An Introduction to Water Quality Analysis

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Abstract - *Water is perhaps the most precious natural resource after air. Though the surface of the earth is mostly consists of water, only a small part of it is usable, which makes this resource very limited. This precious and limited resource, therefore, must be used with prudence. As water is required for different purposes, the suitability of it must be checked before use. Also, sources of water must be monitored regularly to determine whether they are in sound health or not. Poor condition of water bodies are not only the indictor of environmental degradation, it is also a threat to the ecosystem. In industries, improper quality of water may cause hazards and severe economic loss. Thus, the quality of water is very important in both environmental and economic aspects. Thus, water quality analysis is essential for using it in any purpose. After years of research, water quality analysis is now consists of some standard protocols. There are guidelines for sampling, preservation and analysis of the samples. Here the standard chain of action is discussed briefly so that it may be useful to the analysts and researchers.*

Key Words: Water Quality Monitoring, Water Quality Assessment, Water Quality Analysis, Chain of Custody

1. INTRODUCTION

1.1 What is Water Quality?

Water Quality can be defined as the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use.

Water can be used for recreation, drinking, fisheries, agriculture or industry. Each of these designated uses has different defined chemical, physical and biological standards necessary to fulfil the respective purpose. For example, there are stringent standards for water to be used for drinking or swimming compared to that used in agriculture or industry.

1.2 What is Water Quality Analysis?

After many years of research, water quality standards are put in place to ensure the suitability of efficient use of water for a designated purpose. Water quality analysis is to measure the required parameters of water, following standard methods, to check whether they are in accordance with the standard.

1.3 Why Water Quality Analysis is required?

Water quality analysis is required mainly for monitoring purpose. Some importance of such assessment includes:

(i)   To check whether the water quality is in compliance with the standards, and hence, suitable or not for the designated use.

(ii) To monitor the efficiency of a system, working for water quality maintenance

(iii) To check whether upgradation / change of an existing system is required and to decide what changes should take place

(iv) To monitor whether water quality is in compliance with rules and regulations.

Water quality analysis is of extremely necessary in the sectors of:

- Public Health (especially for drinking water)
- Industrial Use

2. PROCEDURES OF WATER QUALITY ANALYSIS

The steps for water quality analysis in general is mentioned in Figure-1.

2.1 Selection of Parameters

The parameters of water quality are selected entirely according to the need for a specific use of that water. Some examples are:

Drinking: As per WHO/CPCB Standards

Irrigation:

