pumping outside air in the mixing tube, inserting the mixing tube to the colorimetric cell and releasing the air to mix the chemical and the water sample; and
 - b. the plunger pump controls pumping a mixed liquid from the colorimetric cell in the mixing tube, raising the sampling arm so that the sampling probe is located above a liquid level of the colorimetric cell, and then injecting the mixed liquid for mixing the chemical and the water sample;
- one or both of the methods a and b is/are used repetitively to complete the mixing.

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WATER QUALITY ANALYZER AND WATER QUALITY ANALYSIS METHOD

Technical Field

[0001] The invention relates to the field of water quality analysis, and in particular to a water quality analyzer and a water quality analysis method.

Description of Related Art

[0002] Water quality analyzers are mainly applied to the analysis of various water quality of tap water, surface water, sewage, seawater and the like. Water quality analysis methods include a flow analysis method, an LFA analysis method, a sequential injection analysis method, a colorimetric method and the like. The colorimetric method is to determine the content of a component under test by comparing or measuring the color depth of a colored matter solution. As a quantitative analysis method, the colorimetric method is featured with high accuracy, high sensitivity and selectivity for reaction, and constant and stable composition of a resulting color compound. For a photoelectric colorimetric method, the working principle is as follows: the absorbance is measured for a series of standard solutions by a photoelectric colorimeter to draw a standard curve, and then the content of the substance under test is worked out from the standard curve according to the absorbance of the solutions under test.

TECHNICAL PROBLEM

[0003] The existing water quality analyzers have the following technical problems to be solved:

[0004] 1. Due to many water quality parameters and restricted analysis time, the existing analyzers can only determine up to four parameters with low analysis speed, and is not available for online measurement; and

[0005] 2. During sampling, the existing analyzers generally conduct sampling through a sampling probe and have no other functions except sampling, a mixing device is then used to mix samples after sampling, thus the devices are complex in structure and high in cost.

TECHNICAL SOLUTION

[0006] An object of the invention is to provide a water quality analyzer and a water quality analysis method to enable efficient multi-parameter water quality analysis.

[0007] To achieve the object as described above, the invention employs a technical solution as follows:

[0008] A water quality analyzer comprises a first disk system, a second disk system, a colorimetric system, a cleaning system, a mechanical sampling system, an analysis system and a center control display, the first disk system and the second disk system being axially rotatable, the first disk system being provided with a plurality of sample installation sites and chemical installation sites at a periphery, the second disk system being provided with a plurality of colorimetric cell installation sites, the colorimetric system being disposed at a peripheral edge of the second disk system, the cleaning system and the mechanical sampling system being disposed between the first disk system and the second disk system, and the analysis system being connected with the colorimetric system and used for analyzing water quality parameters and transmitting the same to the center control display.

[0009] Moreover, the mechanical sampling system comprises an up-and-down control motor, a rotation control motor, a sampling arm, a sampling probe, a control panel, a mixing tube and a plunger pump; and the up-and-down control motor and the rotation control motor are installed below the sampling arm and used for controlling up-and-down and rotation motions of the sampling arm respectively, the sampling probe is installed at an end of the sampling arm, the control panel is connected with the sampling probe, and the mixing tube has one end connected with the sampling probe and one end connected with the plunger pump.

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[0010] Further, the water quality analyzer also comprises an online water sample system, which is disposed beside the mechanical sampling system and comprises a peristaltic pump, a delivery tube and online sample sites, which are connected in sequence.

[0011] Further, the sampling arm comprises a rotation shaft and an arm plate, wherein the arm plate is connected with an end of the rotation shaft, and the middle of the rotation shaft is provided with a hollow through hole allowing a pipeline to pass.

[0012] Preferably, the control panel is provided with a liquid level sensor of the sampling probe.

