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ASSESSMENT OF WATER QUALITY PARAMETERS OF THE TASHLYK COOLING POOL

Data on hydrochemical monitoring parameters and water quality for the South-Ukrainian Nuclear Power Plant cooling pool are considered in the paper. Changes in the Tashlyk cooling pool water physical and chemical parameters under influence of the South-Ukrainian Power Complex are analyzed. It was shown that values of some parameters exceed limited acceptable concentrations for water reservoir for fish economy.

Наведено узагальнені дані хімічних досліджень якості води водоймища-охолоджувача Південно-Української АЕС. Оцінено ступінь змін фізичних та хімічних параметрів води Ташлицького водоймища-охолоджувача та Олександрівського водосховища під впливом роботи об'єктів Південно-Українського енергокомплексу. Показано, що за деякими параметрами спостерігається перевищення ГДК для водоймищ рибогосподарського призначення.

Introduction

Issues concerning ecological state of water object of the South-Ukrainian Power Complex (SUPC) are being discussed in this paper.

The construction of this unique power location was started at the beginning of 1970s in the last century and has not been finished. It unites three sources of energy: the powerful South-Ukrainian Nuclear Power Plant (SUNPP), the traditional Oleksandrivs'ka Hydroelectric Power Station (OHPS) on the Pivdenniy Bug river and the highly-maneuverable Tashlyk Pumped Storage Plant (TPSP) (fig. 1).

On one hand the SUPC and its objects is a strategic object for economic and power development of the country, and on the other hand it is related to a group of environmentally hazardous facilities.

The main problems which became the grounds for numerous public and scientific discussions in the country as well as ecological and technological requirements for creation of complex monitoring system within the SUPC impact zone were considered in [1].

The Tashlyk cooling pool (TCP) constructed on the left tributary of the Pivdenniy Bug river is a cooling pool of the SUNPP and at the same time a storage pool for the TPSP (fig. 1).

Work of three blocks on the TCP initially planned for two blocks has increased the average annual temperature of circulating water and as a result decreased the cooling ability of the cooling pool. Such changes could lead not only to valuable reducing of the power block's exploitation term but also to negative ecological changes in the ecosystem.

To possible ecological damages we can relate increased water mineralization, silt and toxic substances accumulation in bottom sediments, increased level of ground waters, adjacent region climate change. Thus, complex use of storage pools requires precise investigation of their ecological state and assessment of contamination level.

Research analysis

According to working normative base it is necessary to pass ecological expertise for any new object that can negatively affect the environment and to carry out complex ecological monitoring [2–4].

Hydrochemical state of the TCP has been assessed according to 22 thermal profiles using data of environment monitoring carried out by Central Geophysical Observatory, hydrochemical laboratory of the SUPC and Institute of Environmental Geochemistry of National Academy of Sciences and Ministry of Emergencies of Ukraine.

Water was sampled in the following points (fig. 2):

– streamlet Tashlyk (1);
– upper part of the TCP near the bridge (2);
– downstream the TCP near the bridge (3);
– middle part of the TCP, near power line (4).

Having processed and analyzed the data of hydrochemical monitoring held in summer-autumn period of 2006 we can make a conclusion concerning influence of the SUPC on the water quality and ecological state of the TCP.

In July 2006 the water temperature of the TCP was made up $33,1^0$C.

It was much higher than temperature in other water objects of the SUPC. Such difference is caused by dumping of hot water from three power units of the nuclear power plant.

