Numerical Study of Discharged Heat Water Effect on Aquatic Environment From Coastal Thermal Power Plant by Using Two Water Discharged Pipes

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ABSTRACT

The article presents a numerical study of the thermal load on the aquatic environment by using two water discharge pipes under various operational capacities of thermal power plant. It is solved by the Navier-Stokes and temperature transport equations for an incompressible fluid in a stratified medium. The aim of this article is to improve the existing water discharge system for reduce the heat load on the reservoir-cooler of the thermal power plants operation (Ekibastuz SDPP-1). In this article, thermal pollution using only two water discharge pipes, using the existing one and building only one additional in the eastern part of the reservoir-cooler is numerically simulated. The numerical method is based on the projection method, which was approximated by the finite volume method. The obtained numerical results of three-dimensional stratified turbulent flow for two water discharge pipes under various operational capacities of the thermal power plant were compared with experimental data and with the numerical results for one water discharge pipe.

KEYWORDS

5-Step Runge-Kutta Method, Ekibastuz SDPP-1, Navier-Stokes Equation, Operational Capacities of Thermal Power Plant, Stratified Medium, Thermal Discharge, Two Water Discharge Pipes

INTRODUCTION

From an ecological point of view, among industrial objects, power facilities have the strongest and negative impact on the aquatic environment. They lead to a violation of self-recovery, violate the toxicological, hydrochemical and hydrobiological indicators of water bodies. This leads to deterioration in water quality and nutritional value. By reducing the activity volume, it can have a positive impact on the environment as a whole, as well as on its water shell.

Energy companies interact with the environment in all production stages: fuel consumption, recycling and energy transmission. Solid particles represent a significant part of the contaminants. There are including petroleum products, chlorides, sulphates, heavy metal compounds, hydrogen sulphide, formaldehyde and others. The main water consumers at thermal power plants and nuclear power plants are turbine condensers. The water consumption is affected by the steam parameters and the technical water supply system. According to the survey, in the future about 120 kg/(kWh) of water for thermal power plants and 220 kg/(kWh) of water for nuclear power plants will be spent on a water-cooled condenser. The water cost in large installations is determined by the large specific steam consumption at nuclear power plants. Due to washing the aggregates surfaces, dilute hydrochloric

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acid, sodium hydroxide, ammonia, ammonium salts, iron and other substances are formed. In addition, the cooling water discharge from nuclear power plants does not prevent the entry of radionuclides into the aquatic environment.

The basis for various types of power plants is energy. Electricity generated by hydropower plants (HPPs), nuclear power plants (NPPs) and thermal power plants (TPPs), which leads to adverse effects on the water and the atmosphere. TPPs can be divided into condensing power plants (CPPs) designed only for power generation, and central thermal power plants (CTPs) that generate electricity and heat in the form of hot water or steam. District large CPPs are called state district power plants (SDPP).

To remove excess heat, there are three main types of cooling systems (Roberts, 2011):

- Systems with one circulation (water supply with a direct flow system).
- Backward circulation systems, which are divided into two types: a) circulation of cooling tanks; b) circulation cooling towers.
- Air. Few power plants are cooled by air without evaporation.

In the direct water case supply system consuming artificial water bodies or river water, it is not possible to provide sufficient water for cooling the condenser of thermal power plants and nuclear power plants. When the direct water supply is used, dangerous thermal effects are formed. Thermal pollution of water and water disrupts the ecological balance of natural or artificial water bodies. In order to prevent this, most industrialized countries use closed cooling water in natural lakes or rivers. Cooling towers are often used to cool the circulating water with the direct flow of water. They are also used in the recycling of water supply, which entails an increase in 40 times the need for fresh water in power plants.

The single circulation system and cooling towers are the most commonly used cooling systems. The extraction and consumption of water are a difference in cooling systems. A single circulation system consumes a lot of liquid, but almost everything returns to a reservoir with low consumption. The cooling tower recovers much less water but consumes a lot. Cleaning the cooling tower returns to the river with a higher temperature than in a single circulation system. However, the minimum amount of hot water is soluble and cools more easily. A returning hot water system should reduce the impact of sewage on the surrounding atmosphere. Hot water can return back through the diffuser or through surface channels. This accelerates the dilution and reduces the temperature increase. Therefore, when surface channels are used, the surface temperature is higher, this leads to excessive evaporation of heat into the atmosphere, which is forbidden by the rules for the temperature growth of the atmosphere.

The purpose of this work is to improve the existing water disposal system to reduce the thermal load on the reservoir-cooler from thermal power plant (Ekibastuz SDPP-1). For this purpose, two problems were solved. In the first simulation is modeled thermal pollution source from a single discharge pipe. For reliability and verification of numerical results correctness were compared with experimental data. The results obtained were in good agreement with the experimental results all the details are described in papers (Issakov, 2015, 2016a, 2016b). In this paper, the second problem is numerically modelled. The goal of the second simulation was minimizing thermal pollution from the thermal power plants activities in the water environment using a proven mathematical model and the numerical algorithm. The next problem is to quickly cool the heated water release into the reservoir-cooler. Since in practice it is very difficult to minimize thermal emissions from thermal power plants, in this case, from the economic point of view, it is more optimal to use the existing discharge pipe. Also, the smallest number of additional water pipes should be used, since the construction of each new one is expensive. In 2017, within the framework of the project “Modernization and Capacity Expansion of Ekibastuz SDPP-1”, it is planned to complete the reconstruction of the power unit No. 1. This will increase the output electricity production to 4,000 MW, as planned in the projected.
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