[0013] Moreover, the cleaning system comprises a cleaning tank on an upper part, and a cleaning pump, a cleaning fluid barrel as well as a waste fluid barrel on a lower part, wherein the cleaning tank is disposed between the first disk system and the second disk system, the cleaning tank is provided with a cleaning post of a hollow structure in the middle and a waste fluid outlet at the bottom, the cleaning pump is connected with the mixing tube of the mechanical sampling system, the cleaning fluid barrel is connected with the cleaning pump, and the waste fluid barrel is connected with the waste fluid outlet.

[0014] Further, the bottom of the cleaning fluid barrel and the upper part of the waste fluid barrel are further provided with liquid level sensors, which are in signal connection with the center control display.

[0015] Preferably, the water quality analyzer also comprises a cleaning workstation, which is disposed beside the colorimetric system.

[0016] The invention also discloses a water quality analysis method making use of the water quality analyzer above, which comprises the following steps for water quality analysis.

[0017] S1. Pumping of a water sample: the sampling arm rotates to the online sample sites or sample installation sites, and the plunger pump pumps a water sample at the sample installation sites or online sample sites from the sampling probe into the mixing tube.

[0018] S2. Injecting of the water sample: the sampling arm rotates to the colorimetric cell installation sites, and the plunger pump controls the injecting of the water sample in the mixing tube from the sampling probe to the plurality of colorimetric cells of the quantity desired.

[0019] S3. Cleaning: the sampling arm rotates to the cleaning system to clean the sampling probe and the mixing tube.

[0020] S4. Pumping of a chemical: the sampling arm rotates to the chemical installation sites, and the plunger pump controls the injecting of the chemical in a chemical test tube at the chemical installation sites from the sampling probe to the mixing tube.

[0021] S5. Injecting of the chemical: the sampling arm rotates to the colorimetric cell installation sites, the plunger pump controls the injecting of the chemical in the mixing tube from the sampling probe to the colorimetric cells with the water sample injected, and the sampling arm mixes the chemical and the water sample.

[0022] S6. Cleaning: the sampling arm rotates to the cleaning system to clean the sampling probe and the mixing tube.

[0023] S7. Colorimetric analysis: the second disk system rotates to conduct data analysis on the plurality of colorimetric cells from S5 through the colorimetric system in sequence, and resulting data is transmitted to the analysis system for outputting water quality analysis data to the center control display.

[0024] Preferably, the water quality analysis method further comprises S8, in which the colorimetric cells are

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rotated to the cleaning working station for cleaning.

[0025] Moreover, in S3 and S6, a cleaning process for the sampling probe and the mixing tube is as follows: the sampling arm rotates to be above the cleaning tank so that the sampling probe is located at a drainage site outside the cleaning post, the cleaning pump pumps a cleaning fluid in the cleaning fluid barrel to clean the mixing tube, the sampling arm rotates after the cleaning is completed so that the sampling probe is lowered and inserted into the cleaning post, and the cleaning pump is started to pump the cleaning fluid in the cleaning fluid barrel to the sampling probe via the mixing tube and then into the cleaning post; and the cleaning fluid in the cleaning post overflows to the outside of the sampling probe for cleaning, the control panel senses a liquid level of the cleaning fluid and sends a signal to close the cleaning pump, and the cleaning fluid flows into the waste fluid barrel via the waste fluid outlet at the bottom of the cleaning tank. Liquid level sensors are installed at the bottom of the cleaning fluid barrel and on the upper part of the waste fluid barrel for sensing a drainage condition of the cleaning fluid barrel and a waste fluid overflow condition respectively and sending signals indicating both abnormal conditions to the center control display.

[0026] Moreover, in S5, the sampling arm mixes the chemical and the water sample with methods as follows: a. the plunger pump controls pumping outside air in the mixing tube, inserting the mixing tube to the colorimetric cell and releasing the air to mix the chemical and the water sample; and b. the plunger pump controls pumping a mixed liquid from the colorimetric cell in the mixing tube, raising the sampling arm so that the sampling probe is located above a liquid level of the colorimetric cell, and then injecting the mixed liquid for mixing the chemical and the water sample; and one or both of the methods a and b is/are used repetitively to complete the mixing.

