BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg

HYGIENIC ASSESSMENT OF ORGANIC POLLUTION OF WATER BODIES: INDICATORS AND ASSESSMENT PROCEDURE

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Abstract. Organic pollution of surface water bodies deteriorates water quality, disrupts aquatic ecosystems and creates risks to public health. This article describes the hygienic approach to assessing organic pollution of water bodies and the main indicators on which it is based. The assessment procedure includes a sanitary survey of the water body, selection of control points above and below the wastewater inflow, sampling, laboratory analysis and comparison of the results with the sanitary norms that correspond to the type of water use. The key indicators are dissolved oxygen, biochemical oxygen demand (BOD_5), chemical oxygen demand (COD) and permanganate oxidizability, nitrogen compounds (ammonia, nitrites and nitrates), chlorides, sulfates and sanitary-bacteriological parameters. No single indicator gives a complete picture; their mutual ratios show the intensity, age and danger of pollution. Protective measures include wastewater treatment, establishment of water protection zones, water-saving technologies, regular laboratory control and public education. Hygienic assessment is therefore not only a laboratory procedure but also an important tool for protecting population health.

Keywords: organic pollution; water bodies; hygienic assessment; dissolved oxygen; BOD_5; COD; nitrogen compounds; sanitary microbiology.

1. Introduction

Water is the basis of life, yet water taken from a river or a reservoir is not always suitable for drinking or bathing. Every day, domestic and industrial wastewater and runoff washed from agricultural land bring a large amount of organic matter into water bodies. These substances are invisible, but they can seriously threaten water quality, the ecosystem and human health [1, 3]. Environmental factors affect population health in different ways and often show regional features [2]; for this reason sanitary physicians and hygienists regularly monitor and assess the organic pollution of water bodies.

Organic pollution is an increase in the content of carbon-containing substances in water that come from plant and animal residues, food waste, feces, dairy and meat-processing plants, tanneries, textile enterprises and other sources. Industrial production is one of the important sources of such loads on the environment [5]. In water, these substances are decomposed by microorganisms, and the process consumes dissolved oxygen. The stronger the pollution, the faster the oxygen content falls.

Natural water bodies are able to purify themselves: bacteria, algae and small aquatic animals gradually break down organic substances to mineral compounds. However, this capacity is limited. When the amount of wastewater exceeds the permissible level, oxygen is depleted, decomposition

turns into putrefaction, an unpleasant odor appears and the natural balance of the water body is disturbed.

The aim of this article is to systematize the hygienic indicators and the procedure used to assess the organic pollution of water bodies, to explain their hygienic significance and to outline the main protective measures.

2. Methods

2.1. Study design

This work is a descriptive analytical review of the hygienic approach to the assessment of organic pollution of water bodies. No original laboratory measurements were carried out, and no new numerical data were generated. The reference values given below are the approximate norms accepted in the hygienic practice described in this article; the exact values depend on the regulatory document in force and on the category of water use.

Hygienists do not rely on a single indicator but use a set of indicators. The assessment is carried out in the following stages.

2.2. Sanitary survey

Sources of pollution on the bank of the water body are identified: wastewater discharge pipes, industrial enterprises, livestock areas and residential settlements. The condition of water protection zones is also studied.

2.3. Selection of control points and sampling

Samples are usually taken above the point of wastewater inflow (as a control) and below it. Comparison of the results from these two points clearly shows the effect of pollution. Samples are collected in special containers according to established rules and delivered to the laboratory promptly. Separate requirements exist for oxygen and bacteriological analyses.

2.4. Laboratory analysis

Physicochemical and microbiological indicators are determined: dissolved oxygen, biochemical oxygen demand over five days (BOD_5), chemical oxygen demand (COD) and permanganate oxidizability, nitrogen compounds, chlorides, sulfates, total microbial count, *Escherichia coli* (*E. coli*) and coliphages.

2.5. Comparison with norms and hygienic conclusion

The obtained values are compared with the sanitary rules and norms that correspond to the type of water use. Requirements for a water body used as a source of drinking water are stricter than those for a water body used for cultural and household purposes. At the final stage a hygienic

conclusion is formulated: the degree of pollution, its cause and the risk to public health are assessed, and the necessary measures are recommended.

3. Results

The assessment of organic pollution is based on the following groups of indicators. Their main features are summarized in Table 1.

3.1. Dissolved oxygen

Because oxygen is required for the decomposition of organic substances, its concentration is one of the most important signs of the pollution level. According to the norm, the dissolved oxygen content in a water body in the summer period should be at least 4 mg/L. A decrease in oxygen indicates an increase in pollution.

3.2. Biochemical oxygen demand (BOD_5)

BOD_5 is the amount of oxygen consumed by microorganisms for the oxidation of organic substances in water during five days. This indicator provides information about easily biodegradable organic matter. As an approximate norm, BOD_5 should not exceed 3 mg/L for sources of drinking water and 6 mg/L for water bodies used for cultural and household purposes. The higher the BOD_5, the more polluted the water is considered.

