ANALYSIS OF WATER QUALITY

Yurii A. Klyachko (Deceased**)**
Faculty of analytical chemistry in the All-Russia research and development institute of a food-processing industry, Russia

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Contents

Summary

The most important criteria and parameters of quality of potable water and waste water

are considered in this article, and methods for determination of content of various substances affecting water quality are discussed. Also, the most important physical and chemical parameters of water used in various spheres of human activity are described. The basic methods for quality control are described for waste water.

1. Introduction

Water quality, as in general the quality of any item or phenomenon, is the combination of properties (of water in this case) that are manifested in relation to human, other living creatures, items and substances. The exclusive position of water on our planet as a whole was expressed most objectively by the one of the outstanding Russian scientist of the twentieth century, V.I. Vernadsky: "There is not any natural body that could be compared {*with water*} by its influence of the course of the fundamental and most colossal geological processes. Not only earth surface, but deeper parts of the planet (in the scale of the biosphere) are determined in the most important of their manifestations by its existence and its properties". Due to the diversity of the natural forms of the existence of water and diversity of forms of water using by humans (biological and technical), the vast multiplicity of water properties was explored (physical, chemical, biological, and technological). Correspondingly, different classifications of natural waters (e.g. for consumption) were developed. In essence, every specific sort of water requires a special method of quality analysis. However, in practice, general methods of analysis of large groups of water are used: natural water for potable water supply, industrial for use in the production processes, and waste water for discharge into water basins or for further use. The following is a classification of "working" water arranged according to the limitations of its utilization:

- household and potable water and also water for the food and fermentation industry;
- cooling water (for elements of cooling systems of condensers and for systems of freezing products in refrigerators;
- water for use in the steam energetic plants;
- technical water for use in certain manufacturing processes (textile works, pulp and paper plants, tanneries, etc.);
- irrigation water, etc.

Depending on the field of application of the water, the specific requirements are presented for its quality along predetermined parameters.

Several requirements are established for potable water:

1. Temperature, 0 – 30 ^{o}C.
2. Turbidity, not more than 1 mg l^{-1}
3. Color index(degrees of specially introduced scale), 15 - 20 ^{o}C.
4. Odor and aftertaste (points), not more than 2
5. Transparency (on type), not more than 30 cm
6. Total hardness (mg-equiv.), not more than 7
7. Coli-index (number of bacteria *Escherichia coli* in 1000ml of water), not more than 3
8. Coli-titer (the smallest volume of water containing one bacterium *Escherichia*

coli), 300 ml
9. Total oxidizing capability (oxygen on the potassium iodate), 4 mg l^{-1}
10. Containing some elements (mg l^{-1}): lead not more than 0.1; arsenic not more than 0.05; fluorine not more than 1.5; copper not more than 3.0; zinc not more than 3.0; iron not more than 0.3; residual active chlorine (relating to potassium iodide) 0.3 – 0.5; phenol (absence ofchlorophenol odor) 0.001
11. Hydrogen index (characteristic of the active reaction, acidity), pH 6.6 – 9.5
12. Maximum permissible level of radioactivity for potable water on the α-emitters 10^{-9} mCu l^{-1} or 3.7×10^{6} Bk.

The data listed are related to relatively pure, unpolluted potable water. However, even natural waters are characterized by different specific features of their composition and properties depending on their origin. That means that some supplements for cited content of the investigated parameters of potable water are required. Characteristics of waste water are increased considerably, depending on its origin. This is why the maximum list of presently accepted parameters for investigating the composition and properties of waste water covers the whole range of possible methods discussed below. The best versions of these methods will be presented here.

2. General methods of waste water analysis

2.1. Organoleptic properties

2.1.1 Color of water

The color of water is determined by the measurement of optical density (absorptivity) on a spectrophotometer at various wavelengths of the passing light. The wavelength of the light that is maximally absorbed by water is the characteristic of its color (see Table 1). The water under investigation should first be filtered to eliminate possible turbidity. The visible water color is supplementary to the absorbed color measured by spectrophotometer. The value of optical density (absorptivity) is a measure of the color intensity.