Beneficial Effect

[0027] The invention has the following beneficial effects:

[0028] 1. Multiple water quality parameters can be analyzed at the same time with high analysis speed, ABSS related to the water quality can be read by the colorimetric system, and the water parameters can be flexibly adjusted;

[0029] 2. The sampling probe is provided with the mixing tube and the plunger pump to achieve the purpose of sampling and sample mixing at the same time, the sampling and stirring can be completed through the sampling system by virtue of the plunger pump and the mixing tube, and the artful structure effectively reduces the size and cost of the device;

[0030] 3. With the arrangement of the online water sample system, the peristaltic pump can be used on site to pump the water sample to the online sample sites for online water sample analysis; and

[0031] 4. The automation level is increased with the cleaning system for cleaning the sampling tube and the sampling probe and with the cleaning workstation for cleaning the colorimetric cells.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0032] FIG. 1 is a schematically front view of the invention.

[0033] FIG. 2 is a schematically structural view of the invention with a lower section concealed.

[0034] FIG. 3 is a schematically top view of FIG. 1.

[0035] FIG. 4 is a schematically structural view of a mechanical sampling system according to the invention.

[0036] FIG. 5 is a schematically structural view of a cleaning system according to the invention.

[0037] FIG. 6 is a schematically sectional view of a cleaning tank according to the invention.

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[0038] The reference signs of main components are illustrated as follows:

[0039] 1: first disk system, 11: sample installation site, 12: chemical installation site, 2: second disk system, 21: colorimetric cell installation site, 3: colorimetric system, 4: cleaning system, 41: cleaning tank, 411: cleaning post, 412: waste fluid outlet, 42: cleaning pump, 43: cleaning fluid barrel, 44: waste fluid barrel, 45: cleaning workstation, 5: mechanical sampling system, 51: up-and-down control motor, 52: rotation control motor, 53: sampling arm, 531: rotation shaft, 532: arm plate, 533: hollow through hole, 54: sampling probe, 55: control panel, 551: liquid level sensor of sampling probe, 56: mixing tube, 57: plunger pump, 6: analysis system, 7: center control display, 8: online water sample system, 81: peristaltic pump, 82: delivery pipe, 83: online sample site, 9: liquid level sensor.

DETAILED DESCRIPTION OF THE INVENTION

[0040] To make the objectives, technical solutions and advantages of the invention clear and explicit, the invention will be further illustrated in detail with reference to the accompanying drawings and embodiments.

[0041] As shown in FIG. 1, this embodiment discloses a water quality analyzer, which comprises a first disk system 1, a second disk system 2, a colorimetric system 3, a cleaning system 4, a mechanical sampling system 5, an analysis system 6, a center control display 7 and an online water sample system 8.

[0042] As shown in FIGs. 2 to 3, the first disk system 1 is axially provided with a rotation motor to enable the first disk system 1 to rotate axially. The first disk system 1 is provided with a plurality of sample installation sites 11 and chemical installation sites 12 at the periphery, and the sample installation sites 11 in this embodiment are disposed on the outer periphery of the chemical installation sites 12. The second disk system 2 is axially provided with a rotation motor to enable the second disk system 2 to rotate axially. The second disk system 2 is provided with a plurality of colorimetric cell installation sites 21 .

[0043] The colorimetric system 3 is disposed at a peripheral edge of the second disk system 2. The analysis system 6 is connected with the colorimetric system 3 and used for analyzing water quality parameters and transmitting the same to the center control display 7.

[0044] With reference to FIG. 4, the mechanical sampling system 5 is disposed between the first disk system 1 and the second disk system 2. The mechanical sampling system 5 comprises an up-and-down control motor 51, a rotation control motor 52, a sampling arm 53, a sampling probe 54, a control panel 55, a mixing tube 56 and a plunger pump 57. The up-and-down control motor 51 and the rotation control motor 52 are installed below the sampling arm 53 for controlling the up-and-down and rotation motions of the sampling arm respectively 53. The sampling probe 54 is installed at an end of the sampling arm 53 and is connected with the control panel 55. The control panel 55 is provided with a liquid level sensor 551 of the sampling probe. The mixing tube 56 has one end connected with the sampling probe 54 and one end connected with the plunger pump 57. The sampling arm comprises a rotation shaft 531 and an arm plate 532; the arm plate 532 is connected with an end of the rotation shaft 531; and the middle of the rotation shaft 531 is provided with a hollow through hole 533 allowing respective pipelines and wires to pass.

