Analysis of Selected Surface Water Components in the Town of Siedlce, Poland

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Abstract

The paper presents results of a research study into levels of selected surface water components in Siedlce, Poland. Water was sampled in the Muchawka Reservoir and the Muchawka River in March, July and November 2012. Two techniques were applied in the study: isotachophoresis and atomic absorption spectrometry. The analysis results of water sampled in the Muchawka Reservoir indicate that they are borderline compliant with standards for the Class 1 surface waters. On the other hand, the Muchawka River samples were found to be out of any quality class.

INTRODUCTION

Monitoring of human environmental footprint has always been an important issue. Water is the most common chemical compound found on Earth and at the same time the main component essential for the existence of life. Surface waters (especially spring waters) are the main source of drinking or sanitary water. They also include streams, rivers, lakes, ponds, artificial reservoirs, seas and oceans. They differ in mineralization levels and chemical composition and are recharged by rainwater and groundwater. Composition of surface waters is varied and dependent on numerous factors, inter alia: amount of recharging water, season, climate, precipitation, basin management and topography. Composition of waters is also affected by life processes of fauna and flora (Niedzielski et al. 1999; Chrząścik et al. 2007a,b; 2008).

Water pollution involves adverse changes in physical, chemical and bacteriological properties resulting from excess of non-organic, organic and radioactive substances which reduce or make impossible the use of water for certain economic purposes. Degradation of waters is also precipitated by contaminated precipitation and transport pollution.

Capillary isotachophoresis is an analytical method based on a separation process of ions (cations or anions), which are formed in zones in an electric field by the use of adequate leading and terminating electrolyte, according to their decreasing mobility and which are moving with the same velocity. Two different electrolytes are applied in ITP. A mixture of separated ionic substances is inserted between these systems. The first electrolyte (leading, Ld) consists of more mobile ions (cations or anions, depending of conditions) than the ions in the analyzed sample. The
terminating electrolyte ions (Tm) are less mobile than the least mobile component of the separated mixture.

Water pollution is both one of the most common and most vexatious types of pollution. As a result of rampant urbanization, over-fertilization and contamination of the environment by industrial facilities, a significant part of the population does not have access to sources of clean water (Walna, Słipak 1999; Walna et al. 2003; Polkowska et al. 2005; Ignatowicz 2004). There is therefore a case for protecting, above all, air and water against pollution. Research studies are the basis for the protection of the environment. The purpose of such studies is to create a basis for actions aimed at improvement of waters and protection of waters against pollution, including eutrophication resulting from the impact of the communal sector, and agriculture, as well as protection against industrial pollution under the national judicial system and requirements of Water Framework Directive 2000/60/EC (Water Framework Directive 2000). The Directive obliges the Member States to pursue rational utilization and conservation of natural living resources according to the principles of sustainable development. It aims at achieving a good status for all waters by 2015. The aim of the paper is therefore to determine the content of selected ions in the surface waters of the Muchawka Reservoir and River in Siedlce, Poland.

MATERIALS AND METHODS

Experimental part

Water sampling sites are within the limits of the town of Siedlce. Water was sampled in the Siedlecki Reservoir and the Muchawka River (Fig. 1). The Muchawka River is a left-bank tributary of the Liwic River and runs through Siedlce delimiting its western boundary. The reservoir developed on the Muchawka River is an artificial lake used for leisure activities.

Surface waters were sampled in March, July and November 2012. The samples collected were then analyzed as regards the levels of nitrates(V), nitrates(III), chlorides, sulfates(VI), phosphates(V) and heavy metals: zinc, iron, aluminum and manganese. Water samples for analyses of their anions and cations content were collected in separate vessels.

Samples for anions analysis were EDTA preserved in order to prevent catalytic oxidation of nitrate(III) ions. Capillary isotachophoresis was used to determine anions content. Samples for heavy metal content determination were analyzed using atomic absorption spectrometry (AAS) on the sampling day.

The first stage consisted in preparation of solutions and analytical curves. Next, the collected samples were analyzed both qualitatively and quantitatively. Comparative analysis of isotachophoretic results using the spectrophotometric method was not performed as such investigations had already been performed and revealed the maximum difference in the results of ±4%.

Equipment and reagents

Analyses were carried out with the use of EA 202M isotachophoresis analyzer (Villa Labeco s.r.o, Spisska Nova Ves) with the following accessories: a pre-separation column with internal diameter of 0.8 mm and length of 90 mm, an analytical column with an internal diameter of 0.3 mm and length of 160 mm, and a conductivity detector for each column.

All reagents used in the analyses were of p.a. grade. The leading electrolyte for the pre-separation column was prepared of equal volumes of the following solutions: $8 \times 10^{-3}$ mol dm$^{-3}$ NaCl solution (POCH Gliwice), $3 \times 10^{-3}$ mol dm$^{-3}$ bistris propane solution (Aldrich), $1.5 \times 10^{-3}$ mol dm$^{-3}$ β-alanine solution (Aldrich), 0.1% hydroxyethylcellulose solution (Aldrich). The leading electrolyte for the analytical column was prepared of equal volumes of...