

ABSTRACT OF A THESIS

Ph.D. thesis on the specialty 6D070200 - "Automation and Control"

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AUTOMATED SYSTEM OF GAS CLEANING USING POROUS PERMABLE SHS MATERIALS

Relevance of the research. The total installed capacity of all power plants in Kazakhstan is 20,000 MW, and the actual installed capacity is 15,000 MW. Kazakhstan produces 91.9 billion kWh of electric power per year (2013 versus 1,045 billion kWh for Russia, 4058 billion kWh for the US, 5320 billion kWh for China), that is, the electric capacity of the Republic of Kazakhstan 4 , 0 MW * hour / person in a year against 6.7 in Russia, 14 in the US, 3.5 in the PRC. 88% of power plants account for TPPs, and 72% of electricity in the RK are generated by 37 TPPs operating on the coals of Ekibastuz, Maikubin, Turgai and Karaganda basins. Coal energy provides basic pollution of the environment. This is facilitated by low standards for emissions of harmful substances into the atmosphere. So the requirements of technical regulations of December 14, 2007 No. 1232 to emissions into the environment significantly exceed the analogous norms of the European Union.

So for hard particles, mg / m³ at $\alpha = 1.4$ the EU norms are 20-100, PK 670 - 870; by SO₂ mg / m³ at $\alpha = 1.4$ EC 200-400; RK - 2000. The signing by Kazakhstan of the Paris climate agreements providing for the introduction of a "carbon" tax for atmospheric pollution significantly aggravates the situation. According to Russian experts' estimates for the pulverized coal industry of the Russian Federation, the "carbon" tax reaches 100 billion rubles annually. Such huge amounts are prohibitive for both the Russian energy sector and the RK. US President D. Trump left the Paris agreement, which in his opinion will negatively affect the US economy.

Meanwhile, the development of Kazakhstan's energy industry is inextricably linked with pulverized coal production. It was speaking about by the President of the Republic of Kazakhstan N.A. Nazarbayev in the Message of 2014 and Minister of Energy of Kazakhstan K. Bozumbayev at EXPO-2017.

In these conditions, the development of new environmental technologies that reduce the harmful impact of TPP on the environment becomes particularly relevant. It is economically unprofitable to radically solve this problem with the available technologies according existing developments, new innovative ideas related to the use of new materials and full automation of the entire technological process are needed.

The peculiarity of gas collection with SHS-filters is that the flue gases contaminated with fly ash getting into the SV filters quickly clog them and the efficiency of operation sharply decreases. Therefore, a two-stage purification

scheme was adopted. First, in machines with variable geometry and the use of IRO (intensive irrigation regime), we get rid of the fly ash (solid particles), and then after additional heating the gases enter the gas trap. This scheme is effective and provides the required degree of purification from fly ash and then - from harmful gases.

The idea of the research is to link the work of the ash collecting and gas cleaning equipment with the operation mode of each boiler and the characteristics of the burned coals through the use of new structures with variable geometry and process automation.

The use of hydrocyclones and tube-coagulator Venturi structures with variable geometry allows to change and optimize the flow hydrodynamics, to coordinate the results of the equipment operation - the ash removal rate with the boiler operation mode, constant monitoring, ash concentration at the output from the units and achieving by automated change of the geometry of the results meeting the regulatory requirements. The same applies to gas cleaning systems, when using gas catchers on modern SHS-composite materials and automated regulation of the flow around the filters, controlling the percentage of gas trapping at the outlet; it is possible to achieve regulatory requirements. The proposed new constructions have patent purity.

The issues under consideration are very complex theoretically, but they are of great practical importance, providing significant energy efficiency. Energy efficiency issues are given considerable attention in President Nazarbayev's speech and in government documents:

- Law of the Republic of Kazakhstan "On Energy Saving and Energy Efficiency Improvement" (with amendments and additions as dated September 29, 2014);

- Resolution of the Government of the Republic of Kazakhstan dated August 29, 2013. № 904 "On approval of the program "Energy Saving - 2020";

- Decree of the President of the Republic of Kazakhstan dated 06.04.2007. №310 "On further measures to implement the development strategy of Kazakhstan until 2030";

- Government Decision №1002 and 1003 dated 29.06.2009. "On Making Addenda to Some Legislative Acts of the Republic of Kazakhstan on Energy Saving";

- Message of the President of the Republic of Kazakhstan to the people of Kazakhstan 02.02.2010. "New decade - a new economic growth - new opportunities for Kazakhstan";

- Decree of the President of the Republic of Kazakhstan dated 19.03.2010. № 958 "On the approval of the program for the accelerated industrial and innovative development of the Republic of Kazakhstan for 2010 - 2014";

- Decree of the President of the Republic of Kazakhstan of 30.05.2013. №577 "Concept on the transition of the Republic of Kazakhstan to the" green economy ";

- Resolution of the Government of the Republic of Kazakhstan dated 28.06.2014. № 724 "On approval of the Concept of the fuel and energy complex of the Republic of Kazakhstan development until 2030".

Especially important is the economic effectiveness of the nature protection measures proposed in the thesis caused by the modernization of existing extremely expensive equipment that provides significant efficiency (up to 700%). Thus, the proposed research is relevant and in demand.

Purpose of the research. Provide normative indicators for emissions of fly ash and gases through full automation of the technological process and application of new constructions of devices with variable internal geometry.

The object of the research is the dust and gas collection systems for pulverized coal-fired power plants and boiler houses.