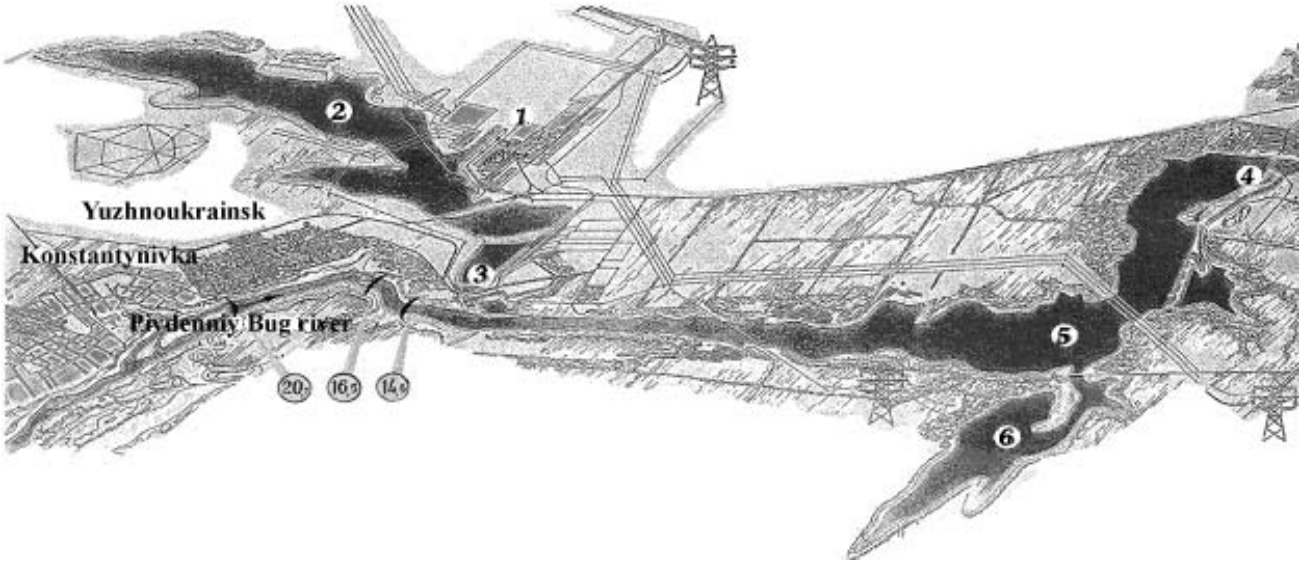

Fig. 1. Location of the South-Ukrainian Power Complex objects:
1 − South-Ukrainian NPP;
2 − Tashlyk cooling pool;
3 − Tashlyk PSP;
4 − Oleksandrivs'ke hydroscheme;
5 − Oleksandrivs'ke storage pool;
6 − Pribujskoe storage pool

