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Original Paper

Development and Application of a Liquid Sampling Device with Timing, Quantitative and Depth Determination

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Abstract

This thesis describes the development process of a liquid sampling device that can be timed, quantitative, and deep. The structural composition, working principle, and innovative features of the liquid sampling device are introduced, and the application prospects are analyzed. The device has the function of controllable and adjustable sampling point depth and sampling volume, and adopts quantitative collection and collection methods without contact with accessories. The device has a silent function in the sample body, which can realize pre-booking of collection time points and multi-point synchronous collection. Wireless remote control automatic mode is adopted for sending and stopping collection instructions, which can be sent one-to-one or one-to-many at the same time. It provides automation links for water quality monitoring projects and meets the requirements of modern scientific and technological development.

Keywords

Timing, Quantitative, Fixed depth, Liquid sampling device

1. Background

The concept of green development has penetrated into all aspects of social and economic development, especially the protection of water resources. Strengthening the monitoring of water quality can effectively evaluate the status of water environment, analyze the types and causes of pollution, and lay the foundation for taking reasonable treatment measures. When working water quality monitoring, it is necessary to conduct comprehensive monitoring and analysis of the sampled field water quality in order to understand the actual situation of the entire water area by samples. Therefore, on-site water quality sampling is a key link in water quality monitoring, and the quality of on-site water quality

sampling is the key factor that determines the accuracy and reliability of monitoring results. It is necessary to strengthen the control of sampling quality to ensure the timeliness, representativeness and accuracy of samples, so as to obtain reliable monitoring results, reflect the real situation of water areas and the role of water quality monitoring, and create good ecological and economic benefits.

2. Issues

Different types of device and instruments are used for field water quality sampling, and the performance of device and instruments is one of the factors affecting the quality of field water quality sampling in water quality monitoring. Especially for the sampling without the contact of appendages, the water quality sampling method has been unable to meet the work requirements of the new era. In the past, the sampler used in water quality sampling was a pure mechanical structure sampling device, and the cover on the sampler was mechanically opened by manual control rope to collect water samples. Through actual operation, it is found that the current sampling device has the following problems:

(1) In the process of liquid sampling, quantitative distribution cannot be carried out, the sampling amount cannot be accurately controlled, and the comparability of detection data is weak;

(2) The existing samplers often collect water samples at non-target depths (especially at non-collection depths near the water surface), which do not meet the sampling specifications, resulting in inaccurate sampling and large deviations in the representativeness of the sampled books;

(3) The mechanical sampling operation of the traditional sampler is easy to damage the sampling bottle, which results in the need to carry multiple spare devices during the sampling work, and increases the cost and reduces the work efficiency;

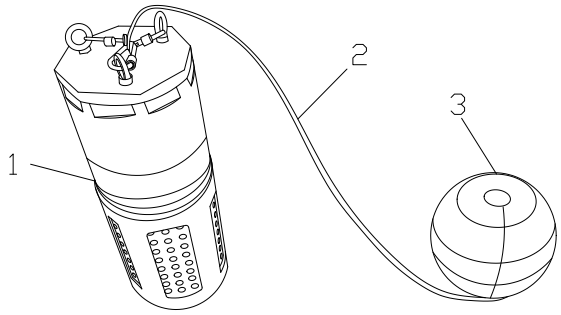
(4) There is no intelligent configuration for traditional liquid samplers.

In order to adapt to the development of the new era, this research overcomes the above shortcomings, and designs a liquid sampling device that can be timed, quantitative, and deep, which can realize 3D controllable liquid sampling with timing, quantitative and depth determination, that is, it can collect quantitative water samples at a set water depth.

3. Structure and Working Principle

3.1 Structure of the Liquid Sampling Device that Can be Timed, Quantitative, and Deep

The liquid sampling device that can be timed, quantitative, and deep is composed of a water sample collector, a floating ball, an adjustable cable chain, etc., as shown in Figure 1.



1. Water sample collector; 2. Adjustable cable chain; 3. Floating balls

Figure 1. Structure Diagram of Liquid Sampling Device with Timing, Quantitative and Depth Determination

3.2 Working Principle of Liquid Sampling Device with Timing, Quantitative and Depth Determination

The liquid sampling device which can be timed, quantitative, and deep adopts a counterweight block connected with the stainless steel drum and located at its lower end to make the center of gravity of the whole device move downwards, so that the sampling bottle is vertical and not inclined when collecting water.

A water sealing caisson located on the upper part of the stainless steel bucket is used to cover the mouth of the water sample collection bottle. When the collection bottle dives underwater, the air in the caisson and the collection bottle is sealed in the water sealing caisson so that it cannot escape upwards, thereby avoiding the collection bottle from entering water.

The rechargeable lithium battery power supply and delay integrated circuit are used. The power supply provides electric energy to the integrated circuit through the liquid level float. The integrated circuit realizes the diaphragm air pump to complete the suction action and suction volume according to the set requirements according to the remote control.

The sealed gas in the water sample collection bottle is sucked out by the diaphragm gas pump and discharged into the electronic caisson. The gas extracted from the collection bottle with reduced volume is filled by the required water sample, so as to realize the required water sample collection. The gas discharged by the diaphragm pump is discharged into the electronic caisson. In the caisson, the gas volume in the electronic caisson is increased, and the waterproof performance of the electronic caisson is increased. The gas exceeding the sealed water pressure of the caisson escapes from the gap at the bottom of the electronic caisson.

The collection device is connected to the floating ball through an adjustable length cable chain. The length between the floating ball and the mouth of the collection bottle is the set sampling water depth. The buoyancy of the floating ball meets the requirements of the sampling bottle full of water and can still float on the water surface.

4. Innovative Features

The main advantages of this device include its small size, easy portability, simple assembly and operation, and the ability to be extended to form an IoT device. Its **sampling point depth and sampling volume are controllable and adjustable**, making sample collection more representative and more in line with monitoring and collection operation specifications.

The quantitative collection and non-contact collection method is one of the biggest characteristics of the device in collection, which can be extended to other fluid sample collection, especially suitable for oil monitoring items.

The device is convenient for collecting water samples at different depths in rivers, lakes and reservoirs. The device has a silent function in the sample body, which can realize the needs of **pre-booking the collection time point and multi-point synchronous collection**. In addition to the traditional water body longitudinal monitoring function, it solves the problem of plane distribution of water samples at the same time.

In the sending and stopping of the acquisition command, the wireless remote control automatic mode is adopted, which can be sent one-to-one or one-to-many at the same time. It provides automatic link for some projects of water quality monitoring, which is in line with the requirements of modern scientific and technological development.

5. Application Prospects

The liquid sampling device with timing, quantitative and depth determination can make the water sample collector stand for a period of time after reaching the rated depth so that the water sample at the required collection place is completely consistent with the environment, and can ensure that the sampling bottle would not enter water during the stand period; During the water intake process, the water sample is not in contact with other components of the container to ensure the representativeness of the sample and reduce the sampling error; During the process of water sample collection and lifting, the collected water sample with rated depth not mixs with the water in shallow water area, which can ensure that the collected water sample is the required depth water sample; The rated depth value can be adjusted, and the length between the floating ball and the mouth of the bottle can be adjusted according to the depth requirements. Therefore, water samples can be collected for water bodies at different locations and depths, especially for water bodies with rated depths that must not be contacted twice.

This collection device developed by the combination of electronic control of basic physical principles and pressure conversion can replace the field collection device of most projects. It has a good application prospect in the fields of water environment monitoring, industrial liquid material sampling, and related colleges and scientific research institutes with higher precision requirements.

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