Concentration of Total Organic Carbon and Its Fractions in Surface Water in Poland and Germany †

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Abstract: Total organic carbon (TOC) present in surface water consists of different fractions like dissolved organic carbon (DOC) or biodegradable dissolved organic carbon (BDOC). BDOC may have an impact on the bacteriological quality of water as it can be a source of carbon and energy for microorganisms. It is important to consider this parameter in case of the distribution of drinking water. The aim of this research was to compare the qualities of chosen surface water in Poland and Germany in terms of concentration of total organic carbon and its fractions. The samples were taken from the reservoir in Poland and Rhine River in Germany. The first one is a source of drinking water for humans. The research showed that, considering the analyzed compounds, the water from the river has better quality.

Keywords: total organic carbon; surface water; organic matter; biodegradable dissolved organic carbon

1. Introduction

Organic matter concentration in water may be described as total organic carbon (TOC) which consists of different fractions, e.g., dissolved or biodegradable form. Especially biodegradable dissolved organic carbon may be important when considering drinking water because of its impact on the bacteriological quality of water. It can be a useful source of energy for microorganisms and may be an essential parameter considering the distribution of drinking water. The aim of this research was the assessment of the concentration of total organic carbon and its fractions, i.e., dissolved organic carbon (DOC) and biodegradable dissolved organic carbon (BDOC) in surface water in Poland and Germany. A TOC analyzer was used to determine the concentration of TOC and its fractions [1,2].

2. Materials and Methods

Water samples were taken from the reservoir located in Silesian Voivodeship in Poland and Rhine River in Kleve, North Rhine-Westphalia state in Germany in the same season (winter). There were six samples taken from both, the river and the reservoir at the same place during six weeks (one sample once a week). The reservoir belongs to Upper Silesian Water Supply Company and was built over the period of 1935 to 1939 and adapted to water supplying in 1948 to 1951. The area covers approximately 6 km² and its volume is about 17 M m³. It is the source of drinking water for few major Upper Silesian cities [3–5]. Rhine is a major European river with length of 1233 km (865 km within Germany borders). Its catchment is inhabited by 50 million people and the river itself is considered highly contaminated [6].

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TOC concentration in the water samples was determined with the use of a TOC analyzer Multi N/C 2100. Fifty milliliters of each sample was taken for this purpose. Then, 0.45-µm membrane filters were used to pass the water samples for DOC determination. The Joret method was applied to analyze the concentration of BDOC [2,7].

3. Results and Discussion

The results of TOC concentration and its fraction in analyzed water samples are presented in Table 1.

| Compound | Reservoir | River |
|----------|-----------|-------|
|          | Average   | Average |
| TOC      | 8.63      | 4.33  |
|          | 8.71      | 4.29  |
|          | 8.90      | 4.94  |
|          | 9.10      | 5.01  |
|          | 8.59      | 3.12  |
|          | 8.54      | 3.06  |
| DOC      | 8.12      | 3.13  |
|          | 8.05      | 3.55  |
|          | 8.10      | 3.45  |
|          | 8.07      | 3.22  |
|          | 8.08      | 3.33  |
|          | 8.09      | 3.34  |
| BDOC     | 0.39      | 0.03  |
|          | 0.37      | 0.35  |
|          | 0.31      | 0.30  |
|          | 0.34      | 0.07  |
|          | 0.35      | 0.17  |
|          | 0.35      | 0.19  |

TOC concentration in the water sample taken from the reservoir amounted to 8.747 mg/L. In case of DOC, it was 8.083 mg/L and the BDOC concentration amounted to 0.350 mg/L. The concentration of TOC in the water sample taken from the Rhine was lower by about half and it amounted to 8.747 mg/L. The DOC concentration in this sample amounted to 3.336 mg/L and BDOC to 0.181 mg/L. In Figure 1, DOC share in TOC in both cases, the reservoir and the river are shown.

In case of water samples taken from the reservoir, the dissolved organic carbon is about 92% of total organic carbon. The water sample taken from the river DOC makes up to 80% of TOC. In Figure 2, BDOC share in DOC in both cases, the reservoir and the river are shown.

In case of water samples taken from the reservoir, biodegradable dissolved organic carbon is about 4% of the dissolved organic carbon. In the water sample taken from the river, BDOC makes up to 5% of the DOC.
4. Conclusions

TOC, DOC and BDOC in water samples showed that all of the analyzed compounds have about twice as high concentration in the water samples taken from the reservoir despite the fact that the river itself is considered highly contaminated and is not the source of drinking water for human consumption (in the sample taking point).

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