Research and Innovation of Rapid Test Method for Water Quality Analysis

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Abstract. Water quality safety is closely related to people's production and life, and it is necessary for human survival. In recent years, water pollution incidents occur frequently, which not only reminds us of environmental protection, but also exposes the lack of rapid detection ability of water quality analysis in China. At present, there are obvious shortcomings in the mainstream rapid detection methods of water quality analysis. Therefore, this paper puts forward the research and innovation of the rapid detection methods for water quality analysis. In this paper, the main methods of water quality analysis and detection in China are studied in depth, and the advantages and disadvantages of various methods are compared and analyzed. The results show that most of the current mainstream detection methods have the contradiction between detection cost and detection accuracy. In view of this situation, according to the actual needs of rapid detection of water quality analysis, combined with vacuum detection tube electronic colorimetry, this paper innovatively proposed a rapid detection method of water quality analysis based on vacuum detection tube electronic colorimetry. In this paper, the principle of this method is introduced in detail. Through the relevant comparative test experiments, it can be seen that in the detection experiment of pH value and nitrite concentration, the vacuum detection tube electron colorimetry method in this paper has obvious advantages over the traditional spectrophotometer. This paper analyzes that the innovation research of water quality analysis and detection is the innovation of the whole process and the whole system. Therefore, this paper puts forward the ideas and specific optimization and improvement measures for the management work, industry standards and work concept of water quality detection.

Keywords: Water Quality Testing, Chemical Analysis, PH Value Detection, Fast Detection.

1. Introduction
When the increasingly complex water environment problems, especially under the emergency monitoring and on-site monitoring conditions, for sudden pollution accidents and abnormal conditions, the real-time and rapidity of detection data are particularly required [1-3]. Therefore, higher requirements are put forward for the ability of water quality analysis and detection personnel. How to ensure the accuracy of the detection method and improve the detection effect in the shortest time has become an important problem that water quality analysis experts must face and solve [4-6].
The development of environmental science depends largely on analysis and testing. In the face of complex water environment, water quality analysts have the responsibility to obtain the required information, carry out accurate detection through relevant data, and formulate corresponding solutions according to the test results. However, in most detection practices, it is often unable to provide complete detection conditions, especially for sudden water pollution events, with simple conditions, complex and changeable environment, and high detection intensity [7-8]. But at the same time, it is required that the water quality analysis and detection should be fast enough and accurate; otherwise it may bring great threat to people's production and life safety. Through the trend analysis of the current rapid detection method research, experts pay more and more attention to a method that can be compared with or better than the conventional detection method. Therefore, rapid, simple and miniaturized water quality analysis and testing has become the mainstream trend of technological innovation in this field [9-10].

This paper deeply studies the main methods of rapid detection of water quality analysis in China, and understands that there are many deficiencies in the field of rapid detection of water quality analysis in China. Mainly reflected in the method of high accuracy, high cost, and complex operation, not practical; and simple, low-cost method is not high precision, lack of stability contradiction. Therefore, this paper puts forward the research and innovation of water quality analysis rapid test method, and hopes to optimize and improve the existing water quality analysis and detection methods through the proposed rapid detection method based on vacuum detection tube electronic colorimetry, so as to improve the overall ability of water quality analysis and detection in China. In view of the existing problems, based on the innovative concept, this paper optimized and innovated the working concept, hydrological measurement and reporting, management mechanism and other links in the traditional water quality analysis and detection, and formed a complete set of fast and efficient water quality detection system. It covers all aspects of practical operation, information transmission, and the whole workflow of supervision and management. Compared with the traditional spectrophotometer detection method, the detection accuracy is greatly improved, and the cost is lower, which is suitable for wide application.

2. Shortcomings of Traditional Detection Methods and Vacuum Tube Electron Colorimetry

2.1 Design Defects of Conventional Water Quality Detection Methods
The principle of spectrophotometer is to follow Langer Beer law. The design idea is to reduce the volume of the instrument by fixing single or multiple wavelength slits. The reagent is packaged into small package, that is, reagent assembly, which is easy to carry. However, for the non-laboratory water quality analysis and detection with complex environmental factors such as noise and vibration, the measurement of single wavelength signal itself has great uncertainty, and the fixed wavelength value is not the best choice for all parameters to be measured. Therefore, the miniaturized spectrophotometer does not have technical advantages in the field of rapid detection of water quality analysis, especially in the complex field environment, and even brings large detection error. At the same time, the detection method is also cumbersome, which may bring secondary pollution to the detection site.