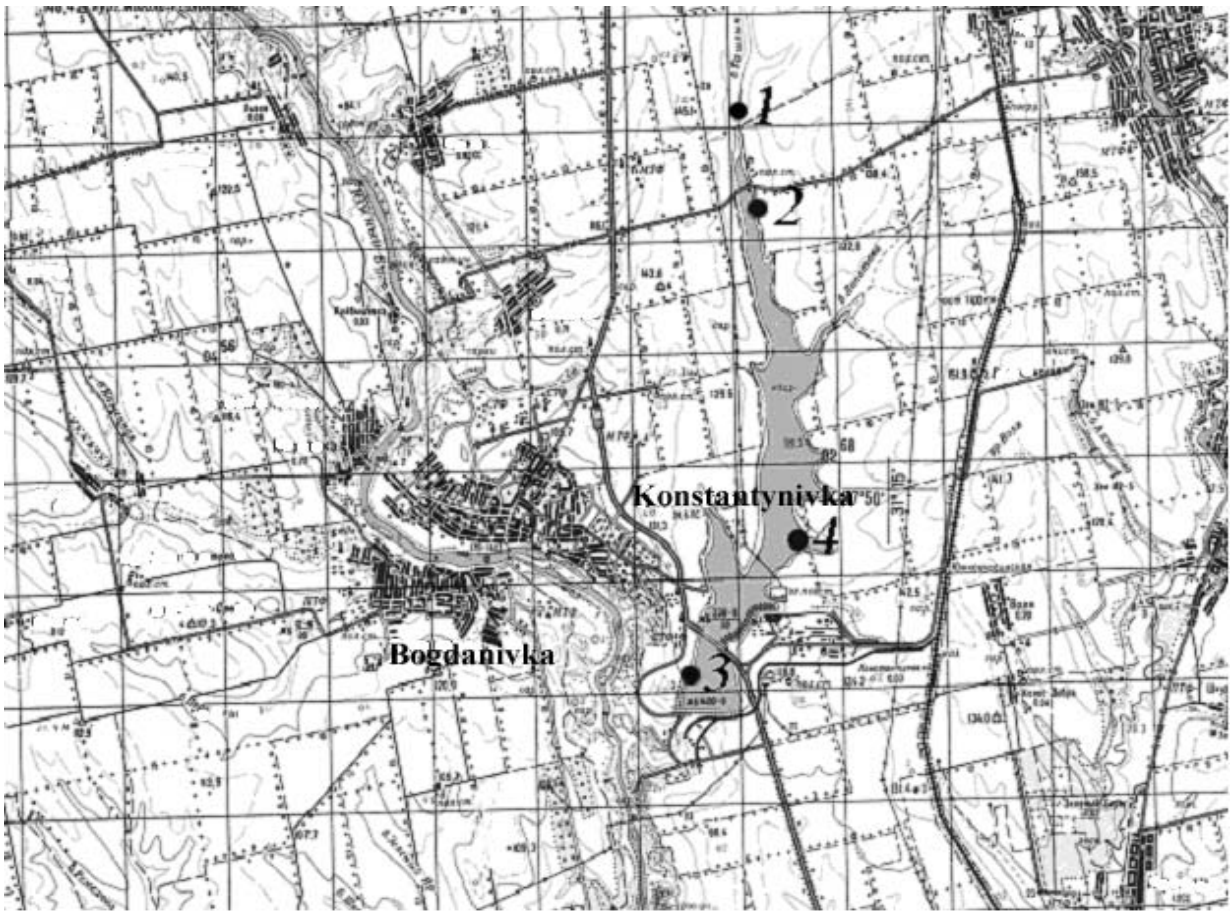

Fig. 2. Sampling points for hydrochemical analysis of the Tashlyk cooling pool

The value of dissolved oxygen in alkaline water solutions (pH=8,68±0,13) equals 86–88% of saturation. It proves some advantage of destructive processes over productive ones.

The most likely that under saturation of water with oxygen at high temperature is caused by decreasing of its absorption from atmosphere and increasing of its expenditure in the result of stirring up of substance biochemical and chemical oxidation processes.

Chemical water content of the cooling pool was formed at water transformation of the Pivdenniy Bug river, high water temperatures and lack of purge. Under these conditions the evaporation processes caused increasing in concentration of sulfates, magnesium chlorides, potassium, sodium and calcium.

But the main reason of the TCP high water mineralization is inflow of highly mineralized underground waters of the girder Tashlyk [3]. These changes led to activation of the internal biological processes that in turn became the reason of increased concentration of organic compounds and undersaturation of water with oxygen.

The latest research of the TCP showed the highest values of water mineralization and main ions content. Such situation is caused by inflow of high mineralized water (near 3,22 %) of the streamlet Tashlyk into the cooling pool. Among cations the Na^+ (sum of $Na^+ + K^+$) and Mg^{2+} ions dominated and among anions the sulfate and chloride ions prevailed. Concentration of these anions in the cooling pool was correspondently 403–430 and 220–290 mg/dm^3 (fig. 3).

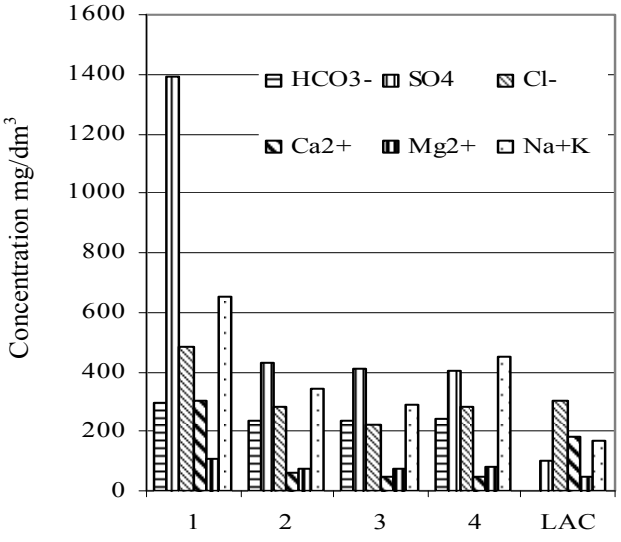

Fig. 3. Water mineralization of the TCP

As far as cooling pool was constructed for technical purposes the content of biological substances mainly depends on content of sewage water and less - on nature and climate change.

During the whole period of research ammonia nitrogen, nitrates, nitrites and phosphates discharged into the cooling pool. The water discharge is regulated by "Limited Acceptable Discharges (LAD) of chemical substances with sewages of water pipe and sewage economy into a water object" of 01.10.2004.

According to the data obtained concentration of ammonia nitrogen $N_{NH_4^+}$ didn't exceed 0,015–0,028 mg/dm^3. These low values of ammonia nitrogen for a given water object need to be further discussed. On the contrary low concentration of nitrite nitrogen $N_{NO_2^-}$ is quite natural because this form of nitrogen is very unstable and easily oxidizes to nitrate form.

