Geophysical Research Abstracts
Vol. 21, EGU2019-18371, 2019
EGU General Assembly 2019

Numerical modelling of thermal pollution of large water bodies in different hydrometeorological conditions

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The paper deals with the numerical simulation of the distribution of thermal pollution in water bodies performed using as an example the water cooling system of the Magnitogorsk Iron and Steel Works (MMK). The discharge channel of this plant drains warm water in the Magnitogorsk reservoir of the Ural River.

At present, the Magnitogorsk Iron and Steel Works is implementing a set of environmental initiatives with the goal to reduce the technogenic impact on water bodies. First of all, these activities were aimed at creating a sustainable system of closed water use excluding the impact of this industrial complex on the Magnitogorsk reservoir. The development of this circulating water use system was based on the active use of hydrodynamic models in 2D and 3D formulations. Analysis of possible regimes was based on consideration of scenarios for extreme technological and hydrometeorological conditions.

To obtain the required stability of the functioning of the water use system, it is necessary to ensure the selective intake of water from the deepest, less heated horizons. Therefore, to solve this problem, it was very important to obtain correct estimates of the temperature distribution of the water, not only in the water area, but also in its depth. As studies have shown, the most correct and efficient way to solve this problem is to use hydrodynamic model in 3D formulation in non-hydrostatic approximation. Such model was used in [1] to study thermal pollution zones formed in the Kama reservoir as a result of wastewater discharge from Permskaya GRES.

The purpose of numerical simulation in the context of the proposed scenarios was to determine the performance of water intake stations during the hottest summer months.

The calculations were carried out taking into account the interaction of the water mass and atmosphere. The data used were based on the maximum daily-average air temperature over the decade (it was observed in July 2012 and was equal to 25.3 ° C) under calm conditions. The results of numerical calculations confirmed the possibility of using the selective water intake from the lower bottom horizons for increasing the stability of the functioning of closed water supply system.

The study was supported by Russian Science Foundation (grant 17-77-20093).

1. Lyubimova T., Lepikhin A., Parshakova Ya., Lyakhin Yu., Tiunov A. The modeling of the formation of technogenic thermal pollution zones in large reservoirs. International Journal of Heat and Mass Transfer 126 (2018) 342–352.