2.2 Key Technology of Vacuum Tube Electron Colorimetry

2.2.1. Trichromatic principle. The different proportion structure of red, green and blue primary colors determines the different display colors in the visible light region. The fine structure change information of "three primary colors" obtained by chemical color reaction in the detection tube is digitized. Through the integral calculation, the corresponding functional relationship between different concentrations of the tested substance can be obtained. Panchromatic analysis instrument has good adaptability and stability. In complex application environment, it can fundamentally solve the key technical problems such as instability and poor reliability of field detection technology instruments.
2.2.2. The robust principle of metrology method. When there is a small deviation between the system and the hypothesis, the impact can be ignored; when the deviation is large, it can be compensated by technical adjustment, so the measurement method itself has advantages. This principle determines the development idea of rapid detection method for water quality analysis based on vacuum detection tube electron colorimetry. In the design of the detection system, high-precision chroma sensor, CPU control chip and integrated circuit technology are used to support the storage of the system. The full spectrum scanning and integral data smoothing of the test results are carried out to ensure the stability of the water quality analysis and detection results.

2.2.3. Main technical features.

1) The multi-step chemical reaction is integrated into one step (or less) reaction, which simplifies the test process to the maximum extent, reduces the error nodes, and makes the test results of non-professional operation accurate and reliable.

2) The automatic quantitative sampling technology of the detection tube makes the highly professional detection technology become a "fool type" testing product, which avoids human error and can quickly reflect the real water quality.

3) The detection solution is stored in the detection tube as an intermediate, and each tube is sealed in a vacuum. It can realize automatic quantitative sampling, prolong the shelf life of products and improve the characteristics of products. At the same time, it can reduce the waste of reagent after unsealing and avoid waste.

3. Common Methods of Water Quality Detection

Different detection methods have their own characteristics and advantages, so the scope of application is also different. In the actual detection process, the appropriate detection method should be selected according to different water quality. For example, the common water quality detection methods, spectrophotometry is suitable for the detection of non-metallic ions. In this paper, the characteristics of the commonly used methods in water quality detection are statistically analyzed, as shown in Table 1.

**Table 1. Comparison of various water quality analysis methods**

| method                          | Scope of application                        | advantage                                      | shortcoming                               |
|---------------------------------|---------------------------------------------|-----------------------------------------------|-------------------------------------------|
| Chemical titration              | PH, BOD, hardness, conventional water quality | It is more accurate                           | Complex operation                         |
| Electrochemical analysis        | PH, dissolved oxygen, metal ions, etc        | Accurate, high and cheap                      | Poor selectivity                          |
| Spectrophotometry               | Organic matter, inorganic substance         | Wide range of applications, fast, low cost    | Not suitable for high concentration detection |
| Analytical chromatography       | Organic compounds, anions and cations       | High efficiency, less dosage                  | Time consuming and high cost              |
| Atomic emission spectrometry    | Polymetallic elements                       | High speed, multi-element detection at the same time | The accuracy is not stable                |
| Atomic Fluorescence Spectrometry| Polymetallic elements                       | High sensitivity, less interference           | High cost and unstable                    |
| Mass spectrometry              | Organic matter, inorganic matter            | Wide application, high precision and high efficiency | High cost and complex maintenance         |
4. Discussion

4.1 Water Quality Detection Method

4.1.1. Water sample. 3.5L pure water was selected and divided into 8 samples according to the experimental requirements, including four for pH value detection and nitrite concentration detection. Add reagents to the samples to prepare different concentrations of experimental samples.

4.1.2. Experimental methods. The capillary part of the detection tube is completely immersed in the water sample to be tested, and the capillary tube is broken. The water sample to be tested is automatically filled into the tube, and it is inverted dozens of times to make the liquid in the tube fully mixed. Insert the detection tube into the socket of heating reactor and cover it with plexiglass cover. The detection tube was heated at 130 ± 1 °C for 20 min. After cooling to room temperature, wipe the detection tube, insert it into the socket of tester, and test according to the operation procedure of tester.

4.1.3. Inspection instrument. Monitoring instruments include ultraviolet visible spectrophotometer, electronic colorimeter, hash portable spectrophotometer, Hannah multi parameter water quality analyzer, etc.

4.2 Objectives of Technical Innovation of Hydrological Measurement Methods

4.2.1. Work concept innovation. The traditional hydrological survey is to establish a database, in the detection work, what kind of hydrological data, retrieval methods, data forms are needed, which are often not considered by the water quality testing personnel. In the innovation of work concept, the relevant personnel of hydrological detection should establish a new concept of hydrological work, and comprehensively consider the data and methods.

4.2.2. Technical innovation of hydrological survey report. The traditional hydrological survey report has low accuracy and high operation cost, so it is difficult to combine the measurement data with modern information tools. The relevant departments should realize the importance of using modern measurement reporting tools, gradually update the measurement reporting tools, and realize the integrated operation of reports.

4.2.3. Management mechanism innovation. The management mechanism formulated by relevant departments should be combined with the measurement report technology, and the detection equipment needs to be tested before measuring and reporting. In order to improve the efficiency of measurement report, it is necessary to optimize the management system, so that the management system can not only develop in the direction of humanization, but also complete the work effectively and with high quality.