3.3. Chemical oxygen demand and oxidizability

Chemical oxygen demand (COD) is determined with strong oxidizing agents and takes into account almost all organic substances in water, including those that decompose slowly. Permanganate oxidizability is a relatively simple method that gives low values in clean water and high values in polluted water. The ratio of COD to BOD_5 shows what part of the organic matter can be decomposed biologically.

3.4. Nitrogen compounds

During the decomposition of organic substances, nitrogen changes gradually, which helps to estimate when the pollution occurred. Ammonia and ammonium salts indicate fresh, recent pollution. Nitrites show that the decomposition process is continuing. Nitrates indicate that the process has finished and mineralization is complete, that is, the pollution is old. The simultaneous presence of ammonia and nitrites is the least favorable situation, because it means that the pollution is still ongoing and the danger persists.

3.5. Chlorides and sulfates

These ions are also present in natural waters, but a sudden increase in their content may indicate that wastewater has entered the water body. Therefore, they are analyzed together with other indicators.

3.6. Sanitary-bacteriological indicators

The total microbial count, *E. coli* and coliphages characterize the microbiological condition of the water. They help to determine whether organic pollution is of fecal origin.

Table 1. Main indicators used in the hygienic assessment of organic pollution of water bodies

Indicator	What it reflects	Hygienic interpretation
Dissolved oxygen	Oxygen balance of the water body	At least 4 mg/L in summer; a decrease indicates stronger pollution
BOD_5	Easily biodegradable organic matter	Approximately ≤3 mg/L for drinking water sources and ≤6 mg/L for cultural and recreational water bodies; higher values mean heavier pollution
COD and permanganate oxidizability	Total organic matter, including slowly degradable fractions	Low in clean water, high in polluted water; the COD/BOD_5 ratio shows the biodegradable share
Ammonia and ammonium salts	Fresh, recent pollution	Presence suggests recent contamination
Nitrites	Ongoing decomposition	Presence suggests that the process is still continuing
Nitrates	Completed mineralization	Suggest old pollution
Chlorides and sulfates	Possible wastewater input	A sudden rise may indicate wastewater; interpret together with other indicators
Total microbial count, *E. coli*, coliphages	Microbiological and fecal status	Show whether organic pollution is of fecal origin

4. Discussion

4.1. Hygienic significance of organic pollution

Organically polluted water creates a hazard in several directions. First, the risk of infectious diseases increases. Water polluted with feces may contain the causative agents of intestinal infections; typhoid fever, dysentery, cholera, viral hepatitis A and other diseases can spread through water. For this reason, organic pollution is often assessed together with fecal pollution.

Second, the organoleptic properties of water deteriorate: its color, taste, odor and transparency change. It is unpleasant to drink such water or to bathe in it, and the cost of treating it for drinking purposes increases considerably.

Third, ecological consequences arise. When nitrogen and phosphorus enter the water together with organic matter, algae multiply sharply and “blooming” of the water is observed. After the algae die, their decomposition reduces oxygen even further, and fish kills may occur.

The findings summarized in Table 1 show that no single indicator gives a complete picture. The intensity of pollution is better reflected by dissolved oxygen, BOD_5 and COD, the age of pollution by the sequence of ammonia, nitrites and nitrates, and its epidemiological danger by the sanitary-bacteriological indicators. Only their combined interpretation allows a reliable hygienic conclusion, in line with the general principle of hygienic evaluation, in which measured parameters are compared with regulatory requirements [3, 6, 7].

4.2. Measures for the protection of water bodies

The following measures are carried out to prevent organic pollution:

- treating wastewater by biological and mechanical methods before discharge into the water body;
- establishing water protection zones and sanitary protection boundaries and restricting polluting activities within them;
- introducing technologies at enterprises that reduce the volume of wastewater and allow water to be reused;
- organizing regular laboratory control of water quality in the water body;
- carrying out explanatory work among the population on the protection of water resources.

The effectiveness of these measures largely depends on public participation. Each person contributes to the condition of the water body by not discarding household waste into water and by using fertilizers and chemicals in moderation. The training of specialists is also important: well-organized education in hygiene, including integrated teaching methods, prepares physicians who are able to carry out such assessments competently [4].

4.3. Limitations

This article is based on a descriptive review and does not contain original measurements. The reference values depend on the regulatory documents in force and on the category of water use, and they may differ between countries. In addition, the pollution load of a water body changes with season, water flow and the intensity of wastewater discharge, so a single sampling campaign may not reflect the real situation. Regular monitoring at fixed control points is therefore preferable. Further studies with field data from specific water bodies would make it possible to test the practical use of the described indicators.

5. Conclusion

The organic pollution of water bodies is assessed using a set of indicators that includes dissolved oxygen, BOD_5, COD, nitrogen compounds and microbiological parameters. A single indicator does not give a complete picture: their mutual ratio shows the intensity, age and danger of the pollution. Hygienic assessment is not only a laboratory activity but also an important means of protecting the health of the population. A clean water body is a guarantee of the health of the present generation and of the well-being of future generations.

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