

ANNOTATION

thesis for the degree of Doctor of Philosophy (PhD) in the direction 6D071700 - "Heat power engineering", 6D071800 - "Power engineering", 6D071900 - "Radio engineering, electronics and telecommunications",

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INVESTIGATION OF ENVIRONMENTAL PROBLEMS OF HEAT-POWER ENGINEERING

(on an example of thermal power station of Almaty)

The urgency of the problem. Scientific and technological progress, intensification and mechanization of all branches of the national economy, an increase in production and unit capacity of aggregates are closely related to the problem of environmental pollution.

The exponential growth of electricity consumption, which is the basis for the production and development of society, causes the intensive growth of energy complexes and, consequently, their impact on the environment. The main sources of pollution are power plants operating on fossil fuels, the share of emissions is about 29%, metallurgical enterprises - 34.5%, petrochemical enterprises - 15.5%, motor transport - 13%, construction materials industry - 8.1%.

An analysis of the development of industrial production at the present stage shows that doubling production every 35 years requires an increase in the output of electricity over the same period by 7-10 times. Therefore, among all sources of pollution, the issues of the effect of thermal power stations on the state of the environment are becoming increasingly relevant. Global consequences can have chemical and thermal pollution of the air basin of the planet.

In the message of Nursultan Nazarbayev. 10 global challenges of the 21st century were noted, including 2 calls (fifth and sixth) directly related to the issues addressed in this paper.

- global energy security. All developed countries increase investments in alternative and "green" energy technologies. By 2050, their use will generate up to 50% of all energy consumed. Obviously, the era of the hydrocarbon economy is gradually approaching its end. There is a new era in which human life activity will be based not only and not so much on oil and gas as on renewable energy sources. Kazakhstan is one of the key elements of global energy security. Our country, which has large reserves of world-class oil and gas, will not step back from its policy of reliable strategic partnership and mutually beneficial international cooperation in the energy sphere.

- the exhaustibility of natural resources. In the conditions of limited, exhaustible natural resources of the Earth, the unprecedented growth of consumption in the history of mankind will warm up variously directed both negative and positive processes. Our country has a number of advantages. The

Almighty gave us many natural riches. Other countries and peoples will need our resources. It is fundamentally important for us to rethink our attitude to our natural riches. We must learn how to properly manage them, accumulating revenues from their sale in the treasury, and most importantly - as effectively as possible to transform the natural wealth of our country into sustainable economic growth.

The protection of the environment from the polluting effects of technological production in our country is carried out within the framework of state policy. In connection with this, the state budget of the country provides for annual allocations for the protection of the environment. At the same time, the costs of environmental protection activities are much higher, since all developed and newly implemented technologies are subject to increased demands from the position of protecting the environment.

The heat power industry belongs to the interbranch energy, that is, it is at the intersection of the development of industries and housing and communal services. A complex, multifunctional infrastructure is its difference. The thermal power industry is represented by enterprises that produce thermal and electric energy (TPPs, boiler houses, etc.), as well as energy consumers whose interaction is provided by the functioning of thermal and electric networks.

In this regard, the positive trend in the development of the heat and power industry directly influences the level of energy supply to enterprises of all sectors of the national economy, as well as the quality and comfortable living conditions of the population of the Republic.

Currently, environmental issues are placed at the forefront of all human values. The successful solution of these issues determines the health and well-being of the present and future generations of people, as well as the development and existence of humanity itself. Already today, the pace and scale of anthropogenic impact are increasing, leading to irreversible processes in nature, such as environmental disasters.

One of the major factors affecting the environment is the presence of nitrogen oxides in gaseous emissions of technological production and vehicles. The formation of nitrogen oxides is caused not only by the high content of nitrogen in the air, but also by the presence of nitrogen in the chemical composition of the fuel burnt.

Regime-technological methods are the most common ways to reduce emissions of nitrogen oxides. However, it is necessary to take into account the need to further improve these methods, which would provide regulatory requirements for NO_x emissions without significant loss of efficiency and reliability of boiler plants.

The processes associated with the formation of toxic ingredients in the combustion of fossil fuels, the conditions of formation and methods for controlling pollution have a common basis for both energy, industry and transport.

The urgency of the work is related to the necessity of scientific justification of the parameters of the microwave technology - the impact on coal, first of all, in the drying processes, thermal preparation, combustion intensification, etc. One way

to reduce the formation of nitrogen oxides can be microwave treatment of the fuel before burning.

However, according to the forecasts for the future coal, for a long time will retain the leading positions in the market of fuel resources for the production of heat and electricity, which makes it necessary to improve and modernize the coal preparation processes for incineration. This primarily relates to the process of drying coal, the purpose of which is to increase the efficiency of heat, power plants and reduce the amount of harmful emissions into the atmosphere.

As shown by experiments, the use of microwave radiation can reduce the emission of harmful substances during coal combustion, improve energy efficiency, reduce the technological time, etc. To find the optimal modes of microwave processing, it is very demanded to search for theoretical approaches. In particular, engineering practice requires analytical solutions for heat treatment of coal massifs, which was done in this work.