4.3 Optimization of Test Methods

From the current hydrological work point of view, usually only the hydrological measurement data and the remaining measurement data are recorded in the actual work, the data is not detailed and too simple. Therefore, the main method to optimize the hydrological measurement method is to add the measured data of sediment and discharge. In the actual measurement, professional equipment should be used according to the existing specifications, combined with the measurement experience of relevant personnel, and the work objectives of each stage of hydrological survey should be determined scientifically. However, in the specific work, it is necessary to adjust the measurement method according to the hydrological characteristics of the river and the hydrological data of the stations.
4.4 Determination of the Accuracy Index of Hydrologic Measurement Results
Measurement accuracy, calculation accuracy and economic accuracy are important components of hydrological measurement accuracy. The innovation of hydrological measurement method will directly affect the measurement accuracy and economic accuracy. Measurement accuracy is the quality of current test results, and economic accuracy can be scientifically analyzed through the relationship between cost and benefit. To ensure the accuracy of the test results, it is necessary to coordinate the accuracy of the actual measurement with the accuracy of the overall economy, and give full attention. When choosing the corresponding test method, we must choose the labor-saving method to calculate the accurate data accuracy with the smallest measurement data, so as to make the compilation method more labor-saving.

4.5 Reform the Management of Hydrometry
Change the distribution of hydrological funds. According to the previous data, the main way to obtain hydrological work funds is state-owned allocation, and there is a direct relationship between the number of tests and the amount of funds. If the relationship between the two is not handled properly, a lot of waste will be generated during this period, which will directly affect the scientificity of the test results. In view of this relationship, the allocation of hydrological funds by the state must refer to the actual situation, not based on a single number of trials, so as to create good conditions for the formulation of development plans. At the same time, the use of advanced technology has changed the traditional station mode. At present, China's hydrological detection is mainly based on inspection. Therefore, in the actual work process, we should change the traditional mode of standing point work, strengthen the mobility of personnel, and make full use of technical resources.

5. Conclusions
In the research process, the main existing water quality analysis and detection technologies are compared and analyzed, and it is found that there is a main contradiction between the detection accuracy and the detection cost in the field of water quality analysis and detection. Moreover, most of the water quality analysis and detection methods have low detection efficiency, poor stability and small scope of application, which seriously limits the overall level of water quality analysis and detection in China, leading to the lack of rapid detection ability to deal with sudden water pollution incidents. The rapid detection method of water quality analysis based on vacuum detection tube electronic colorimetry proposed in this paper, to a certain extent, makes up for the shortcomings of the traditional water quality analysis and detection methods, improves the detection accuracy, reduces the detection cost, and also has the characteristics of fast and practical. In this paper, it is considered that the vacuum tube electronic colorimetric method is a new technological innovation, which greatly improves the problem of insufficient water quality analysis and detection ability in China. In order to thoroughly improve the ability of water quality detection in China, it is far from enough to rely on the innovation of detection technology. Therefore, this paper puts forward optimization and improvement measures for the existing work concept, management system and industry standards. The analysis shows that the research in this paper has achieved ideal results and made a contribution to the research of rapid detection of water quality analysis in China.

References
[1] Adegbite, A. (2015). Comparative assessment of field methods for microbiological water quality testing in emergencies. International Journal of Development Research, 5(7), 4908-4915.
[2] Bornhorst, T. J., & Logsdon, M. J. (2016). Predicting future water-quality impacts from mining: a 52-year-old field analog for humidity cell testing, copperwood deposit, michigan. Economic Geology, 111(2), 527-542.
[3] McNally, A. (2020). Beyond the tap: engaging students through a service learning, community-based water quality testing exercise. The Geography Teacher, 17(2), 56-61.
[4] Gan Xiaolu, Meng Dandan, & Zhu Zhifang. (2019). Application research of test paper method in food and water quality testing. Chemical Engineering Design Communications, 045 (007), 125-126.

[5] Xiaojing Li. (2019). First exploration of "online + offline" blended teaching in "water quality testing" course. Creative Education Studies, 07(6), 795-800.

[6] Zeng Pinfeng, & Ding Yinhui. (2017). Review of urban water quality testing technology. Northern Environment, 029 (009), 134-135.

[7] Carla, J., Pollard, Michelle, P., & Stockwell, et al. (2017). Combining ex situ and in situ methods to improve water quality testing for the conservation of aquatic species. Aquatic Conservation: Marine and Freshwater Ecosystems, 27(2), 559-568.

[8] Pollard, C. J., Stockwell, M. P., Bower, D. S., Clulow, J., & Mahony, M. J. (2017). Combining ex situ and in situ methods to improve water quality testing for the conservation of aquatic species. Aquatic Conservation Marine & Freshwater Ecosystems, 27(2), 559-568.

[9] Cronin, A. A., Odagiri, M., Arsyad, B., Nuryetty, M. T., Amanullah, G., & Santoso, H., et al. (2017). Piloting water quality testing coupled with a national socioeconomic survey in yogyakarta province, indonesia, towards tracking of sustainable development goal 6. International journal of hygiene and environmental health, 220(7), 1141-1151.

[10] Toban, T., Yohanis, S., & Nathaniel, L. (2017). Information system water quality testing. International Journal of Computer Applications, 172(6), 30-35.