Numerical Modeling of Influence of the Thermal Power Plant with Considering the Hydrometeorological Condition at the Reservoir – Cooler

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ABSTRACT

This paper presents the mathematical model of the thermal power plant in cooling pond under different hydrometeorological conditions, which is solved by three dimensional Navier-Stokes equations and temperature equation for an incompressible fluid in a stratified medium. A numerical method based on the projection method, which divides the problem into three stages. At the first stage it is assumed that the transfer of momentum occurs only by convection and diffusion. Intermediate velocity field is solved by method of fractional steps. At the second stage, three-dimensional Poisson equation is solved by the Fourier method in combination with tridiagonal matrix method (Thomas algorithm). Finally at the third stage it is expected that the transfer is only due to the pressure gradient. To increase the order of approximation compact scheme was used. Then qualitatively and quantitatively approximate the basic laws of the hydrothermal processes depending on different hydrometeorological conditions are determined.

Keywords: Hydrometeorological Conditions, Large Eddy Simulation, Navier-Stokes Equation, Parallel Technologies, Stratified Medium, Thermal Power Plant, Three Dimensional Poisson Equation

INTRODUCTION

Environment - the basis of human life, as mineral resources and energy are produced from them. Moreover they are the basis of modern civilization. However, the current generation of energy cause appreciable harm to the environment, worsening living conditions. The basis of the same energy - are the various types of power plants. But power generation in thermal power plants (TPP), hydro power plant (HPP) and nuclear power plants (NPP) is associated with adverse effects on the environment. The problem of the interaction of energy and the environment has taken on new features, extending the influence of the vast territory, most of
the rivers and lakes, the huge volumes of the atmosphere and hydrosphere.

Previously, the impact on the environment TPP was not in first priority, as before to get electricity and heat had a higher priority. Technology of production of electrical energy from power plant is connected with a lot of waste heat released into the environment. Today the problem of influence of the nature by power is particularly acute because the pollution of the atmosphere and hydrosphere increases each year.

Figure 1 shows that the energy consumption scale is increasing year by year, as a result the negative impact of energy on the environment increases too. In the terms of energy primarily guided feasibility in terms of economic were costs, but now in the construction and operation of energy the most important issue is their impact on the environment.

Another problem, of TPP is thermal pollution of reservoirs or lakes. Dropping hot water - is a push chain reaction that begins reservoir overgrown with algae, it violates the oxygen balance, which in turn is a threat to the life of all its inhabitants. Thermal power plants with cooling water shed 4 - 7 kJ of heat for 1 kW / h electricity generation. Meanwhile, the Health Standards discharges of warm water with TPP should not raise the temperature higher than 3°C in the summer and 5°C in winter of the reservoir initial temperature.

Spread of harmful emissions from TPP depends on several factors: the terrain, environmental temperature, wind speed, cloud cover, precipitation intensity. Speed deployment and increases the thermal pollution area - are meteorology conditions.

As seen in Figure 2, large proportion of electricity (81.3%) in the world is produced by thermal power plants. Therefore, emissions of this type of power plants to the atmosphere and hydrosphere, provide the greatest amount of anthropogenic contaminants in it.

Thermal pollution of reservoirs or lakes water that cause multiple violations of their state is a one representation of environment danger. Thermal power plants generate energy through turbines, driven by hot steam and exhaust steam is cooled by water. Therefore, from the power plants in the reservoirs or lakes is continuously transferred from the water flow temperature at 8-12°C above the temperature of the water in the reservoir. Large TPP shed till 90m$^3$/s of heated water. For example, according to estimates of German and Swiss scientists, the possibility of rivers of Switzerland and the upper flows of the Rhine on the heating heat relief stations have been exhausted. Hot water at any place of the river should not exceed more than 3°C maximum temperature of the river water, which is assumed to be 28°C. Following these conditions, the power station of Germany, constructed on the Rhine, Inna, Weser and Elbe, is limited by 35 000 MW. Thermal pollution can lead to tragic consequences. Scientists predict changes in the characteristics of the environment in the next 100 - 200 years can cause large changes...
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