STUDY OF THE HEAT INFLUENCE OF THE COOLING SYSTEM OF UZBEK NPP ON TUZKAN LAKE

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ANNOTATION. The work examines the heat engineering effect of the cooling system of the future Uzbek nuclear power plant on the environment, in particular, on the water balance of Lake Tuzkan. Calculations are carried out taking into account local specific factors, initial technological requirements. Conclusions are drawn on the use of a specific type of cooling system.
KEYWORDS. Nuclear power plants, thermal effects, water supply system, direct-flow system, water and heat balance.

The need for removal of heat to the environment by capacitors Nuclear power plant (NPP) dictated by the laws of thermodynamics. When the efficiency of operating nuclear power plants (as well as TPP) equal to about 30%, and the thermal power ~ 3000 MW, about 1000 MW only used to generate electricity, while the remaining about 2000 MW is discharged into environment.

For heat removal, technical water supply systems are used, which are divided into direct-flow and reverse. With a once-through water supply system, a natural water body is used: a river, lake or sea. Cooling water passes through the condenser once and then discharged into the water body.

The advantages of a direct-flow water supply system (WSS) include relatively inexpensive hydraulic structures and low operating costs, ease of maintenance and repair. One of the options for the direct-flow WSS of the first nuclear power plant in Uzbekistan is the forward flow from Lake Tuzkan. It is not possible to use reverse WSS, due to the high hardness of the water of Lake Tuzkan [1].

Typical water consumption for large power plants for the removal of 1 MW of heat is in the range from 0,02 m^3/s (when heating the water in the condenser at 12 °C) to 0,034 m^3/s (when heating the water at 7 °C) , which for large power plants has a significant effect on the thermal balance of the reservoir [2].

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To calculate the temperature regime of the lake, the characteristics of the WWER-1200 turbine equipment - flow rate of water and temperature difference on turbine condensers — as well as the geometric parameters of Lake Tuzkan - free surface area and average depth were adopted .

Calculation of changes in temperature throughout the year applied to the monthly average meteorological conditions laid down for long-term observations, taking into account the heat storage capacity of the reservoir and the expected plant performance schedule.

The heat balance equation for calculating the transient temperature regime of a reservoir has the form:

$$\frac{c\rho H}{k}\cdot\frac{dT}{dt}+\alpha_e(e_m-e)+\alpha_c(T_s-T_a)-R-\frac{\Delta S}{\Omega}=0, \qquad (1)$$

where T_s is the average temperature of the free surface of the reservoir; t is the time; c and ρ - specific heat and density of water, taken constant; ΔS - the difference in heat content entering the reservoir and water taken from it per unit time; α_e - heat transfer coefficient by evaporation; α_c - convection heat transfer coefficient; e_m - maximum vapor pressure at temperature T_s, determined by reference; e - absolute humidity; T_a - air temperature; R is the radiation balance (a component of the heat flux density on the free surface due to radiation heat transfer and radiation); Ω and H is the free surface area and the average depth of the reservoir-cooler; k is the coefficient of uneven distribution of water temperature over depth, numerically equal to the ratio of the average temperature of the free surface to the average temperature over the volume of water.

The heat balance equation (1) is solved by numerical method for integrating differential equations [3]. Below table 1 shows the results of calculating the thermal influence on lakes of Tuzkan, once-through cooling system of nuclear power plant of 4800 MW.

Table 1

Estimated figures	Units	Values
The area of the active zone of heat transfer (evaporation) on the surface of the lake Tuzkan	Km^2	42,0
Specific area of the active zone	$\frac{m^2}{m^3/day}$	4,4
Water temperature at the intake / outlet (during the hottest period)	^{0}C	30,8/40,8
The water temperature at the water intake / on water outlet (average annual)	^{0}C	22,1/34,1
The average equilibrium temperature of the lake (during the hottest period / average annual)	^{0}C	33,8/26,9
The amount of water evaporated from the surface of the lake EPA without nuclear heat reset (the hottest period)	m^3/h	330113,0
Amount of evaporated water from the lake surface during thermal discharge from nuclear power plants (during the hottest period)	m^3/h	335095,1
Increase in the amount of evaporated water (during the hottest period)	m^3/h (%)	4982,1 (1,5%)
The increase in the amount of evaporated water (average annual)	m^3/h (%)	4,014.7 (3,9%)
The average annual of thermal discharge power of NPP to the lake Tuzkan	MW	2697,9
Average annual and level changes due to increased evaporation of water from the surface of the lake	m	0,05*

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*) typically, based on the practice, average waveform to 1,3 meter [4].

Conclusions

The results of the calculations indicate that when using a direct-flow WSS of 4800 MW of nuclear power plant thermal discharge into lake composition 2697,9 MW, which will lead to an increase of 1,5% of the quantity vaporized water from the surface of the lake. For the year decline lake levels due to heat discharge amount 0,05 m, it should be noted level variations due to climatic influences, which is 0,7-1,5 m. In this way, the effect of the thermal reset lake has not Tuzkan significant effects on the water balance of the lake.

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