In spite of high concentration of nitrate nitrogen in the streamlet Tashlyk (1,814, that is 5–7 times higher than in the water of the Oleksandrivs'ke storage pool) its concentration in the TCP was quite low and made up 0,065–0,176 mg/dm^3.

Phosphates $P_{PO_4^{3-}}$ and iron concentration is also insignificant and made up 0,010–0,018 mg/dm^3 (fig. 4).

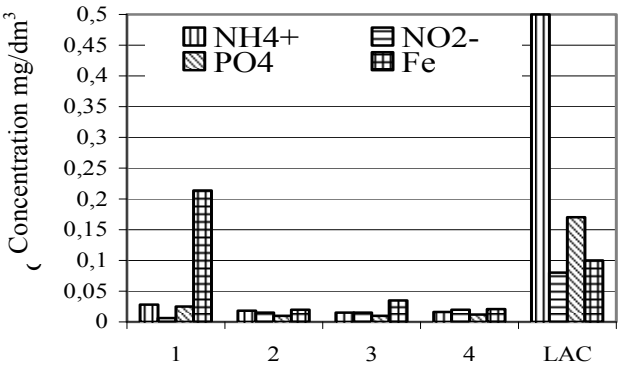

Fig. 4. Content of biogenic substances in the TCP

PO value in TCP didn't differ much from values of this parameter in the other sampling stations and made up 11,2–13,8 mgO/dm^3.

At the same time the value of BO was almost two times higher than acceptable one and made up 43,8–66,9 mgO/dm^3.

In 2006 the investigated water object characterized by rather high content of heavy metals.

Concentration of lead (II) and zinc (II) was especially high in water of the streamlet Tashlyk and made up correspondently 83,0 mkg/dm^3 and 9,5 mkg/dm^3 (fig. 5).

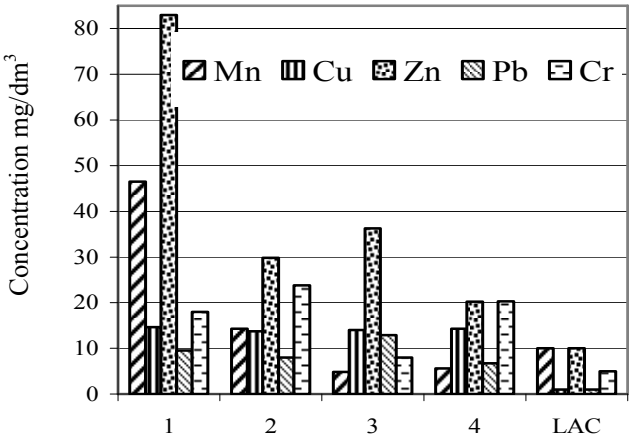

Fig. 5. Content of heavy metals in the TCP

These results testify about significant contamination of the Tashlyk cooling pool with heavy metals.

In summer-autumn period of 2006 the water of the TCP occurred with great concentration of oil products that made 2,322 mg/dm^3. It was almost 8 times higher than acceptable value. This fact requires further deep analysis.

Conclusion

Chemical water content of the TCP was formed at water transformation of the Pivdenniy Bug river, high water temperatures and lack of purge.

These changes led to activation of the internal biological processes that in turn became the reason of increased concentration of organic compounds and undersaturation of water with oxygen.

Having analyzed data of chemical investigations we can make a conclusion that water of the Tashlyk cooling pool corresponds to highly mineralized hard water of sulphate-hydrocarbonate water class of the sodium-magnesium group.

Following fish economy demands for the TCP water quality we can note the excess for: magnesium, copper, sodium+potassium, sulphates, phosphates, lead, zinc and DO.

References

1. *Lysychenko G.V., Dudar T.V.* Database creation on the monitoring system for the South-Ukrainian Power Complex. Brownfields. Multimedia Modelling and Assessment. WIT Press. Southampton, Boston, 2004. – P. 109–116.

2. *Закон* України ”Про екологічну експертизу” від 09.02.95 ВР № 46/95-вр.

3. *Звіт* „Виконання робіт з комплексного екологічного моніторингу в зоні впливу Ташлицької ГАЕС” // ІГНС НАН та МНС України. – К., 2006. – 350 с.

4. *Програма* комплексного наукового супроводу спорудження та роботи Ташлицької ГАЕС (в частині моніторингу навколишнього середовища). – К.: ДНІЦ СКАР, 2004.

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