pH
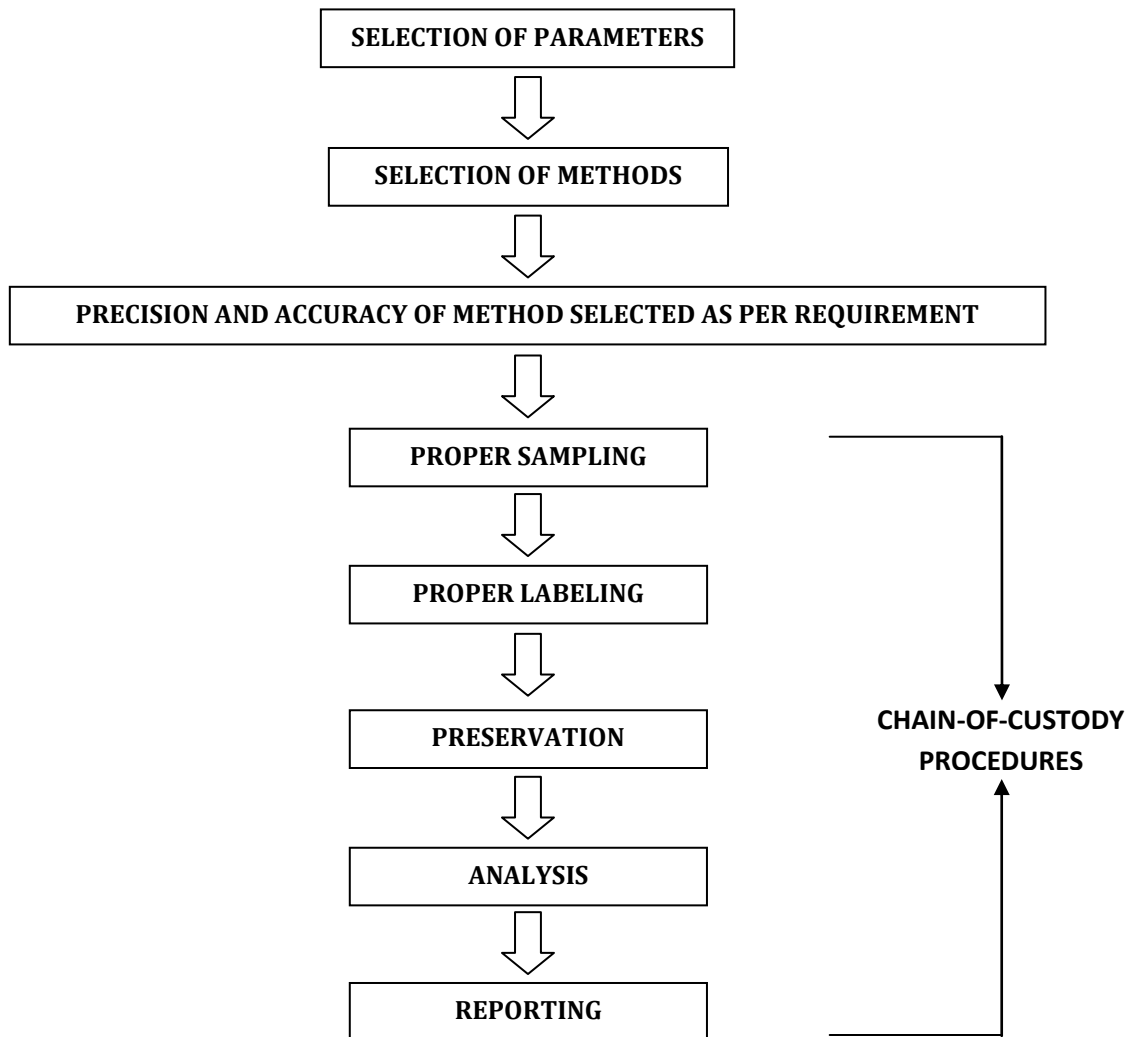
Conductivity

Sodium & Potassium

Nutrients

Specific compounds

Industries: As per specific requirement

Domestic Consumption: As per BIS Standards

Water Bodies: As per CPCB guidelines

However, some of the most common parameters assessed for checking potability and industrial use in India are in Figure-2.

Figure -1: Steps for Water Quality Analysis

2.2 Selection of Methods

The methods of water quality analysis are selected according to the requirement. The factors playing key role for the selection of methods are:

(i)   Volume and number of sample to be analyzed

(ii) Cost of analysis

(iii) Precision required

(iv) Promptness of the analysis as required

## 2.3 Precision and Accuracy of Method Selected as per Requirement

What precision and accuracy to be maintained against a particular method is decided according to the objective of the monitoring. The factors influencing this decision includes:

- Budget of Monitoring System
- Parameters to be Monitored
- Use of the Water

2.4 Chain–of–Custody Procedures

Properly designed and executed chain-of-custody forms will ensure sample integrity from collection to data reporting. This includes the ability to trace possession and handling of the sample from the time of collection through analysis and final disposition. This process is referred to as "chain-of-custody" and is required to demonstrate sample control

Figure -2: Parameters for Water Quality Analysis
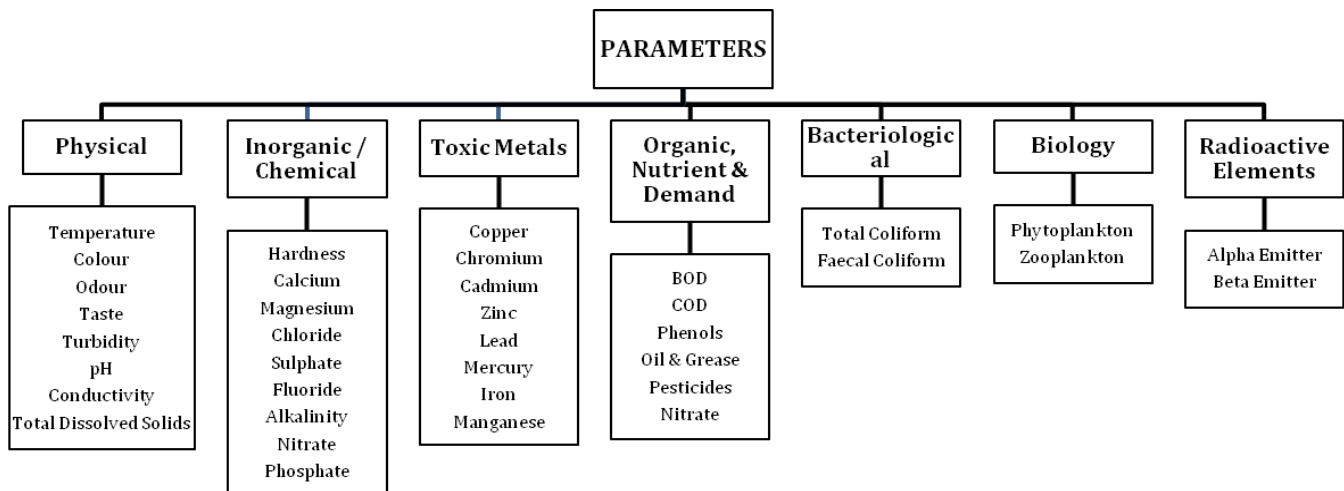
when the data are to be used for regulation or litigation. Where litigation is not involved, chain-of-custody procedures are useful for routine control of samples.