[0045] With reference to FIGs. 5 and 6, the cleaning system 4 is disposed between the first disk system 1 and the second disk system 2. The cleaning system 4 comprises a cleaning tank 41 on an upper part, and a cleaning pump 42, a cleaning fluid barrel 43 as well as a waste fluid barrel 44 on a lower part. The cleaning tank 41 is disposed between the first disk system 1 and the second disk system 2; the middle of the cleaning tank 41 is

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provided with a cleaning post 411 of a hollow structure; and the cleaning tank 41 is provided with a waste fluid outlet 412 at the bottom. The cleaning pump 42 is connected with the mixing tube 56 of the mechanical sampling system 5; the cleaning fluid barrel 43 is connected with the cleaning pump 42; and the waste fluid barrel 44 is connected with the waste fluid outlet 412. The bottom of the cleaning fluid barrel 43 and the upper part of the waste fluid barrel 44 are provided with liquid level sensors 9, which are in signal connection with the center control display 7.

[0046] The online water sample system 8 is disposed beside the mechanical sampling system 5 and comprises a peristaltic pump 81, a delivery tube 82 and online sample sites 83, which are connected in sequence.

[0047] The cleaning workstation 45 is disposed beside the colorimetric system 3 for cleaning the colorimetric cells.

[0048] The invention also discloses a water quality analysis method of the water quality analyzer described above, comprising the following steps.

[0049] S1. Pumping of a water sample: the sampling arm 53 rotates to the online sample sites 83 or sample installation sites 11, and the plunger pump pumps a water sample in the sample installation sites 11 or online sample sites 83 from the sampling probe 54 to the mixing tube 56. In the pumping process above, the end of the sampling probe 54 is raised into the water sample, the sampling probe 54 is stopped from moving downwards after the liquid level sensor 551 of the sampling probe senses a liquid level, and then starts pumping the water sample.

[0050] The water sample can be pumped on site in real time through the online sample sites 83, where a pipeline of the peristaltic pump 81 is in contact with a water source; the peristaltic pump 81 is started to pump the water into the online sample sites 83 via the delivery tube 82; and the sampling arm 53 accurately and quantitatively draws the water source in the online sample sites 83 into the mixing tube 56 via the plunger pump 57.

[0051] The water source sampled to a laboratory can be held in a test tube and placed on the sample installation sites 11; the sampling arm 53 rotates to be above the sample installation sites 11; and the sampling probe 54 is raised into the test tube to draw the water sample into the test tube 56.

[0052] S2. Injecting of the water sample: the sampling arm 53 rotates to the colorimetric cell installation sites 21, and the plunger pump 57 controls the injecting of the water sample in the mixing tube 56 from the sampling probe 54 to the plurality of colorimetric cells of the quantity desired.

[0053] Many parameters are needed for water quality analysis, the invention is available for analyzing more than eight parameters each time, therefore, the water sample can be injected to more than eight colorimetric cells for subsequent simultaneous analysis of multiple parameters.