In the thesis the basic laws of the formation of toxic substances in the combustion of fossil fuels are analyzed and methods for reducing the concentration of polluting ingredients contained in flue gases.

The purpose of the work is:

- Investigation of the level of nitrogen oxide emissions in the atmosphere with microwave exposure to combustible fuels;
- Investigation of the influence of microwave influence on the solid fuel structure and on emissions of harmful substances during its combustion;
- Comparison of traditional methods of drying and microwave influence on Ekibastuz and Karaganda coals;
- Development of a mathematical model for the efficiency of microwave radiation - effects on fuel to reduce emissions into the atmosphere;
- Development of a device for drying Kazakhstani coals based on microwave radiation.

To achieve the goal, the following tasks will be accomplished:

- analysis of harmful factors in the fuel and energy complex in the pre-production, production and post-production cycles;
- analysis of methods to reduce harmful emissions of heat-engineering production;
 - conducting experimental studies of the effect of microwave treatment of coal (drying) on the concentration of harmful substances in the waste gases;
 - numerical simulation of the effect of microwave treatment on the concentration of harmful substances in the waste gases of boiler plants;
 - analysis of the system for assessing the ecological state of the OS in the area of TPP dislocation;
 - determination of the main criteria for compiling a mathematical model for the efficiency of microwave radiation for fuel to reduce emissions into the atmosphere;

The scientific novelty of research results is that for the first time:

- Investigation of the effect of microwave treatment on the structure of coals of the Karaganda and Ekibastuz deposits;

- numerical simulation of fuel combustion based on the results of the study.
- developed a mathematical model of the efficiency of microwave radiation
- effects on fuel to reduce emissions into the atmosphere;
- a scheme for drying coal using microwave was developed.

Scientific significance of the thesis

Substantiation of recommendations on the choice of operating mode of boiler equipment in order to reduce emissions of nitrogen oxides into the atmosphere.

Reliability of the obtained research results.

The reliability of the results obtained is ensured by the use of modern research methods, as well as by comparison with the results of other authors. To obtain experimental data, modern means of control and processing were used.

Practical value of the work. The research is provided by application of widely approved software products, satisfactory coincidence of calculated and experimental data, use of modern methods of processing and generalization of experimental data.

Provisions to be protected:

- results of experimental studies of the effect of microwave treatment of coal (drying) on the concentration of harmful substances in off-gases and on the composition of coal;
- results of numerical simulation of the influence of microwave treatment on the concentration of harmful substances in the waste gases of boiler plants;
- A mathematical model of the efficiency of microwave radiation - the effect on fuel for reducing emissions into the atmosphere;
- A scheme for drying coal with the use of microwave was developed, allowing more efficient preparation of coal for combustion in boiler plants.

Theoretical bases of research. The methodological basis of the work is a systematic approach to the study of the problems of interaction between fuel and energy complex and nature. The theoretical basis was the scientific works of Russian and foreign scientists in the field of heat power engineering.

The method of investigation is theoretical-statistical and experimental-research.

In the course of the dissertation, the following results were obtained: analytical dependences of the oxygen content, the temperature of the layer, the yield of nitrogen oxides, depending on the heat capacity of the aggregates, were determined; the influence of microwave fuel processing on the temperature of the outgoing gases and the efficiency of the operation of the boiler has been established, nomograms have been compiled for determining the characteristics of the combustion mode for microwave fuel processing.

The object of research of the thesis is the economic relations formed as a result of the impact of heat and power production and transport facilities on the environment and state intervention in the regulation of this impact.

Application area. The received results can be used at carrying out of regime-technological measures on steam boilers on increase of their ecological

purity, reliability and profitability of boilers, and also for creation of regime maps of works of boilers.

The main results of the work are reflected in the following publications:

The materials of the thesis are discussed and reported at the international scientific and technical conferences: VIII International School - a seminar of young scientists and specialists. "Energy Saving - Theory and Practice." Moscow 2016; V International Farabi readings. Materials of the international scientific conference of students and young scientists "Farabi Alemi". Almaty 2018; Radioelectronics, electrical engineering and energy. The twenty - second international scientific and technical conference of students and PhD students. Moscow 2016.

Publications on the thesis work. The main scientific results of the doctoral dissertation were published in 7 articles, including 1 scientific article included in the «Tomson» Reuters information database in the journal «Energy» in England, 3 scientific articles in periodicals recommended by the Committee for Control in Education and science MES RK, 3 articles in the materials of international scientific and technical conferences and is confirmed by the act of implementation.

Volume and structure. The thesis contains content, normative references, list of abbreviations, introduction, 5 sections, conclusion, list of references and annexes. The volume of the thesis is 130 pages of computer set, 13 tables, 39 pictures.

In conclusion, I would like to note that an analysis of environmental problems in Almaty has been carried out. It is shown that heat-and-power production, in particular CHP plants, has a significant impact on the ecological situation of the city. Based on this problem, the methods used for drying fuel are analyzed.