A sample is considered to be under a person's custody if it is in the individual's physical possession, in the individual's sight, secured and tamper-proofed by that individual, or secured in an area restricted to authorized personnel. The following procedures summarize the major aspects of chain-of-custody:

(i) Sample Labels: Labels are used to prevent sample misidentification as well as to identify the collector, if required. In other words, labeling ensures the responsibility and accountability of the collector.

(ii) Sample Seals: Sample seals are used to detect unauthorized tampering with samples up to the time of analysis. So, it is essential to seal a sample before leaving the custody of the collector. Sealing must be done in such a way as one have to break the seal to access the sample.

(iii) Field Log Book: All the useful information related to a field survey or sampling should be recorded in a Log Book. At least the following data should be in the log book:

    (a)   Purpose of sampling

    (b)   Location of sampling point

    (c)   Name and address of field contact

    (d)   Producer of material being sampled and address, if different from location

    (e)   Type of sample

    (f)   Method, date, and time of preservation.

(iv) Sample Analysis Request Sheet: The sample analysis request sheet accompanies samples to the laboratory. The collector completes the field portion of such a form that includes most of the pertinent information noted in the log book. The laboratory portion of such a form is to be completed by laboratory personnel and includes: name of person receiving the sample, laboratory sample number, date of sample receipt, condition of each sample (i.e., if it is cold or warm, whether the container is full or not, color, if more than one phase is present, etc.) and determinations to be performed.

(v) Sample Delivery to the Laboratory: Sample(s) should be delivered to laboratory as soon as possible after collection, typically within 2 days. Where shorter sample holding times are required, special arrangements must be made to insure timely delivery to the laboratory. Where samples are shipped by a commercial carrier, the waybill number to be included in the sample custody documentation. Samples must be accompanied by a complete chain-of-custody record and a sample analysis request sheet.

(vi) Receipt and Logging of Sample: In the laboratory, the sample custodian inspects the condition and seal of the sample and reconciles label information and seal against the chain-of-custody record before the sample is accepted for analysis. After acceptance, the custodian assigns a laboratory number, logs sample in the laboratory log book and/or computerized laboratory information management system, and stores it in a secured storage room or cabinet or refrigerator at the specified temperature until it is assigned to an analyst.

(vii) Assignment of Sample for Analysis: The laboratory supervisor usually assigns the sample for analysis. Once the sample is in the laboratory, the supervisor or analyst is responsible for its care and custody.

(viii) Disposal: Samples are held for the prescribed amount and duration for the project or until the data have been reviewed and accepted. Samples are disposed usually after documentation. However, disposal must be in accordance with approved methods.

2.5 Proper Sampling

Proper sampling is a vital condition for correct measurement of water quality parameters. Even if advanced

techniques and sophisticated tools are used, the parameters can give an incorrect image of the actual scenario due to improper sampling. The proper sampling should fulfill the following criteria:

(i) Representative: The data must represent the wastewater or water body being sampled. So, the following factors must be well planned for proper sampling:

  (a)   Process of Sampling

  (b)   Sampling size/volume

  (c)   Number of Sampling Locations

  (d)   Number of Samples

  (e)   Type of Samples

  (f)   Time Intervals

During sampling, these factors must also be taken care of:

  •   Choosing of proper sampling container

  •   Avoiding contamination

  •   Ensure the personal safety of the collector

(ii) Reproducible: The data obtained must be reproducible by others following the same sampling and analytical protocols.

(iii) Defensible: Documentation must be available to validate the sampling procedures. The data must have a known degree of accuracy and precision.

(iv) Useful: The data can be used to meet the objectives of the monitoring plan.

2.6 Proper Labeling

Proper labeling prevents sample misidentification and ensures the responsibility and accountability of the collector. The sample container should be labeled properly, preferably by attaching an appropriately inscribed tag or label. Alternatively, the bottle can be labeled directly with a water-proof marker. Barcode labels are also available nowadays.