[0054] S3. Cleaning: the sampling arm 53 rotates to the cleaning system 4 to clean the sampling probe 54 and the mixing tube 56. A cleaning process is as follows: the sampling arm 53 rotates to be above the cleaning tank 41 so that the sampling probe 54 is located at a drainage site outside the cleaning post 411; and the cleaning pump 42 pumps the cleaning fluid in the cleaning fluid barrel 43 to clean the mixing tube 56. After the cleaning is completed, the sampling arm 53 rotates to lower and insert the sampling probe 54 into the cleaning post 411; and the cleaning pump 42 pumps the cleaning fluid in the cleaning fluid barrel 43 to the sampling probe 54 through the mixing tube 56 and then into the cleaning post 411 for cleaning the inside of the sampling probe 54. After a

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period of time, the cleaning fluid inside the cleaning post 411 overflows to the outside of the sampling probe 54, enabling the cleaning of the outside of the sampling probe 54. The control panel 55 senses the liquid level of the cleaning fluid and sends a signal to close the cleaning pump 42. The cleaning fluid flows into the waste fluid barrel through the waste fluid outlet 412 at the bottom of the cleaning tank 41.

[0055] Liquid level sensors 9 are installed at the bottom of the cleaning fluid barrel 43 and on the upper part of the waste fluid barrel 44 for sensing a drainage condition of the cleaning fluid barrel and a waste fluid overflow condition respectively and sending signals indicating both abnormal conditions to the center control display 7. When the cleaning fluid barrel is pumped up, an alert message appears on the center control display 7 to remind an operator to add the cleaning fluid; and when the waste fluid overflows, an alert message appears on the center control display 7 to remind the operator to discard the waste fluid.

[0056] S4. Pumping of a chemical: the sampling arm 53 rotates to the chemical installation sites 12, and the plunger pump 57 controls the injecting of the chemical in a chemical test tube at the chemical installation sites 12 from the sampling probe 54 to the mixing tube 56. In the pumping process above, the end of the sampling probe 54 is raised into the chemical, and the sampling probe 54 is stopped from moving downwards after the liquid level sensor 551 of the sampling probe senses the liquid level of the chemical, and then starts pumping the chemical.

[0057] S5. Injecting of the chemical: the sampling arm 53 rotates to the colorimetric cell installation sites 21, the plunger pump 57 controls the injecting of the chemical in the mixing tube 56 from the sampling probe 54 to the colorimetric cells with the water sample injected. Based on the quantity of the colorimetric cells, the chemical is injected to each colorimetric, the sampling arm 53 is then used to mix the water sample and the chemical, and one or both of the mixing methods a or b below is/are used repetitively to complete the mixing.

[0058] a. The plunger pump 57 controls pumping outside air in the mixing tube 56, inserting the mixing tube 56 to the colorimetric cell and releasing the air to mix the chemical and the water sample.

[0059] b. The plunger pump 57 controls pumping a mixed liquid from the colorimetric cell in the mixing tube 56, raising the sampling arm 53 so that the sampling probe 54 is located above a liquid level of the colorimetric cell, and then injecting the mixed liquid for mixing the chemical and the water sample.

[0060] S6. Cleaning: the sampling arm 53 rotates to the cleaning system 4 to clean the sampling probe 54 and the mixing tube 56. The cleaning process is the same as that of S3.

[0061] S7. Colorimetric analysis: the second disk system 2 rotates to conduct data analysis on the plurality of colorimetric cells from S5 through the colorimetric system 3 in sequence, and resulting data is transmitted to the analysis system 6 for outputting water quality analysis data to the center control display 7.

[0062] The colorimetric system 3 is internally provided with a set of standard filter disks from light colors to deep colors, which are divided into three color series, i.e., red, yellow and blue series. The filter disks are rotated to determine and analyze the color, tone and color value related to the water quality and read the ABSE for the water quality.

[0063] S8. Cleaning of the colorimetric cells: the colorimetric cells are rotated to the cleaning workstation 45 for cleaning.

[0064] Above all, the invention realizes the online discontinuous analysis of the water quality with high analysis speed and many analysis parameters and is suitable for promotion and application.

[0065] The description above only provides the preferred embodiments of the invention. Any variations or

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substitutions conceived by those skilled in the art within the technical scope disclosed by the invention shall be construed to fall within the protection scope of the invention.

Industrial Applicability

[0066] The invention can be applied to the field of analysis of various water quality of tap water, surface water, sewage, seawater and the like for identifying and determining the content of substances and chemical components contained in water.