

ABSTRACT

dissertation for the degree of Doctor of Philosophy (PhD) specialty
6D072300 - Technical Physics

MAXIMOV VALERIY JUREVICH

THE RESEARCH OF THERMAL PROCESSES AND AERODYNAMIC CHARACTERISTICS OF COAL HEATING PLANT

Relevance of the topic of the dissertation. In the power system of Kazakhstan for energy use low-grade fuel (coal) with low calorific value and high ash content (over 40%). However, to combustors in industrial boilers currently meet strict environmental requirements. Compliance with these requirements, along with the need to save capital and operating costs complicates research in this direction.

With the development of new energy units using pulverized coal, combustion research processes in order to improve them is extremely difficult. To improve the reliability and quality of the design becomes increasingly **important** to develop methods for the calculation of complex combustion equipment with the aerodynamics of the combustion chamber, ignition and heat transfer mechanisms burn pulverized coal flame.

Currently, the only way to implement a comprehensive study of the combustion of pulverized coal in boiler fireplace industrial plants (TPP, TPS, etc.) are the numerical methods and computational experiment using three-dimensional modeling techniques and the involvement of modern computer equipment computer equipment and software package. Only when using a computer 3D- modeling takes into account the largest number of events and factors affecting the flow of real processes. In addition, this research technique provides high accuracy in predicting the behavior of these factors in the calculations.

The aim of the dissertation - a study of physical and technological processes in the combustion chambers of the real power facility (CHP RK) by burning pulverized coal in it.

The object of study in the thesis were the physical processes of burning energy consumption (low-grade coal from Kazakhstan) in the combustion chamber of BKZ 75-39FB Shakhtinskaya TPP.

The subject of the study - high-temperature turbulent reacting flows resulting from the combustion of pulverized coal, aerodynamic, thermal and concentration characteristics of the combustion chamber of the boiler BKZ 75-39FB Shakhtinskaya CHP.

The results of their research and scientific innovation

Scientific novelty conducted in the thesis research is to develop new methods of calculation is to obtain a full description of the complex processes of heat and mass transfer and the formation of harmful gaseous and particulate emissions from combustion of energy fuels in the combustion chambers of existing power facilities, using modern numerical methods and techniques 3D-modeling.

First time developed a geometric, physical, chemical and mathematical model of heat and mass transfer in heterogeneous coal-fired turbulent flows with and without the effect of gravity on the solid particles of coal dust in the process of combustion in the combustion chamber of the power boiler. In developing the above models were used initial and boundary conditions that reflect the actual physical and technological processes in the combustion chamber of the boiler BKZ 75-39FB Shakhtinskaya TPP.

To carry out numerical experiments for the first time used in modern numerical methods for solving the system of equations describing the process of burning pulverized coal mixture, taking into account gravity, turbulence model, the nonlinear nature of the distribution of radiative and convective heat transfer, multiphase environment, as well as the kinetics and multistage chemical reactions.

First carried out the computational experiments, the result will be the aerodynamic pattern investigated the combustion chamber of the boiler BKZ 75 -39FB Shakhtinskaya TPP built temperature and concentration fields, the fields of pressure, velocity and turbulence characteristics in the whole volume of the combustion chamber , and a comparison with experimental data and results of the analytical calculation .

New results on the development of modern methods of theoretical, mathematical and 3D-computer modeling to study the turbulent heat and mass transfer processes taking into account the effect of gravity on the solid particles of coal dust in the process of combustion in the combustion chamber.

Conducted in the thesis research are new and original, and the results contribute to the theory and practice of turbulent combustion, and the addition of computational experiments in 3D-modeling of complex processes.

The practical importance of the dissertation

The results of the dissertation research are of great **practical importance**:

1. The studies make an important contribution to the study of the formation of harmful dust and gas emissions, which is an important component in the development of highly efficient and environmentally friendly technology for solid fuel burning power plants.

2. The developed method of three-dimensional modeling of heat and mass transfer of two-phase reacting flows by burning fuel energy can be used to determine the effects of both operating and design parameters of combustion chambers of industrial boilers, and the organization of the fuel and oxidizer to the processes of its ignition and combustion.

3. Used in the thesis of physico- chemical and mathematical models can be applied to the study of the combustion of various types of coal, with an inhomogeneous distribution of the coal particles in diameter (fineness), under different conditions of ignition and combustion stability, as well as working out various design and layout decisions flue cameras TPP Boilers .

4. A technique investigations of combustion of energy fuels and the formation of harmful gaseous and particulate emissions, proposed methods of three-dimensional modeling and developed a corresponding concept of computer simulation to improve the efficiency of power plants and reduce the emission of harmful substances into the atmosphere.

Testing of the dissertation: Proceedings of the thesis presented at the following international and national conferences:

The Republican contest for the best scientific work of students in the natural sciences, engineering and the humanities' Fund of the First President "(Almaty, 2009) - **first degree and medal**;

II Всероссийская научно-практическая конференция с международным участием (Самара, 2010);

Международная конференция «Энергетика в глобальном мире» (Красноярск, 2010);

7 Международная конференция «Современные достижения физики и фундаментальное физическое образование» (Алматы, 2011);

Международная научно-практическая конференция «Техника и технологии: пути инновационного развития» (Курск, 2011);

I-ая Международная научно-практическая конференция «Достижения и перспективы естественных и технических наук» (Ставрополь, 2012);

V международная научно-практическая конференция «Теория и практика современной науки» (Москва, 2012);

VII Международная научно-практическая конференция студентов, аспирантов и молодых ученых (Кемерово 2012),

8 Школа-семинар молодых ученых Академика РАН В.Е. Алемасова «Проблемы теплообмена и гидродинамики»;

18 Всероссийская научная конференция студентов-физиков и молодых ученых ВНКСФ-18 (Екатеринбург, 2012);

14 Минский Международный форум по тепло - и массообмену (Минск, 2012);

Международная научно-практическая конференция «Современная наука: тенденции развития» (Новосибирск, 2012);

Международная научно-практическая конференция «Физико-математические науки и информационные технологии: актуальные проблемы» (Новосибирск, 2012);

V Международная научная конференция «Инновации в технологиях и образовании» (Белово, 2012);

18 Международная научная конференция «Современная техника и технологии» (СТТ-2012, Томск);

20th International Congress of Chemical and Process Engineering CHISA – 2012 (Praha, Czech Republic, 2012);

Международный симпозиум «Экология и безопасность» (Болгария, 2012);

2nd International Conference on Mechanical, Production and automobile Engineering (ICMPAE-2012, Singapore);

6th International Conference on Advanced Computational Engineering and Experimenting ACE-X-2012 (Istanbul, Turkey, 2012);

International Conference on Applied Mathematics and Computational Methods in Engineering (Греция, 2013);

11th International Conference on Heat Transfer, Thermal Engineering and Environment HTE '13 (Греция, 2013);

15th International Heat Transfer Conference (Япония, 2013); 4th International Academic Research Conference on Business, Education, Nature and Technology (США, 2013);

IV International Conference “Science and Education” (Германия, 2013).

The results of the thesis “The research of thermal processes and aerodynamic characteristics of coal heating plant” introduced at Shakhtinskaya TPP (Shaktinsk, Kazakhstan), the **Act of the introduction** № 16-0913 of 16 September 2013 and at Gusinozerskaya TPP (Gusinozersk, Buryatia), the **Act of the introduction** № 11-0767 of 11 July 2013.