Heavy metals in water and bottom sediments in reservoirs of the Dnipro cascade

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Introduction

Objectives. The purposes of this study were:
- assessment of suspended matter income sources as a basis for the Dnipro reservoir cascade bottom deposits forming;
- study of the main processes of heavy metals transformation in “water-suspended matter-bottom deposits” system;
- study of heavy metals distribution in different types of bottom deposits of the Dnipro reservoirs cascade;
- quantitative assessment of heavy metals remobilization from the Dnipro reservoirs cascade bottom deposits.

Methods. Reservoirs of the Dnipro cascade were the objects of research.

Results

The significant part of suspended matter is formed due to transformation of dissolved organic matter of humus origin (humic and fulvic acids) of the rivers Dnipro, Desna, and in particular of the river Prypiat.

Annual incoming of suspended solids reached 205.9 thousand tones; dissolved organic substances – 553.5 thousand tones.

In soluble phase of the last Kakhovskyi Reservoir the amount of suspended particles remains a bit higher than 196.0 thousand tones; accumulation is equal to 363.5 thousand tones.

Sorption on to suspended particles which are represented by organic substance (humic and fulvic acids) and iron. Fulvic and hydroxyl-fulvic complexes of iron form the suspended matter system being the powerful collector for heavy metals removal from solution phase, especially during the spring period when the changes of physicochemical conditions of water media occur (Fig. 9-5).

Changing of physicochemical conditions of water media leads to polymerization of dissolved high-molecular fraction of humic and fulvic acids and their subsequent transferring to the suspended migration form.

Besides that, the part of the bottom deposits complex is formed due to the removal of calcium carbonate (CaCO₃) from the water column. This is more characteristic for the Kremenchutsyi Reservoir and Kakhovskyi Reservoir as being the most bioproductive. During the summer time owing to the shift of the carbonate-calcium system toward forming of the high-soluble compounds of CaCO₃ dozens of thousand tones of calcium carbonate are removed only to the bottom deposits of the Kakhovskyi Reservoir (Fig. 6).

Conclusion

The Dnipro reservoirs cascade serves as a powerful biogeochemical barrier concerning the heavy metals entering the water media as a result of the different kinds of human activities.

Hydrological factors, physicochemical and biological processes are the leading driving forces in heavy metals transferring from the solution phase to suspended form with subsequent sedimentation and accumulation in bottom deposits.

Quantitative assessment and calculation of heavy metals molecular diffusion velocity from interstitial water of bottom deposits have shown that manganese is the most labile. For the other heavy metals, the secondary pollution originated from the bottom deposits under current physicochemical conditions of water media is practically impossible.

The content of heavy metals in silty sediments of the Dnipro cascade reservoirs is shown in Fig. 8.

Fig. 1. The Dnipro cascade scheme and fields work

Fig. 2. Daily discharged of suspended solids and organic matter

Fig. 3. Correlation between suspended forms of Fe and organic matter

Fig. 4. Correlation between suspended forms of Fe and Pb, mg/kg

Fig. 5. Correlation between suspended forms of Fe and Zn, mg/kg

Fig. 6. The dependence of the saturation index (SI) regarding the system calcite and magnesite from the pH value in the Kakhovskyi reservoir

Fig. 7. Content of iron, copper, lead and nickel in the different suspended fraction size

Fig. 8. Content of heavy metals in silt sediments of the Dnipro cascade reservoirs