CAPACITY TO ACCUMULATE THALLIUM IN SURFACE MICROLAYER OF WATER OF URBAN PONDS (NORTH POLAND)

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Introduction

Surface microlayer is a thin layer occurs at the interface between the hydrosphere and atmosphere (Norkrans, 1980). Surface microlayer (SML) of water is a unique chemical, physical and biological environment different from the subsurface water (SUB) (Maki, 1993; Hillbricht-Ilkowska & Kostrzewska-Szlakowska, 2004). This ecotone is the habitat of living neustonic organisms (Mudryk et al., 2003). This ecotone is an area of exchange of matter and energy between the atmosphere and the hydrosphere. Surface microlayer of water has the ability to accumulate high contents of heavy metals in much higher concentrations than observed in the subsurface water (Trojanowski & Antonowicz, 2011; Antonowicz et al., 2015). This feature due to the physical forces, such as: surface tension, adhesion, cohesion, vortex moves and the Langmuir circulations and also affected by the chemical composition of the water and its biological properties (Norkrans, 1980; Maki & Hermansson, 1994; Antonowicz et al., 2015). The research of thallium are important to understand its occurrence. This element is toxic to aquatic organisms (van Loon and Duffy, 2008). Thallium is used in the production of electronic compounds, optical lenses, imitation jewelry, artist paints and low temperature thermometers (La Dou, 1997).

Methods

The object of the study was four ponds localized in Słupsk, North Poland (approx. 20 km from coastal of Baltic Sea). Ponds are located in the plane of the north-south: Pond 1 (located on the most northern, it is away from the main areas of urban infrastructure, near railway tracks north), Pond 2 (near Kaszubska St.), Pond 3 (near Nad Śluzami St.), Pond 4 (near Arciszewskiego St.). Samples were collected for one year (from October 2007 to September 2008). Samples of the surface microlayer (SML) (thickness 242 µm ± 40) were collected with a Garrett net (Garrett, 1965), while samples of the subsurface layer (SUB) were taken at the depth of about 10-15 cm. The concentrations of thallium was measured by Perkin Elmer Elan DRC-e mass spectrometer (based on a calculation ^{205}Tl). Then these results were compared with the reference standard samples (produced by Perkin Elmer Co.) by the instrument controlled by the ELAN Perkin Elmer SCIEX Instrument Control software. In order to compare the investigated layers, i.e. surface microlayer and subsurface water, we applied average enrichment factors ($EF = C_{SML}/C_{SUB}$, where C_{SML} and C_{SUB} are concentrations of thallium (Estep et al., 1985).

Results

Table 1 shows the enrichment factor for thallium. The ability to enrich surface microlayer of water was in the range from 2.0 to 3.8. Ponds 2, 3, 4 located near urban infrastructure showed an enrichment factor in the range of 2.4 to 3.8. The lowest enrichment factor was indicated in suburban Pond 1 (EF = 2.0). Concentration of thallium in subsurface water of studied ponds was low and according to van Loon & Duffy (2008) it indicates that they are uncontaminated area.

Table 1. The enrichment factors of thallium in surface microlayer of water in studied ponds (mean, minimum and maximum).

	Pond 1	Pond 2	Pond 3	Pond 4
EF_{mean}	2.0	2.4	2.5	3.8
$EF_{min} – EF_{max}$	0.9 – 4.4	1.0 – 4.3	0.8 – 6.8	1.0 – 11.0

Conclusion

The study shows that thallium accumulates in SML in higher quantities than in the SUB. It can be assumed that higher enrichment factors were observed in the ponds 2, 3 and 4 located in close proximity to urban infrastructure are caused by urban pollution. Perhaps the impact on the accumulation of a deposition from the atmosphere. The highest enrichment factor was observed in the Pond 4 located in the southern part of the Słupsk City and often winds blow here from the north to the south. In the Pond 4 we have also seen the greatest dynamics of EF in the studied period.

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