Information on the sample container or the tag should include at least:

  (i)   Sample code number (identifying location)

  (ii)   Date and time of sampling

  (iii)   Source and type of sample

  (iv)   Pre-treatment or preservation carried out on the sample

  (v)   Any special notes for the analyst

  (vi)   Sampler's name

2.7 Preservation

Usually a delay occurs between the collection and analysis of a sample. The characteristics of the sample can be changed during this period. Therefore proper preservation is required in the way to laboratory after collection, and in the laboratory upto when analysis starts.

Complete and unequivocal preservation of samples, whether domestic wastewater, industrial wastes, or natural waters, is a practical impossibility because complete stability for every constituent never can be achieved. At best, preservation techniques only retard chemical (especially, hydrolysis of constituents) and biological changes that inevitably continue after sample collection.

No single method of preservation is entirely satisfactory; the preservative is chosen with due regard to the determinations to be made. Preservation methods are limited to pH control, chemical addition, the use of amber and opaque bottles, refrigeration, filtration, and freezing.

2.8 Analysis

The samples, after reaching laboratory, are analyzed, according to the requisite parameters, following standard methods and protocols.

2.9 Reporting

The ultimate procedure of water analysis is to prepare a proper report against the submitted requisition. The report must be authenticated before handing over the authority. All data should be kept in the laboratory log and preferably in laboratory database.

An alternative way to present the overall quality of water is to express it in the form of Water Quality Index (WQI). WQI is a concise numerical representation of overall water quality of a water body, which is convenient to interpret and used widely. WQI expresses the overall quality of water with a single digit, instead of many digits for all the WQP. Thus, it is readily conceivable for common people.

3. CONCLUSION

Assessment of water quality is essential to check the suitability of a water source for the designated use. Several water quality parameters are assessed and compared with their standard values to determine the acceptability of the water to be used. After prolonged research, the procedures for the assessment of the water have been standardized. In this article such guidelines are discussed concisely in one place for the convenience of the researchers and analysts. Thus, it may be helpful for them to get an overview of the water quality assessment standards and procedures.

REFERENCES

[1]   American Public Health Association and American Water Works Association 1999 Standard Methods for the Examination of Water and Wastewater. 20th Ed, Washington, D.C., USA

[2] Brown R. M., McClelland N. I., Deininger R. A., Tozer R. G. 1970 A water quality index- do we dare? Water and Sewage Works, October 1970, 339-343

[3] Bureau of Indian Standards 2012 Indian Standard Drinking Water Specification (Second Revision)

[4] Deshpande L. undated Water Quality Analysis: Laboratory Methods. National Environmental Engineering Research Institute (NEERI), Nagpur, Council of Scientific & Industrial Research, New Delhi, Govt. of India

[5] Kori R., Parashar S., Basu, D.D. undated Guide Manual: Water and Wastewater Analysis. Central Pollution Control Board, Ministry of Environment and Forest, India

[6] Metcalf E., Eddy H. 2003 Wastewater Engineering: Treatment and Reuse. Tata McGraw-Hill Publishing Co Ltd, India.

[7] Roy R. 2018 An Approach to Develop an Alternative Water Quality Index Using FLDM. In: Majumder M. (eds) Application of Geographical Information Systems and Soft Computation Techniques in Water and Water Based Renewable Energy Problems. Water Resources Development and Management. Springer, Singapore, 51-68

[8] Roy R., Majumder M. 2017 Comparison of surface water quality to land use: a case study from Tripura, India. Desalination and Water Treatment, 85, 147-153

[9] Roy R., Majumder M. 2018 A Quick Prediction of Hardness from Water Quality Parameters by Artificial Neural Network. International Journal of Environment and Sustainable Development, 17(2/3), 247-257

[10] Tyagi S., Sharma B., Singh P., Dobhal R. 2013; Water Quality Assessment in Terms of Water Quality Index. American Journal of Water Resources, 1(3), 34-38

[11] World Health Organization 2004 Guidelines for Drinking-Water Quality (3rd edition)

BIOGRAPHY

Mr. Ritabrata Roy was born in Kolkata and a currently resides in Budge Budge, a suburb of Kolkata, West Bengal, India. He completed schooling from Ballygunge Govt High School, Kolkata. After completion of his M.Sc. in Environmental Science from Vidyasagar University, he joined West Bengal Biodiversity Board as a Project Fellow. Later he joined NIT Agartala as Technical Assistant in the School of Hydro-Informatics Engineering. His area of interests are Water Quality and its Modeling and Environmental Issues. Presently, he is doing his PhD from NIT Agartala. His likes to read any kind of books and fond of photography.