Wave length of the absorbed light, nm	Color of the absorbed radiation	Supplementary (visual) color of the investigated water
400 – 450	Violet	Yellow green
450 –480	Dark blue	Yellow
480 – 490	Green blue	Orange
490 – 500	Blue red	Red
500 – 560	Green	Purple
560 – 575	Yellow green	Violet
575 – 590	Yellow	Dark blue
590 – 605	Orange	Green blue
605 – 730	Red	Blue green
730 – 760	Purple	Green

Table 1. Wavelength of the spectrum and corresponding colors.

The rules and regulations on the discharge of waste water into water basins require that the water in the water basins should not possess visible color in a layer with thickness of 10 cm. This is why the degree of dilution of waste water is determined in practice, at which the water color becomes negligible. To determine the degree of dilution, three glass cylinders with diameter 20 to 25 mm are taken and placed on a paper sheet. The waste water is poured into one of them to form a layer with a thickness 10 cm. The same volume of distilled water is placed in the second cylinder. The same waste water diluted a few times consecutively with pure water is placed into the third cylinder. The operation of diluting is repeated until the water in the third cylinder becomes colorless, like the distilled water in the second cylinder. The water sample to be analyzed should be filtered and analyzed two hours after take-off by the measuring on the spectrophotometer in a few wave lengths of transmitted light.

An older visual method of determination of color index of water is used in fieldwork. Quantitative determination of the water color (called water color index) is carried out by colorimetric analysis, i.e. cobalt solutions (potassium chloroplatinate K_2PtCl_6 mixed with cobalt chloride $CoCl_2 \cdot 6H2O$). The primary reference solution is prepared as a mixture of 1.246 g of platinum salt with 1.009 g of crystalline cobalt chloride hexahydrate. These amounts of salts are dissolved in 100 ml of distilled water; 100 ml of hydrochloric acid with specific density 1.19 g cm^{-3} is added to this solution, and its volume is adjusted to 1.0 l with distilled water. The color index of the obtained solution is taken as 500^o, because it contains 500 g of pure platinum per 10^6 ml of water. Standard solutions are prepared from various amount of the primary solution:

- No. 1 – color index 0^o (distilled water);
- No. 2 – 10^o (4 ml of primary solution are diluted with distilled water to a volume of 200 ml);
- No. 3 – 20^o (as reference solution No. 2, but prepared of 8 ml of primary solution);
- No. 4 – 30^o (as reference solution No. 2, but prepared of 12 ml of primary solution);
- No. 5 – 40^o (as reference solution No. 2, but prepared of 16 ml of primary solution).
- Further reference solutions are prepared by analogy till the solution No. 9:
- No. 9 – 80^o (as reference solution No. 2, but prepared of 32 ml of primary solution).

The water under investigation is compared with the reference solutions using a set of similar cylinders made of colorless glass, and so its color index is determined. The color index of the natural water depends on the presence of humic acids in the soil, on biological processes (water florescence), and on pollutants of various origin. This latter factor is decisive for waste water.

2.1.2 Odor of water

Two groups of odors are differentiated in water and wastes. These groups differ one

from another, and are designated in different ways in the protocols of odor investigations. Unnatural odors are designated by the Latin letter S. Odors of natural origin are separated into two groups: non-putrefactive odors are designated by the Latin letter R (odors of flowers, wood bark, earth, hay, moss, etc.), and putrefactive odors are designated by Latin letter G (putrefactive odors of decay of organic compounds, odors of spoiled eggs, fecal and musty odors). The odor of waste waters is determined by the diverse sources of their formation (household, industrial, agricultural, atmospheric, etc.) and by the products of interaction of their components. The odor of potable water is often determined by the substances used for its preliminary treatment.

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Biographical Sketch

Yurii A.Klyachko was former head of the faculty of analytical chemistry in the All-Russia research and development institute of a food-processing industry. His interest was in scientific researches and development in the field of analysis of a structure both properties of different chemical agents and articles of food.