The subject of the research is automation of technological processes of dust and gas trapping of boiler houses and thermal power plants.

Objectives of the research. It is necessary to solve the following tasks to achieve this goal:

- 1) Develop a technology for cleaning flue gases from particulate matter (fly ash) by automating the process and using devices with variable geometry;
- 2) Develop a device that provides automated cleaning of flue gases with the help of SHS filters;
- 3) Develop ACS gas cleaning technology with the use of SHS-filters, which provide normative indicators of emissions of harmful substances.

Methods of the research. The research methodology is based on a systematic approach to the substantiation of a set of theoretical and experimental results obtained by methods of mathematical and statistical analysis, mathematical and physical modeling. Experimental researches are carried out using modern electrical and electronic devices.

Scientific position and results for the defense

- 1) The proposed ACS and a new method of ash collecting on the basis of a device with variable geometry, intensive irrigation regime and automation of the process;
- 2) It has been developed a device implemented this method of ash collecting;
- 3) A new method for gas purification of flue gases from TPPs using SHS catalysts is proposed, which makes it possible to increase the gas purification degree to regulatory requirements;
- 4) It has been developed the automated control system and the automated device realizing a method of gas cleaning using SHS-catalysts.

Scientific novelty of the work

- 1) Mathematical models of flow in devices with variable geometry (tube-coagulator Venturi, hydrocyclones, etc.) and in structures with automatically controlled SHS filters for gas purification have been developed;
- 2) New constructions of apparatuses with variable geometry proposed for patent purity are proposed;
- 3) A new method for multistage purification of gases is proposed;

4) The system of automatic regulation of hydrocyclone parameters, tube-coagulator Venturi and SHS filters have been developed;

5) The complex software that implements the proposed models and algorithms for the optimal control of the dust and gas trapping system with the use of SHS filters has been developed.

The validity and reliability of the scientific propositions, conclusions and recommendations formulated in the work are based on the integrated use of modern theoretical, experimental research methods and general approaches to the modeling of complex systems, taking into account the existing uncertainties affecting the operation of the dust-gas collection control system. Comparability of the results of theoretical studies, modeling results and experimental results is quite high, which makes it possible to consider the results of the thesis as sufficiently substantiated and reliable.

Practical value of the work. The use of devices with adjustable geometry allows you to change and optimize the flow hydrodynamics, to coordinate the results of the equipment operation - the ash removal percentage with the boiler operation mode, the constant monitoring (control) of the ash concentration at the output from the units and achieving by automated modification of the geometry of the results corresponding to the standards.

The same applies to gas cleaning systems, when using gas catchers on modern SHS-composite materials and automated regulation of the flow around the filters, controlling the percentage of gas trapping at the outlet, it is possible to achieve regulatory requirements. The proposed methods and new constructions have patent purity.

Realization of the results of the research. The main scientific and practical results of the thesis are accepted for the introduction of the LLP "Iron-Technics", the Kazakh-French enterprise LLP "Laboratory of alternative energy", LLP "TECHNO-VOSTOK", some results are used in the educational process of D. Serikbayev EKSTU. Acts of implementation are given in the Appendix.

Dissertational work was reported at the Academic Council of JSC the academician Sh.Ch. Chokin "KazSRIEnergetics". A positive review of the relevance and prospects of implementing the results has been received. Excerpt from the minutes is given in the appendix.

Relationship with the government programs. The subject of the research is based on the priority areas identified in the Decree of the Government of the Republic of Kazakhstan No. 1232 dated December 14, 2007. All newly introduced and existing boilers of TPP from 01/01/2013 should have lower emissions of pollutants into the atmosphere.

The scientific researches presented in the thesis were carried out within the framework of grant financing of the Ministry of Education and Science of the Republic of Kazakhstan on the theme "Development of a new automated technology of hydrosoldering at typical TPPs and mining enterprises of Kazakhstan using hydrocyclones with controlled geometry", where the dissertator was the executor.

Approbation of the research. The main results of the thesis are reported and discussed at: International Conference "Proceedings of the International Symposium Reliability and quality ». Russia, Penza, 2015; International scientific and technical conference "Materials of II ISTC" Creativity of young people - innovative development of Kazakhstan "; EKSTU, Ust-Kamenogorsk, April 14-15, 2016 »; International scientific and practical conference "13th international scientific technical conference on actual problems of electronic instrument engineering (apeie - 2016)"; "11th International Forum on Strategic Technologies IFOST-2016. NSTU, Russia, Novosibirsk "; International Conference "Modern Trends in Training Technical Staff and Teaching English in the Conditions of Industrial and Innovative Development of the Republic of Kazakhstan" and the 13th International Conference of KazTEA "25th Anniversary of Independent Kazakhstan: Towards New Achievements with the English Language". June 16-18, 2016. Ust-Kamenogorsk.

Publications. 15 scientific works were published on the topic of the thesis, including 1 article in the conference indexed in the Thomson Reuters database, 1 article in the journal indexed in the Scopus database, 1 article in the conference indexed in the Scopus database, 5 papers in the journals recommended by the Committee on control in the sphere of education and science of the Ministry of Education and Science of the Republic of Kazakhstan, 1 monograph, 2 patents, 5 works in collections of international conferences.

Structure and scope of the dissertation. The thesis consists of an introduction, 4 sections, conclusion, a list of references 73 titles, outlined on 126 pages of computer text, includes 60 figures, 6 tables and 6 applications.